TROPMET-2018

National Symposium
on

Understanding Weather and Climate Variability : Research for Society

ABSTRACTS

24 to 27 October, 2018

Organised by
INDIAN METEOROLOGICAL SOCIETY

Editors
D. R. Pattanaik
A. K. Sahai
S. K. Dash

TROPMET 2018

Understanding Weather and Climate Variability : Research for Society

24-27 October, 2018
BHU, Varanasi

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TROPMET 2018

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FROM EDITORS' DESK

As you know this year the Indian Meteorological Society (IMS) is organizing its national conference (TROPMET series) on**"Understanding Weather and Climate Variability: Research for Society" during 24 to 27 October, 2018 in Banaras Hindu University, Varanasi, Uttar Pradesh.** Considering the importance of Research and Development in providing better weather and climate forecasting services to the user communities, the theme of this year TROPMET was chosen with focus on understanding weather and climate variability: research for society. With improvement in observational tools, improvement in assimilations of data in numerical models, improvement in numerical model with availability of high computing system etc., both the Research communities and Operational weather & climate forecasters have shown significant improvement in quality of the research as well as its use in operational weather& climate forecasting.

We are very happy to report that TROPMET-2018 has received overwhelming response from government department, academic and research institutes, universities, industry and civil society. More than 500 contributory papers have been received for presentation, which are accommodated both in ORAL and POSTER presentations in 27 technical sessions in the areas of seven broad themes in three parallel sessions. Some of these contributory papers are converted into Lead Talk with other separate experts are also invited for remaining Lead Talks. In addition, there will be 12 Invited talks by distinguished senior scientists and domain experts in 4 Plenary Sessions. **We are very happy to bring out this ABSTRACTs book containing these contributions.**

Further, to encourage young research students carrying out PhD in different universities in the field of Atmospheric Sciences, we are arranging a special Pre-PhD session for presentation of their PhD results. We are very happy to note that 56 students have registered for the Pre-PhD presentation.

We are very much thankful to all the researchers who have submitted their research paper for presentation in TROPMET-2018. Thanks are also due to the distinguished experts for sparing valuable time and accepting our invitation to deliver the talks during this symposium.

Thanking you all.

D R Pattanaik
A K Sahai
S K Dash

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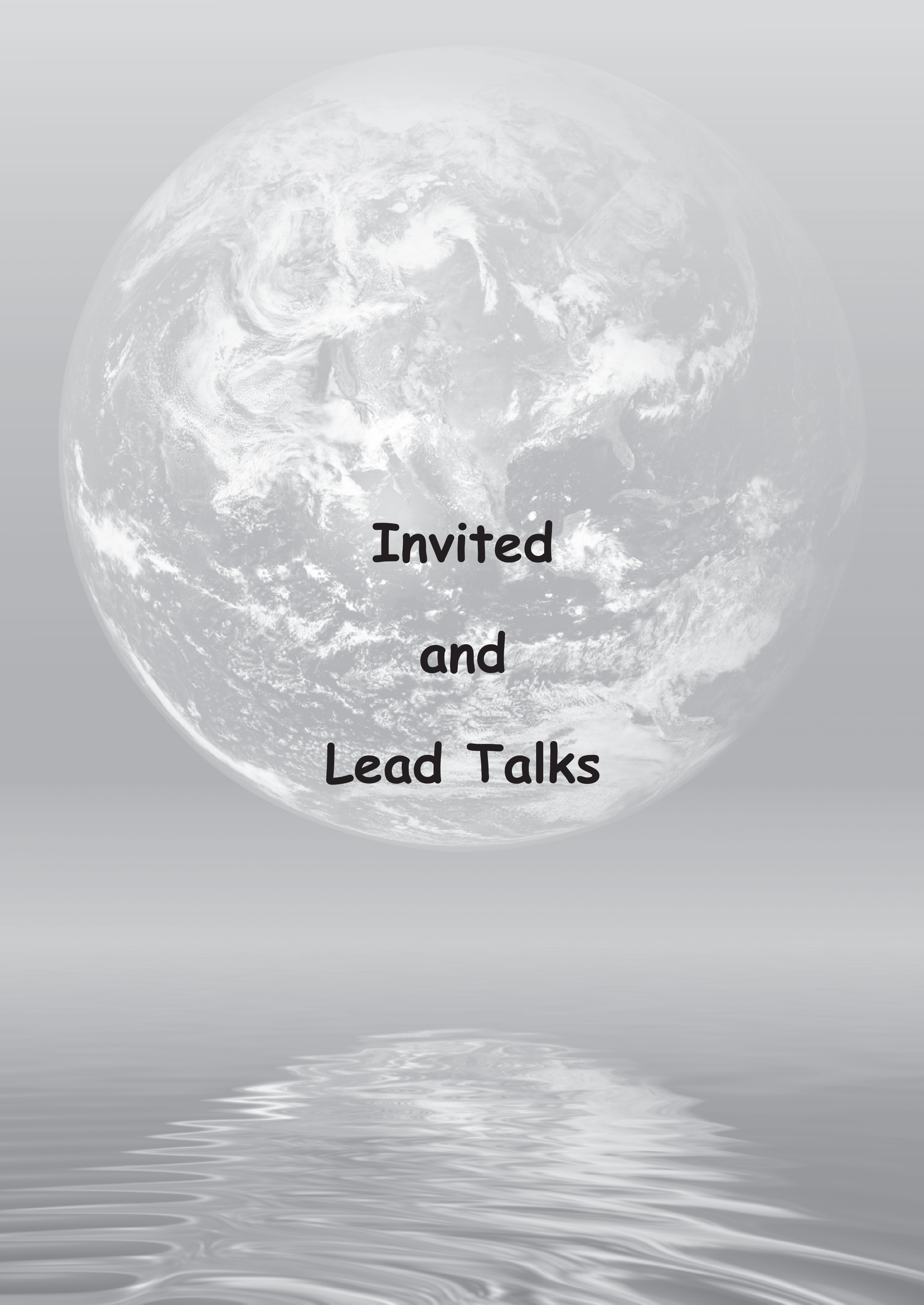

Invited and Lead Talks

"Requirements of Climate Services for Water Sector in India"

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ABSTRACT

India, like many other countries, is facing difficulties in coping with the increasing effects of hydrometeorological hazards and resulting disasters, such as floods, droughts, coastal erosion etc. Damage due to water related disasters is increasing due toincrease in the number of severe events, wider exposure of the society, heightened vulnerability, and limited capacities or a combination of all factors. The socioeconomic consequences of these water related hazards are often most severely felt at the local level; consequently, climate risk management requires that decisionmaking be based on climate information that can be “downscaled” to a local context.

In the water sector, like in the other sectors, a systematic processto gather and analyse the requirements for climate information needs to be developed, at the national level. The targeted climate services require multidisciplinary and multi-institutional collaboration to assess the climate-related risks across the spectrum of activities within each of the sectors.Key to the water related hazard risk reduction is the establishment of a National Framework for Climate Services(NFCS) at the national level on the lines of the Global Framework for Climate Services (GFCS) establishedby WMO at the global level, to enable society to better manage the risks arising from climate variability and change.

An NFCS would be an institutional mechanism to coordinate, facilitate and strengthen collaboration among national institutions to improve the co-production, tailoring, delivery and use of science-based climate services.NFCS would serve as a national mechanism to bridge the gap between the climate information being developed by meteorologists and service providers on the one hand, and the practical needs of users from various sectors including the water sector. The talk will outline the framework particularly with reference to the water sector.

Integrating multi - Hazard early warning system and impact Assessment tools

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Abstract

Recently, India Meteorological Department (IMD), has taken major steps in improving the weather, climate and hazards warning services capabilities in the country with a focus to minimize the loss of life and property.

With the improvement in observational and forecasting tools including augmentation of NWP Models, Radar network and satellite products, forecasting/warning services in respect of tropical cyclones, severe thunderstorms, now casting, flash/urban floods, urban climate, climate change, heavy rainfall, advisories to farmers, pilgrimage forecast, heat waves/cold wave etc has been further strengthened.

IMD scientists in collaboration with scientists from other institutes of MoES are working strenuously in providing better weather and climate services to all users by further augmenting modeling and observational network.

Climate change research in India retrospect and prospect

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Abstract

Responding to the global concerns for climate change impacts, India practively initiated systematic research after the publication of first and second assessment reports of IPCC. The Department of Science & Technology launched an extra-mural funding programme called Indian Climate Research Programme (ICRP) in 1997. Several multi-disciplinary and multi-institutional field observational programmes were also conducted in the Indian sub-continent region that included Monsoon Trough Boundary Layer Experiment (MONTBLEX) ; Land Surface Process Experiment (LASPEX); Bay of Bengal Monsoon Experiment (BOBMEX), ARMEX (Arabian sea Monsoon EXperiment) and Indian Ocean Experiment (INDOEX). Under Intensive Research in High Priority Areas (IRHPA) programme of DST a Global Climate Modelling Project was supported to develop a general circulation model (GCM) to predict the Climate at seasonal scale. A Centre on Global Change was positioned at National Physical Laboratory (NPL), New Delhi to study the Green House Gas emissions and related activities. The IPCC adopted this Centre's Methane budget estimates for India.

Responding to 4th Assessment Report of IPCC (AR4) brought out in 2007, India released its National Action Plan on Climate Change (NAPCC) in the 2008. The NAPCC contained some major initiatives that included launch of 8 national missions on climate change. DSTwas entrusted with the responsibility of coordinating two out of these eight national missions on climate change. These are: (a) National Mission for Sustaining Himalayan Ecosystem (NMSHE) and (b) National Mission on Strategic Knowledge for Climate Change (NMSKCC). Both these missions were launched with broad objectives of building S&T Capacity for sustenance of Himalayan Ecosystem and for developing strategic knowledge system

The missions implemented by DST made good progress in recent years which included establishment of 11 Centres of Excellence; 23 Major R&D Programme; 7 Human Capacity Building Programmes in CC adaptation and mitigation; 8 Global Technology Watch Groups (GTWGs); State Climate Change Cells in 22 States/Union Territories; 7 National Network programmes in the areas of climate modeling, climate change & human health, aerosols, coastal vulnerability and urban climate; 6 Thematic Task Forces; An Inter-University Consortium of 4 universities on Cryospheric research, an Indo-Swiss bilateral programme on capacity building in glaciology and an Indo-US Fulbright-Kalam Doctoral and Post-Doctoral Fellowship programme in Climate Change.

During past 5 years the DST-sponsored programmes have made a significant impact and resulted in a large number of useful publications in national and international journals. Over 850 research publications have come out of these programmes so far, out of which a large numbers are in international journals of high impact factors. About 60 new techniques have been developed as part of programmesunder two missions. Nearly 1000 scientists, experts and students and 200 institutions in the country have been associated with climate change programme of DST. Nearly 150 PhD and PG students have been enrolled as part of two missions. More than 200 Workshops were organized wherein over 5500 personnel were trained. State CC Centres conducted 250 training programmes wherein over 50000 personnel were trained.

India has over the years built a strong climate change research base in terms of number of quality researchers, long term data and infrastructure. The Climate Change Programme of DST has achieved considerable progress during past 5 years. Plans are afoot to strengthen the programme by building human and institutional capacities, developing greater linkages among the institutions and widening the network of researchers.

Intraseasonal Variability: Structure and Trends

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Abstract

Daily data of rainfall from TRMM has been analysed to understand the complex structure of intraseasonal variability of the Indian Summer Monsoon. It is seen that while the 20-60 day period variations has a predominantly northward mode, 10-20 day variability has a complex structure encompassing north westward propagations and interactions with the mid-latitudes. Further analysis of IMD daily rainfall data shows that the variability in the 20-60 scale is reducing while variability in the synoptic (3-10 days) is increasing. Using model simulations it is shown that increase in extreme rainfall events during break phases is a possible cause for these changes.

Risk Based Warnings for Hydro-meteorological Hazards

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Abstract

Natural Disasters are increasing globally. The overall number of people affected by disasters has been increasing by 6% each year since 1960. Trend is expected to continue primarily because of increased concentration of people and economic assets in the areas exposed to natural hazards and will get aggravated because of climate change.Hydro-meteorological disasters constitute more than 80% of Natural Disasters. Natural Disasters have devastating short and long term impacts on the society and economy of the country.This is particularly true in the case of least and less developed countries. It calls for paradigm shift in disaster management i.e. from Relief and Rehabilitation to Disaster Preparedness and Risk Reduction.

Early Warning is an important component of Disaster Management. Early Warnings have shown significant improvement in recent decades. Over a period of time Weather Forecasting has moved from General Forecasting to impact based weather forecast and now need for Risk based Warning is being felt in many quarters. It is to be noted that Risk based Warning is much more than Weather Warning. It requires understanding and identifying risks by working closely with disaster professionals. Risk based Warning Framework consist of Risk/Vulnerability Analysis, Location specific Thresholds of Disasters, Forecast of Hazard, Risk Assessment and Dissemination of Risk-based Warning. Implementation of Risk based waning will require training of Forecasters about concept of risk and its application to hydro-meteorological events. Creation of data base of location specific hydro-meteorological hazards/disasters and corresponding thresholds of meteorological parameters are necessary for risk assessment and developing risk based warnings. In view of increase in the frequency of flash floods, landslides, local severe storms, it is high time for National Weather Service and Disaster Management Authority to consider developing Risk based Warning Framework for Hydro-meteorological Hazards.

Non-monsoonal precipitation response over the western Himalayas to climate change

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Abstract

Winter-to-early spring non-monsoonal precipitation over the western Himalayas (WH) primarily comes from eastward propagating synoptic-scale weather systems known as western disturbances (WDs). Earlier studies have noted that an increasing trend of synoptic-scale WD activity in the past few decades has contributed to enhanced propensity of daily precipitation extremes over the WH, although it remains unclear as to whether these regional changes are manifestations of climate change. This issue is addressed by conducting a suite of long-term climate experiments using a global variable-grid climate model with high-resolution telescopic zooming over the South Asian region. Our findings highlight that human-induced climate change has implications on the rising trend of synoptic-scale WD activity and precipitation extremes over the WH during the recent few decades, and these changes cannot be explained by natural forcing alone. A stronger surface warming, in response to climate change, is noted over the vast expanse of the high-elevated eastern Tibetan Plateau relative to the western side. The model simulations show that strengthening of positive east-west temperature gradient across the Tibetan Plateau tends to alter the background mean circulation in a manner as to favor amplitude enhancements of the synoptic-scale WDs and orographic precipitation over the WH. With continuation of global warming in future and enhancement in the east-west temperature gradient across the Tibetan highlands, the trend of precipitation extremes over the WH and synoptic-scale WD activity are projected to rise into the 21st century. While the high-resolution simulations of this study offers promising potential to understand changes in synoptic-scale WD activity and precipitation extremes over the WH, further investigations are necessary to decipher the multi-scale behavior and intricacies of the Himalayan precipitation variability under changing climate.

Recent Advances in Modelling and Data Assimilation at NCMRWF

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Abstract

NCMRWF Unified Model (NCUM) is a seamless prediction system is used for medium range numerical weather prediction at NCMRWF. The NCUM global analysis forecast system was upgraded recently with a latest UM (version 10.8), with improvements in model horizontal resolution (12 km), Observation Processing System, Hybrid 4D-Var data assimilation system, Surface data assimilation/preparation system, and in-house developed Observation Pre-Processing System. This upgraded NCUM was made operational in the new HPCS (Mihir) from 1st June 2018. A brief description of this upgraded system and its performance highlights during Monsoon 2018 will be presented.

The Global NCMRWF EPS (NEPS) was recently upgraded to 12 km horizontal resolution with 22 members in the newly acquired Mihir HPC and made operational from 1st June 2018. The resolution (12 km) of the NEPS is the highest among all the operational global operational weather forecast centres in the world.The new 12-km NEPS is expected to be more skillfull, especially in generating more accurate and area specific forecast of extreme weather events like rains, heat wave and cold wave, the track and the intensity of the cyclonic storms due to its very high horizontal resolution. A brief description of this upgraded NEPS and its performance highlights during Monsoon 2018 will also be presented.

Climate Services in India

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and

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Abstract

Under the Global Framework for Climate Services(GFCS) five major components of modern climate services are identified - Climate Monitoring, Climate Data Management, Capacity building programs, Climate Prediction, and Climate Service Application. This framework has to be followed by all nations in developing their climate services by orienting their existing climate services towards the proposed framework and if required by augmenting new services. In order to provide effective climate services, we need availability of climate data, existence of a proper climate monitoring mechanism, appropriate prediction systems and sector-specific product generation.

In India, GFCS is being implemented by the Office of Climate Research and Services, India Meteorological Department (IMD), Pune. IMD has a rich long period data set of surface and upper air observations, starting from 1901 onwards. For climate prediction at seasonal, monthly and extended range scales, the CFSv2 (Climate Forecast System version 2) model from NCEP has been employed at IITM under National Monsoon Mission program. Considering their promising skill, the seasonal and extended range prediction systems developed at IITM have been transferred to IMD for operational purpose. The extended range prediction system (ERPS) provides forecasts of impending weather events for the next 32 days, on every Thursday. The ERPS has reasonable skill in predicting the onset, withdrawal and active/break spells of the southwest monsoon, Madden-Julian Oscillation (MJO), northeast monsoon, heat/cold waves, cyclones and heavy rainfall events.

Based on the seasonal and extended range forecasting systems are strongly used in agricultural, health, hydrological and power sectors. It is expected to advance the climate services by improving prediction accuracy, extending climate service field and by strengthening partnership with global agencies.

Severe Weather Forecasting in India : Issues and Challenges

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Abstract

India experiences several types of severe weather events including cyclones, heavy rainfall, heat wave, cold wave, severe thunder storms, hailstorms and tornadoes. The risk management of these weather related hazards include several steps based on its severity and importance (i) hazard analysis, (ii) vulnerability analysis, (iii) preparedness & planning, (iv) early warning, (v) prevention and mitigation. The early warning component includes (i) skill in monitoring, detection and prediction of severe weather events, (ii) assessment of impact and risk and (iii) effective warning products generation and dissemination, (iv) coordination with emergency response units and (v) awareness and perception of disaster managers and general public about the credibility of the official predictions and warnings for effective response action.

There have been significant improvement in severe weather monitoring, forecasting and warning system in recent years due to various initiatives of Ministry of Earth Sciences and India Meteorological Department (IMD) resulting in significant decrease in loss of lives and properties. However, there are still issues and challenges to be addressed for further improvement to provide impact based forecast and risk based warning at higher spatial and temporal resolution with longer lead period. The specific issues and challenges needing improvement include (i) improvement of monitoring and prediction of mesoscale severe weather hazards like thunderstorm and associated thunder squall, hailstorm and lightning, (ii) improvement in intensity prediction of cyclones, (iii) improvement in sectoral applications of early warning with real time impact and risk assessment, (iv) warning communication to last mile and disaster managers through state of art technology, (v) development of synergized standard operation procedure among the early warning agencies and user agencies and (vi) upgradation and enhancement of the link between IMD and disaster managers. Considering the upgradation of tools and technology including integrated numerical modeling approach of Ministry of Earth Sciences along with continuously upgraded computational power and telecommunication tools, and enhanced collaboration with the academic and research institutes, there is scope to address these issues and challenges and hence to minimize loss of lives and properties through improved early warning services.

Evolution of Meteorological and Oceanographic Observations from Indian Satellite Missions

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Abstract

Since the launch of Bhaskara-1 satellite with a **SA**tellite **MI**crowave **R**adiometer (SAMIR) in 1979 that provided total precipitable water and liquid water over the global oceans, India has launched a number of satellites for oceanographic and meteorological research. Over the last decade, an increasingly large number of satellites are deployed to cater to the growing need of meteorological observations for various applications ranging from agriculture, aviation, tourism, power sector, sports, planning to cyclones and monsoon forecast/research. The various parameters such as wind fields, temperature and humidity profiles, precipitation, sea/land surface temperature, soil moisture, sea surface salinity, snow cover, etc., are presently available in high spatial and temporal resolutions and with improved accuracies. The satellites that are presently providing such measurements are INSAT-3D, INSAT-3DR, SCATSAT-1, Megha-Tropiques, and AltiKA. This paper highlights the evolution of the meteorological and oceanographic observations from the past missions to the present generation satellite missions. This paper discusses various presently available geophysical parameters from different Indian satellite missions, their retrieval methods, limitations, and accuracies. This paper further discusses the future ISRO missions such as INSAT-3DS, GISAT, Oceansat-3, etc., which are to be launched in next few years.

LIDAR sensor development at LASTEC

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Abstract

In recent times there is a growing concern of air pollution which has a serious toxicological impact on human health and environment.Together with the impending threat of toxic chemical agents, it has become very important to measure spatial and temporal distribution of chemicals, aerosols & clouds alongwith their microphysical properties which is a challenging task.Light detection and ranging(LIDAR) which is a laser based active remote sensing technique has immense potential for these applications. Very short laser pulses of known energy and frequency are transmitted into the atmosphere and the backscattered signal is collected and analysed as a function of time. Suitable algorithms are used to retrieve the desired information from the back scattered signal about the vertical profile of the aerosols and clouds alongwith their range information. LIDAR techniques are based primarily on two important interactions namely scattering and absorption of the incident radiation. A single frequency laser (operating at near IR wavelength) is useful for characterization of atmospheric aerosols and clouds while a differential absorption lidar (DIAL) operating in Mid IR wavelength band with tunable wavelength feature is most suitable for standoff detection and identification of toxic chemical agents. Laser science and technology centre, a premier laboratory of Defence Research & Development Organization is actively working on development of different variants of LIDAR sensors for above applications. Prototypes of cloud lidar (ceilometer), aerosol lidar & Mid IR differential absorption lidar(DIAL) have been developed and tested under different weather conditions ranging from cold winter to hot and humid conditions prevailing in Delhi.The cloud lidar and aerosol lidar (both operating at 1064 nm wavelength)were used successfully for measurement of multiple cloud layers & aerosol characterization upto vertical/slant ranges of more than 10 kms. A dedicated horizontal line of sight test range of more than 4 kilometers at TBRL (DRDO), Chandigarh campus was used for elaborate testing of Mid IR DIAL sensor(operating in 3-4 micron wavelength band) with special chemical cloud compositions and DIAL signal was detected upto standoff ranges upto 4 km. Our centre has also developed instrumentation for measurement and characterization of atmospheric turbulence in the ground layer in terms of measurement of refractive index structure parameter C_n^2, which is an important parameter governing optical propagation through atmosphere. This talk will present details about the design and capabilities of lidar sensors and C_n^2 instrumentation developed at LASTEC. The results obtained during several successful test compaigns carried out with the developed sensor systems will also be presented.

Desert Storms & Cloudbursts: A hypothetical linkage

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Abstract

The Desert Storms or the Dust & Sand Storms (locally known as "Aandhi") occur frequently over the Northwest India, Pakistan, and Afghanistan during the premonsoon season. In this season, the lowest atmospheric layers have very high temperature and relatively low moisture content, which makes high bases (of the order of 3–4 km) of the thunderstorms above the ground. The convection currents produced by heated ground having plenty of loose fine dusts enable the severe thunderstorms of northwest India to generate dust storms. The dust storms pump huge amount of aerosols in the atmosphere, and can cause imbalances in the radiative-convective budget of the atmosphere. The dust aerosols may also act as condensation nuclei and facilitate the growth of clouds downstream where sufficient moisture is available. The chain reactions may also induce electrifications of the clouds.

Cloudbursts over the mountains may be affected by the Sand & Dust Storms, becausethe westerly troughs are sometimes amplified over the western parts of India picking up moisture from the Arabian Sea as well as the dust particles from the underlying desert regions through the south-westerly flows. The loading of dusts in the way can act as condensation nuclei and facilitate in the formation of clouds. The elongated troughs reach the mountain and are lifted to greater heights due to the combined effects of orography and convergence of easterly monsoon currents producing strong instability and deep clouds over the mountains leading to the cloudbursts.

There is a need for intensive field observations of the desert storms and extreme weather systems to improve their skills of forecasting through data assimilation, modelling and research. The modelling of dust storms and cloudbursts will be reviewed during the seminar.

Advances in AgrometeorologicalServices for Farmers in India

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Abstract

India Meteorological Department (IMD), Ministry of Earth Sciences (MoES), Indian Council of Agricultural research (ICAR), State Agriculture Universities (SAUs) and other organizations are jointly rendering weather forecast based District level Agrometeorological Advisory Services (AAS) for benefits of farmers in the country under the scheme "Gramin Krishi Mausam Sewa (GKMS). AAS provides advance weather information along with crop specific agromet advisories to the farming community by using state of the art instruments and technology through efficient delivering mechanism of the information which ultimately enables farmers to take appropriate actions at farm level. Weather forecast at 12 Km resolution aggregated at district level with value addition in medium rangeby RMC/MCs is the basis for agrometadvisory generation every Tuesday and Friday. Nowcast information on extreme weather events like cyclone, thunderstorm and hailstorm etc are provided to the farmers in advance through SMS in order to take necessary action.

Extended range forecast are also translated in advisory for outlook for next 15 days and weekly update on every Friday to help the planners and other stakeholders. Use of seasonal climate forecast to help the farmers as proof of concept is also initiated on pilot basis in Tamil nadu &Bihar for monsoon 2018, where fortnightly condition and forecast for rest of the season is provided in the form of advisory to selected group of farmers. Efforts is also made to prepare met subdivision/state level monsoon forecast in experimental mode but there is requirement to have information at district level for better planning and decision making. Climate services is also being strengthened objectively for Irrigation water management and hydrology reservoir management.

In the wake of changing climate leading to more uneven distribution of rainfall and other weather elements spatially and temporally, block level weather based services to farmers is being implemented by IMD and ICAR through establishing Agromet unit at Krishi Vigyan Kendra (KVK) in each district. The various components of GKMS service viz. observing weather, its monitoring and forecast; crop specific advisory bulletin generation; outreach and feedbackare being digitized to help develop an integrated plateform, called automated Agromet Decision Support System. This includes a dynamic framework to link the existing knowledge base on crop weather calendar, contingency action plan etc. to translate weather forecast into actionable farm advisories for efficient farm level decision making. Services are now available to 39 million farmers through mobile SMS. Besides mass media, other modes of communication such as Kisan Call Center and Text To Speech, are being aggressively used to reach upto each and every end user.

Radar Meteorology in India

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Abstract

With one of its main mandates being the collection of atmospheric observations, India Meteorological Department (IMD) started to use RADAR as an operational tool to observe, and study the life cycle of clouds, thunderstorms, cyclones and other amenable weather phenomena that occur in the atmosphere. The initial radars were World War-II surplus, which were followed by indigenously made weather radars manufactured by M/S Bharat Electronics Ltd. (BEL). Radars were primarily used for locating storms and also for tracking weather balloons used for deriving wind from successive positions of balloon-borne target.IMD radar network then comprised of S-band radars were used for cyclone surveillance from the coasts and X band radars, primarily located near airports, for thunderstorm monitoring as well as for wind finding.

As time and technology progressed, a new generation of digital radars with attributes like improved sensitivity, ability to quantify echo intensity and flexibility to store data for future visualization, animation, value addition etc., have evolved. A quantum jump in that direction was the application of well-known Doppler Effect for estimation of mean and spread of particle velocity inside a radar sample-volume. In the early years of 21st century, such digital Doppler radars were inducted into IMD, expanding the domain of their application from mere storm detection to quantitative precipitation estimation, wind estimation specifically associated with severe weather events like cyclones, aviation forecast and air hazard warning, weather nowcasting and providing data for NWP model initialization and prediction verification. Enhancement of radar potential in estimating wind and turbulence parameters in addition to detecting tracking and quantifying intensity of echoes not only added more precision and confidence to the forecasts but also provided means for retrospection. With the advent of radar polarimetry, weather radar products gained new dimensions in hydrometeor classification, improved clutter mitigation, better heavy rain estimation and reasonable attenuation correction. As dual-pol radars became commercially available for operational use IMD procured and installed a few dual-pol radars and further engaged in deploying such radars to cover the entire country.

With IMD's modernization of observational network, a large network of DWRs and a huge amount of radar data is now available. The time is ripe for the advancement of radar meteorology in India. Applications of various DWR products for short term weather predictions, numerical modelling, hydrological modelling and flood forecast, etc. need to be prioritized. Radar products when merged with satellite cloud products will be useful for generating cloud climatology over the Indian region and also for model assimilation. Doppler Weather Radars (DWRs) network throughout the country can provide information on the 3D structure of precipitating systems. High priority needs to be given to the analysis DWR data, its interpretation and modelling.Some of the recent studies based on Doppler Weather radar data are discussed in the paper with emphasis on the recent Chennai Floods in 2015 and utilisation of C band DWR data for Delhi for urban Flooding.

Climate-induced Disasters in Odisha: Effects, Resilience and Future Policy Implications

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Abstract

Layers of hazards, vulnerabilities and risks have made India as one of the most disaster-prone countries. The state of Odisha in India is one of the most disasters prone statein India with cyclones, floods, droughts, heatwaves and lighteningdistressing its population, health and development.This study assesses the impacts of climate-induced disasters and resilience among rural communities in Odisha, India. This study used mainly primary data collected among rural communities in Odisha, India in (April-June) 2017. The findings showed thatflood, cyclone and drought are severely affecting the people of Odisha in various ways along with heatwaves and lightning slowly emerging as major threat in recent years.The impacts of natural disasters are catastrophic on people's life, and particularly on their livelihoods, agriculture, food security, health, and water resources. The impacts of disasters have both physical and psychological consequences. The most vulnerable sections of population were the most severely affected, and selling of livestock, borrowing of food, loans, mortgages and migration were the most common coping mechanisms reported in the study areas. The government's measures/programs likeearly warning system, public distribution system, multipurpose cyclone rehabilitation centre, Seasonal Residential Care Centre,self-help groups were playing a major role in plummeting the effect of disasters among rural communities.The findings suggest focusing on reducing people's underlying vulnerabilities by pro-active measures; engage community in decision making and generating sustainable livelihood options.

Tipping Elements Approach for Forecasting Monsoon in Central India: Results 2016 – 2018

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Abstract

According R. Anantha krishnan and M.K. Soman, 1990, "The onset of monsoon..is not a transition from a regime of no rain to rain; it is a transition from a regime of sporadic rainfall to spatially organized and temporally sustained rainfall…". In this study, we present an evidence from observational data that we can consider the onset of monsoon as a critical transition - a sudden transition when critical thresholds (in particular, in near-surface air temperature, relative humidity) are reached. This finding allows us using the critical transition theory for developing the Tipping elements approach for a prediction of onset and withdrawal dates of the summer monsoon.

This approach is based on a newly discovered feature of Indian summer monsoon wherein two geographic regions in the areas of the Eastern Ghats (EG) and North Pakistan (NP) act as tipping elements, which play a crucial role in the spatial organization of Monsoon. Observations of the near-surface air temperature and relative humidity in these areas allow us forecasting of the monsoon onset and withdrawal dates for 40 and 70 days in advance respectively.

Moreover, the results show that the method used in this study allows predicting the monsoon retrospectively (over the period 1951-2015), as well as for the future. Such,successful predictions for 2016, 2017 and 2018 have validated the accuracy of the study and proved that such early predictions of monsoon timings are possible. Further, what is important to note is that the forecast of monsoon onset date through this study is the earliest, whereas the withdrawal date is the only one available in India.

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Research Opportunities and Projects under the Naval Research Board (NRB)

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Abstract

The Naval Research Board (NRB) was setup by the Defence Research and Development Organisation (DRDO) in 1996 in order to strengthen knowledge base on naval sensors, systems, materials, weapons, platforms, etc., which is essential for naval operations. The purpose of NRB is to encourage research which is relevant to naval environment, the end users being DRDO and Indian Navy. It provides funds through Grants-in-Aid schemes to academic institutions, public and private sector R & D institutions to nurture research talents in the areas that are important for the development of advanced naval systems. At present seven specialist panels are functioning under NRB, namely, 1) Materials 2) Hydrodynamics 3) Sonar and Signal Behaviour 4) Ocean Environment 5) Scientific Computing 6) Marine Systems and 7) Hydro Vibro Acoustics. Each panel consists of head and a few other members who are experts drawn from various academic and research institutions for evaluating new project proposals and to review ongoing projects under the each panel. Normally at least two meetings are conducted in a year by these panels with their respective panel members. All these seven panels are guided by a Chairman, NRB. Member Secretary of NRB is a serving DRDO scientist at DRDO Bhavan, New Delhi. Half-yearly meetings are also held under the chairmanship of NRB, panel heads and DRDO officials to review the progress of projects and sanctioning of high value projects.

So far more than 400 projects were sanctioned by NRB and approximately 75% of them have been completed. The Principal Investigators (PIs) of these projects include IITs, NITs, IISc, Universities, private and Government institutions like CSIR-NIO, NIOT, etc. Prospective PIs who intend to apply for projects under NRB are required first to make a brief two-page proposal and submit it to the user lab of DRDO with a copy to concerned panel head and member secretary of NRB. The user labs of NRB research projects are NSTL, Visakhapatnam, NPOL, Kochi, NMRL, Ambernath and DMRL, Hyderabad. Thrust areas of research and more details can be seen in NRB website http://nrbdrdo.res.in/.

The Ocean Environment Panel (OEP) under NRB provides opportunity to carry out research in several areas related to marine and atmospheric sciences which are pertinent to naval operations and applications. Understanding ocean environment, forecasting ocean and marine boundary layer parameters are of utmost importance to naval operations. Underwater bioluminescences, harmful algal blooms, novel methods of estimation of coastal bathymetry and remote sensing applications for naval warfare are some grey areas where more in depth research is needed.

The structure of NRB, how to apply for projects, thrust areas of research under OEP, expected outcome and deliverables from the projects, documentation and dissemination of results, etc. are covered in this talk.

Indicators and drivers of mass-balance over Karakoram-Himalayan glaciers

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Abstract

The Karakoram-Himalayan (KH) mountain range is one of the world's largest sources of freshwater, as all the perennial rivers originate in Northern India are fed by glacier melting especially during non-monsoon seasons. KH is also called as "water tower of Asia." Glaciers are the key indicators of climate change, the study of glacier dynamics is very crucial for freshwater availability and its overall societal impacts. Several studies showed that glaciers are shrinking significantly over these regions, especially smaller in size and located at lower altitudes, in recent decades. Therefore it is interesting to understand the drivers and indicators of glaciers mass balance (MB) over KH region.To determine the mechanism behind dynamics and variation in glaciers, we have simulated a high-resolution dynamical glacier-climate model (REMOglacier) at 0.220x0.220 over South-Asia for the period 1989-2016. REMOglacier has a unique capability to capture the MB and area change of glaciers. It is found that the model can capture MB reasonably well regarding magnitude and variability. The model shows a contrasting pattern in MB in the first decades of the 21st century with respect to time and space. The model simulates the significant positive MB over the Karakoram that is called "Karakoram anomaly." This study also shows that both snowfall and rainfall are dominant in winter and summer season respectively. Different energy balance parameters have been analyzed to indicate the significant drivers of MB over the region. The analysis suggests a strong interrelationship between parameter including MB.

Real-time operational extended range forecast : Prospects and challenges

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Abstract

The forecasting of southwest monsoon rainfall on extended range time scale is vital for the vast agro-economic country of south Asia including that of India. The extended range forecasting of monsoon in 3 to 4 weeks time scale is very useful for taking tactical decisions in Agriculture, water resource management, health, power and many more sectors. Like the extended range forecast (ERF) of rainfall the ERF of temperature (maximum and minimum temperature) is also very crucial as the countries over south Asia are vulnerable to extreme high and extreme cold temperatures. During summer of 2015 (late May to early June) eastern coastal states, central and north-western parts of India experienced severe heat wave conditions with more than 2400 deaths in India. The heat wave related deaths have increased by many folds in recent times. It is not only the loss of human life but also the animals and birds were very vulnerable to this extreme heat wave conditions. Similarly during the year 2017 the month of February witnessed large scale warming over north and central parts of India with warming anomaly exceeding more than 5^0C during the few weeks of February, 2017 (14 February- 28 February). Forecasting of such extreme events in real time can have vast applications in various sectors.

The capability of numerical models in capturing MJO signal (which is the dominant mode of tropical intra-seasonal variability) is very crucial in capturing the active/break cycle of monsoon. Now the growing demand for the country like India is to have a better forecast of monsoon on extended range time scale. The India Meteorological Department (IMD) has been issuing the operational extended range forecast since 2009 by using outputs from various statistical, dynamical models along with its Multi-model ensemble (MME) with varied success. The real time forecasts during these past 7 to 8 years (2009 to 2016) have demonstrated useful skill in extended range forecasting of different phases of southwest monsoon viz., onset, active/break and withdrawal phase of monsoon.

During 2016 IMD has implemented a coupled modeling system for real time extended range forecast. This suite of models at different resolutions with atmospheric and oceanic Initial conditions obtained from NCMRWF and INCOIS assimilation system respectively are (i) CFSv2 at T382 (≈ 38 km) (ii) CFSv2 at T126 (≈ 100 km) (iii) GFSbc (bias corrected SST from CFSv2) at T382 and (iv) GFSbc at T126. The Multi-model ensemble (MME) out of the above 4 suite of models are run operationally for 32 days based on every Wednesday initial condition with 16 ensemble members. The same suites of model are also run on hindcast mode for 14 years (2003-2016). The forecast products are prepared for 4 weeks on every Thursday for operational use.

The real time ERF of rainfall and temperature during 2017 monsoon season and hot/cold weather seasons are discussed. The potential application of these products in Agriculture, Power, Water Resource and Health sectors are also discussed.

Trends and tele-connections of monsoons over South and East Asia: A review

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Theme:Observations in Climate Variability and Changes.

Abstract

The connections between South and East Asian Summer Monsoons have been a topic of research since decades. Several studies by the Chinese and the Indian scientists have documented that the summer monsoon rainfall over the Indian region is directly related with summer monsoon rainfall over North China but inversely related with monsoon over the Korean peninsula and the surroundings. While one school of thought suggests the impact of the Indian Monsoon on the East Asian Monsoon another view suggests the opposite. Furthermore the summer monsoon rainfall over India and over North China has been indicating a decreasing trend and that over the Korean peninsula an increasing trend. The possible roles of the Indian Ocean, the Pacific Ocean, the El Nino Southern Oscillation phenomenon, the Indian Ocean Dipole Mode, the West Pacific Subtropical High and the South Asian High to understand in these observed climate trends and tele-connections will be presented at the TROPMET2018.

Did OCKHI cyclone cheat the weather forecasters or severe weather alertswere overlooked ? Performance evaluation of a regional NWP model COSMO – A case study

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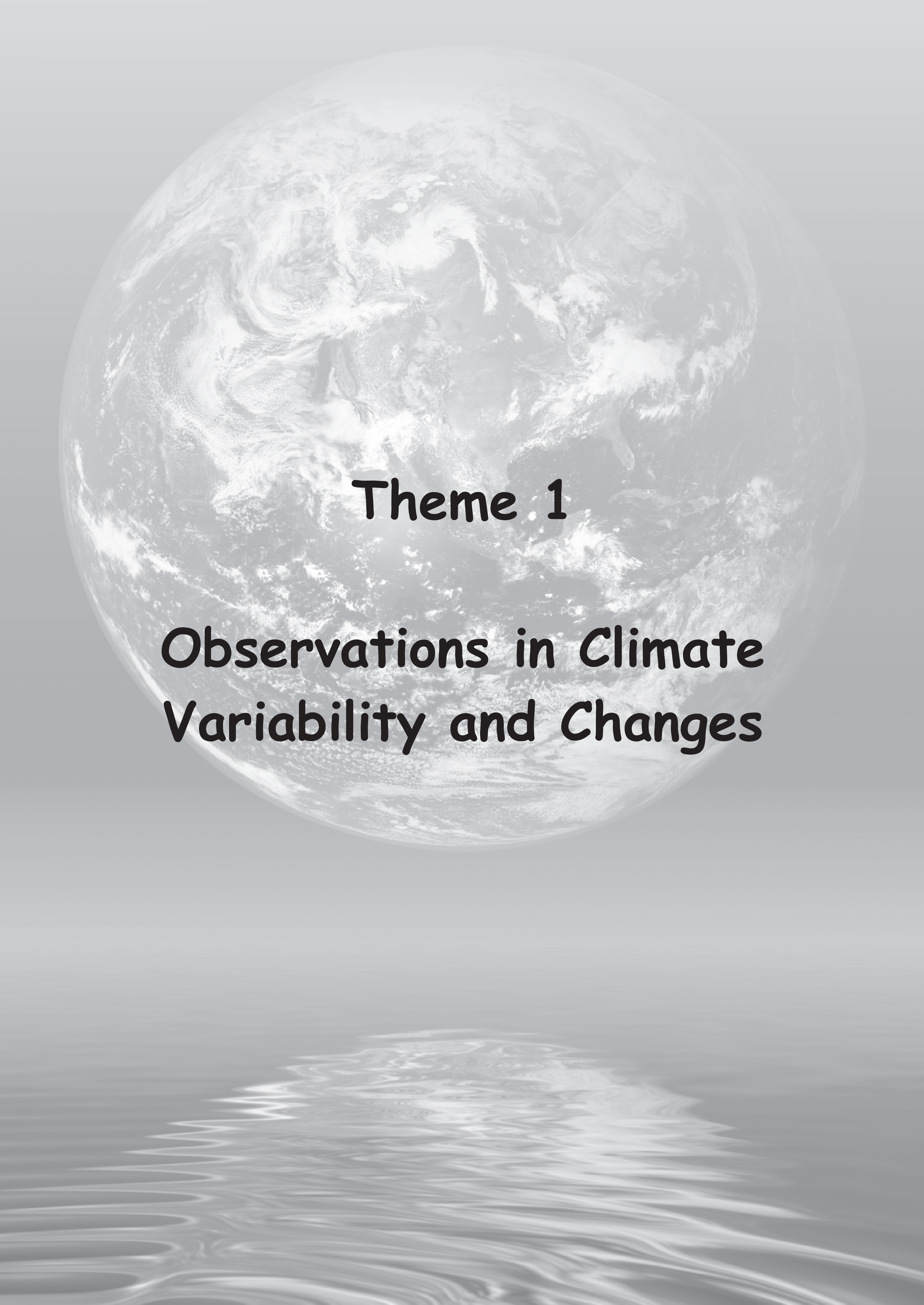
Themes : Weather forecasting Services at Different Time Scales.

Abstract

In the first week of December 2017, a very severe cyclonic storm, namely - "OCKHI" made its landfall over the western coastline of the Indian peninsula. In a climatological perspective, this was one of the very rarest cyclonic storms that developed over the Comorin sea with rapid intensification from a deep depression into a cyclonic storm within six hours. Here, we present a case study on the performance evaluation of a regional numerical weather prediction (NWP) model, COSMO (Consortium for Small-scale Modelling) during the passage of this cyclonic storm over the Arabian Sea by comparing the model-simulated fields against concurrent observations from the Indian Meteorological Department (IMD) and European Center for Medium Range Weather Forecasts (ECMWF) Reanalysis observations respectively from 29th November 2017 to 6th December 2017. Results obtained from this case study indicate good credentials to the COSMO model in capturing the progression of OCKHI from its genesis as a deep depression in the early hours [0230 Indian Standard Time (IST)] of 30th November 2017 to a very severe cyclonic storm in the afternoon (1430 IST) of 01st December 2017 with a lead time of about 18 h. However, the intensity of the storm simulated by COSMO in terms of wind speed magnitudes and convective rainfall was found to be low in magnitudes as against the observations. The mean deviations between the model-simulated and observed trajectory of the storm was about 74 km for a lead time of 24 h. The progression of OCKHI and the prevailing meteorological conditions for its intensification and subsequent weakening are also discussed in this article.

Oral Presentations



Theme 1

Observations in Climate Variability and Changes

Abstract ID – 2

Impact of moisture and heat index on tree ring-width records over the western Himalaya in India

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Abstract

Tree ring-width index chronology based on a well replicated trees core samples from the western Himalaya has been carried out in relation to climate variability / change. The analysis indicates that the moisture (which is a function of rainfall and temperature) and heat index showed better performance than rainfall and temperature in trees growth variation over the region. The existent of the strong positive correlation between tree ring-width index chronology and moisture index during spring season demonstrate that the moisture availability at the root zone of the trees plays a vital role in developing of Himalayan trees growth, whereas heat index is not found conducive in favor of trees, due to enhancement of transpiration and evaporation which cause insufficient moisture supply at trees root zone, indicates adverse impact on trees growth during growing season.

Abstract ID – 7

Variability appraisal of ocean surface wind vector over NIO with NCEP-NCAR, Era-Interim , CCMP and SCATSAT-1 observations

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Abstract

Ocean surface currents are a defining feature of the interactions between the ocean and the atmosphere. Almost all ocean processes can be related to the ocean currents, making them an important physical parameter for marine meteorology and physical oceanography. Surface wind is one of the atmospheric parameters required for estimating momentum and turbulent heat fluxes to the sea ice and ocean surface.Ocean wind on another side is a important parameter for detecting and tracking tropical cyclone. The Indian subcontinent is one of the most adversely affected tropical cyclone (TC) affected basins that experience on an average 4-5 cyclones every year. In comparison to other TC basins, this region is the most vulnerable, due to relatively dense coastal population, shallow bottom topography and coastal configuration. To overcome the loss of human lives due to heavy rains and floods, the advance prediction of track, genesis and intensity of cyclone is highly important. The prediction of TC genesis and intensity are still challenging as in TC predictions, the requirements of accuracy in genesis, track and intensity are higher compared to normal numerical weather predictions. Ocean surface vector wind fields from reanalysis data sets and scatterometerderived gridded products are analyzed over the North Indian Ocean during the period from October 2016 to September 2017 (12 months). The data sets include the NCEP-NCAR reanalysis, ERA-Interim, Cross-Calibrated Multiplatform (CCMP) wind product version 2 and recently released SCATSAT-1 products. The study region is the North Indian Ocean (0°-20°N; 60°-100°E), which include Bay of Bengal (BOB) and Arabian Sea (AS) . The wind fields are derived from reanalysis and scatterometer-based data sets in order to evaluate their variabilities at different temporal (monthly and seasonal) and spatial (large-scale and mesoscale) scales for the time period from October 2016 to September 2017. The analysis starts with monthly scale and then wind circulation on seasonal basis is analysed. The characteristics of cyclones derived from the wind data sets are compared. Wind speeds and directions from the reanalysis and scatterometer-derived wind data sets are evaluated. The objective of the study is to assess the variability in the wind vector fields in the data sets and reveal possible implication of this variability. Large- scale and mesoscale characteristics of winds are compared at monthly and seasonal timescales. Bias and root mean square error in conventional data with respect to SCATSAT-1 data has been estimated and evaluated. Analysis of the wind fields have been carried out for cyclonic characteristics with the data sets. The variability is clearly observed on synoptic and meso timescales. The SCATSAT-1 and CCMP products are observed to be quite comparable; however, substantial biases are found in the NCEP-NCAR and ERA-Interim products of wind fields.

Abstract ID – 15

Vertical structure of latent heating associated with various types of clouds over the Indian summer monsoon region

Sub-theme:Observations in Climate Variability and Changes

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Abstract

The cloud latent heating (LH) plays a pivotal role in various atmospheric processes and serves as a secondary energy source (the Sun being the primary) for driving the large-scale atmospheric circulation. It is known that vertical structure of LH and their radiative properties differ from one cloud type to other as individual cloud types have the different microphysical properties such as liquid water contents/ drop size distribution/ ice water content. Therefore to understand the cloud feedback mechanism in totality, the LH of various cloud types will be useful along with other their radiative properties. In this regard, an attempt is made to study the vertical structure of different cloud types during Indian summer monsoon (ISM) using TRMM and CloudSat measurements. The LH profiles were derived using TRMM based measurements, while the cloud type information is derived using CloudSat observations. Figure1 shows the mean vertical profiles of LH over the Bay of Bengal (BoB), Arabian Sea (ARB), Central India (CI) and Western Ghats (WG) regions, which corresponds to Deep Convective (DC), Stratocumulus (Sc), DC and Cumulus (Cu) clouds respectively. The vertical structure of LH is very similar in BoB and CI region with LH peak height at ~ 7 km with slight variation in their magnitudes. The LH is positive throughout the troposphere and negative at below 1 km, which results due to the evaporative cooling. The BoB experience a strong presence of DC and releases a large amount of LH in the atmosphere as compared to CI region. Over the ARB and WG regions, the LH structure is confined to lower troposphere and peaks at ~ 2km altitude. This is mainly due to the presence of Sc and Cu clouds over ARB and WG regions. The observed LH structure is associated with the various cloud types in the present study, thus bringing out the vertical structure of LH over ISM region. The observed LH profiles of various types of cloud exhibit a different altitudinal structure and peak magnitude, which is envisaged to have important implications in understating the cloud feedback processes. Further, the horizontal distribution of LH over the ISM region and its interannual variability are also established. The significance of the present study lies in establishing the vertical structure of LH associated with various cloud types over ISM region for the first time using TRMM and CloudSat observations.

Keywords - TRMM, Latent heating, cloud types, Indian summer monsoon (ISM).

Abstract ID – 17

Comparative analysis of observed energy fluxes during pre-monsoon thunderstorms at Ranchi, India

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Abstract

Weather is dynamic in nature varying geographically and dependent on land surface processes and wind circulation patterns. Land surface processes play a major role in partitioning of energy and this in turn affects the weather of an area. Ranchi, Jharkhand lies in the eastern side of the monsoon trough and experiences thunderstorms regularly in the pre- monsoon period having climate of Cwa type. The convective precipitation caused by the thunderstorms before the monsoon are essential for the agricultural community.Thunderstorms are initiated by the changes in energy fluxes and alterations in atmospheric stability conditions. The aim of the study was to compare the changes occurring in the flux parameters such as Momentum flux, sensible heat flux and turbulent kinetic energy on a day of thunderstorm and a clear day. The observational data was collected by CR1000 data loggers and sonic anemometer installed at micro metrological tower at BIT Mesra campus, Ranchi at intervals of every half hour. The results depicted high momentum flux values during the initiation and progress of thunderstorm due to high wind speed dipped later. On the clear day the momentum flux (MF) had very low values and they peaked in the afternoon and gradually reduced as the day progressed. The turbulent kinetic energy also depicted high values before and during the thunderstorm indicating high turbulence in the atmosphere. The turbulent kinetic energy (TKE) on the clear day rose to a low peak during the daytime and gradually reduced. The sensible heat flux showed a similar pattern on a clear day of a gradual rise when the shortwave radiation was maximum and dipped in the evening without any abrupt changes. The sensible heat on the thunderstorm day rose steadily and dipped just before the thunderstorm as the energy was converted for the condensation which led to the rainfall. There was a sharp rise in the sensible heat flux (Hs) when the storm was in progress and another sharp dip just after the first storm.These variations in energy fluxes on a clear day and thunderstorm day exhibit the importance of analyzing the variability in flux parameters as they have a direct impact on local weather. As convective rainfall is crucial for the farmers of Jharkhand, the genesis of thunderstorm must be studied carefully to bridge the knowledge gap. The energy fluxes are affected by the type of land surface therefore the changing land use land cover pattern causes variability in the convective thunderstorms that occur in the region. This study is helpful to get a better understanding of the relation between the energy fluxes and the convective rainfall variability.

Keywords - Thunderstorms, Convective rainfall, Sensible heat Flux, Momentum flux, Kinetic turbulent energy.

Abstract – 20

An investigation on the effect of meteorological parameters on the evolution of fog over the Indo-Gangetic plains using satellite data

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Theme:Weather and Climatic Extreme Events

Abstract

The Indo-Gangetic (IG) plains experience severe fog conditions during every winter (November-February). Fog occurrence is a major obstacle to flight operations, shipping, land transportations and public health. In the present study, the effect of different meteorological parameters such as soil moisture and surface temperature on the formation of fog over the IG plains has been investigated. The study has been carried out over six locations (Amritsar -31.7°N, 74.8°E, Delhi -28.6°N, 77.1°E, Jaipur- 26.8°N, 75.8°E, Lucknow -26.8°N, 80.9°E, Varanasi -25.5°N, 82.9°E and Patna- 25.6°N, 85.1°E) in the IG plains during the period from May to February for the years 2015-2016 and 2017-2018 using the Soil Moisture Active Passive (SMAP) derived soil moisture and surface temperature product. For the identification of fog events during the period of study, the Indian National Satellites (INSAT-3D) derived fog products(www.imd.gov.in, www.mosdac.gov.in) has also been used. In 72.82% of cases, the SMAP and INSAT-3D observations are in agreement. Results indicated an increase in soil moisture and decrease in surface temperature before the onset of fog in a large number of cases. Moreover, promising results has also been observed between the maximum soil moisture in monsoon and number of fog days in winter over the IG plains. Similarly, the number of days having soil moisture more than 20% in monsoon and the number of fog days in winter season has also been indicated a positive correlation. The present study suggested that both soil moisture and surface temperature plays a crucial role on the evolution of fog over the IG plains and has the potential to be used as a tool for now-casting/forecasting purposes which will be beneficial for the society.

Keywords -Fog, Soil moisture, Surface temperature, SMAP, INSAT-3D.

Abstract ID – 22

Desertification hot spot identification using Aridity Index

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Abstract

Desertification and land degradation constitute two main processes affecting two third countries of the world on which one billion people live. Climatic variations and anthropogenic activities can be regarded are the main causes of desertification. As the days get warmer and precipitations become infrequent, periods of drought become more frequent, desertification is imminent.

Aridity index (AI) is a useful parameter to study desertification condition and its pattern. The AI formulation adopted by United Nations Environment Programme(UNEP), Food and Agriculture Organization (FAO), and United Nations Convention to Combat Desertification (UNCCD), represents a simple but effective scientific investigation tool. The AI is calculated by dividing the total annual precipitation by the annual potential evapotranspiration (PET) (UNEP, 1992).

The objective of this paper is to study and identify the desertification hotspot using the AI over the Gujarat state. Desertification hot spots are vulnerable areas within define aridity zones. This paper is mainly emphasises the annual variability in AI for the Gujarat state and how it affects the vegetation cover. For this study we have used weather data e.g. minimum temperature, maximum temperature, solar radiation, wind speed, humidity, rainfall which were collected from Agro-Meteorology observatories of Agriculture Universities in Gujarat. Weather data, as mentioned earlier, for more than 22 locations all over Gujarat for past 18 years were collected for this study. Using these weather data, FAO Penman-Monteith method were used to calculate PET. PET and rainfall were used to calculate AI for different locations. Annual AI map for the whole Gujarat was generated using these values. In addition we have also used satellite derived product like Normalised Difference Vegetation Index (NDVI). MODIS-Terra NDVI product for the past 18 year period of *rabi* season were used for the analysis. Annual AI and NDVI were compared and were found to be correlated well.

In addition to comparing annual AI and NDVI data, thirty years average AI map was also developed for the state. Gujarat state mainly comes in three aridity zones e.g. arid, semi-arid and sub-humid zones having AI less than 0.65. Study with the long term average AI reveals small areas of arid zones in Bharuch, Amreli and Ahmedabad districts although most part of these districts is in semi-arid zone. Similar observations were noted in north Gujarat, Kachchh and some parts of Saurastra.

Abstract ID – 27

Nowcast of the squally wind using Doppler weather Radar (DWR) products

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Abstract

Thunderstorm / Dust storm and associated squally winds are the weather phenomena which can adversely impact any outdoor activity. Thunderstorms/dust storms develop due to intense convection and are generally associated with thunder, heavy rainfall, lightening, hail and squall line. The lightning and thunder are produced by cumulonimbus clouds having high vertical extent. In India, when continental air and warm moist oceanic air meets, the severity of thunderstorm increases, particularly in April - May (pre-monsoon season). In this period, the northern, northwestern and eastern part of India is influenced by thunderstorms. A detailed analysis of DWR, synoptic, METAR and satellite data for the events which occurred during the May-June 2018 over Delhi NCR region has been carried out. In this study now-cast of thunderstorms (TS) / dust storm (DS) accompanied with squall (wind speed > 60 kmph) over Delhi and its adjoining regions have been discussed with its antecedent parameters (cloud cell maximum height, reflectivity of DWR, wind speed, CAPE value and approximate distance from observatory Safadarjung or Palam), that usually support to strong rise in wind speed and favorable to development of TS/DS. Monitoring of DS/TS, Gusty winds with horizontal movement of clouds and maximum height of convective cloud cell / storm may help the forecaster to now cast the development and movement of TS/DS associated with strong wind speed i.e. squall.The severity of TS/DS events for five events which occurred over Delhi NCR on 02 May, 07 May, 13 May, 1 June and 9 June 2018 are investigated using the synoptic, satellite (INSAT-3D) and radar data. Based on the analysis, it may be concluded that if the average translational speed of any thunderstorm /dust storm (TS/DS) is approximately 50 kmph and if a TS/DS is observed in radar images fulfilling the criteria (cell height >9 km, reflectivity >50dBz and at a distance of around 70km) then there is very high possibility of occurrence of squall over the observatory/ location at a distance nearly 80 km from the radar echo.

Keywords - Nowcast, Dust storm, Thunderstorm, Squall, Reflectivity (Z), Gusty wind, Doppler weather radar (DWR), Synoptic data, METAR.

Abstract ID – 46

Modulation of Bay of Bengal Tropical Cyclone Activity by the ElNino-Southern Oscillation

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Abstract

The present study investigates the role of El Nino-Southern Oscillation (ENSO) in the modulation of tropical cyclone (TC) activity overthe Bay of Bengal (BoB) during post-monsoon season (peak TCs season) for the period 1972-2015. The results exhibit that out of the total 144 TCs (mean 3.27 per year; standard deviation = 1.56), 92 (mean 2.09 per year, standard deviation = 1.38) occurred during the post-monsoon season (October-December). The mean accumulated cyclone energy (ACE) and power dissipation index (PDI) during the peak TCs season are 8.71 (standard deviation of 9.33) and 6.39 (standard deviation of 8.68), respectively. It has been noted that the peak season TC activity, ACE and PDI values are negatively correlated with the Nino 3.4 sea surface temperature anomalies (SSTAs), significant at the 95% confidence level. La-Nina years' experience more frequent and more intense cyclonic events than El-Ninoyears'. Also,ENSOsignificantly modulates the genesis locations, tracks and landfalling locations of TCs. The combination of enhanced convection, less vertical wind shear (VWS), high SST (≥28°C), more mid-tropospheric relative humidity and low level cyclonic vorticity have provided favourable conditions for cyclogenesis during La-Nina and vice-versa in El-Nino conditions.The large-scale oceanic and atmospheric conditions in above normal and below normal TCs frequency yearsfor different ENSO phaseshave also been investigated.

Abstract ID – 48

On the Association Betweenthe Western Pacific Convective Systems, Strength of ElNino/LaNina and the Indian Summer Monsoon Activity

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Abstract

The summer monsoon rainfall over India, exhibits a large interannual variability in terms of the onset of monsoon over Kerala (MOK), the amount of rainfall received over various meteorological sub divisions and also the monsoonactivity(active and break spells).The association between the intensity of El Nino/La Nina (weak, moderate, strong and very strong) and Indian summer monsoon rainfall activity over the Indian subcontinent has been studied for the period of 1957-2017 (61 years). The intensity of El Nino/La Nina is determined based on the Oceanic Nino Indexsea surface temperature.The characteristics of the convective systems such as frequency, duration and direction of the movement of themover the Bay of Bengal and the Western Pacific region have been studied using the data from the UNISYS website(http://weather.unisys.com) and their association with the monsoon activity over the Indian subcontinent. During the study period, the earliest MOK date was on the 14thMay 1960(neutral phase) and most delayed was on 18thJune, 1972 (Strong ElNino). The delayed onsets were in general associated with strong and very strongEl Nino years; whilst La Nina years were associated with early MOKs. Further, La Nina years, in general had equal number of active and break spells. El Nino years on the other hand had, very less number of active spells.In order to bring out the differences in geographic location, duration and tracks of the convective systems over Bay of Bengal and Western Pacific, composites for weak, moderate, strong and very strong El Nino, La Nina and Neutral conditions were plotted. A study oftracks of the convective systems formed over the Western Pacific region showed a significant change in the tracks during the El Nino years as compared to Neutral and La Nina years, indicating their predominant role on the monsoon activity over the Indian subcontinent.

Abstract ID – 59

Changes in the northeast monsoon rainfall over South Peninsular India in the recent three decades

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Abstract

The variability of the NortheastMonsoon (NEM) over South Peninsular India has been studied using the sub-divisional rainfall ofIndian Institute of Tropical Meteorology (IITM), Pune monthly rainfall, IMD gridded rainfall datasets, upper air temperatures, Sea Surface Temperatures [SSTs] and zonal wind components for the 60 year period 1956- 2015. The study period is divided into two parts 1956–1985 [Past] and 1986–2015 [Present]. The differences in the frequencies of thedays having different rainfall limits [zero, 0 to 20 mm, 20–60 mm, 60–100 mm and greater than 100 mm]for these two periods are also evaluated. It is observed that the rainfall activity over India during the recent three decades has increased. The increase in rainfall is associated with the no rainy & moderate rainy days showed a decline and rainy (0 to 20mm) & extreme rainy days are increased during the recent 30-year period. Analysis of zonal winds at 850 hPa and 200 hPa levels has shown strengthening of the low level easterlies and upper level westerlies indicating anincrease in thenortheast monsoon circulation over South Peninsular India.

Key points -Rainfall, Northeast monsoon, Wind, Global warming.

Abstract ID – 64

Subsurface ocean biases in climate models and its implications in the simulated interannual variability

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Abstract

Coupled ocean atmosphere general circulation models (CGCMs) are known to have deep ocean biases when simulated over long term climate timescales. Here, an analysis has been done for investigating the impacts of these deep ocean biases, especially those which occur in temperature and salinity, ensuing biases in ocean dynamics and large scale air-sea interactions in state of the art CGCMs. The outputs from historical runs of 20 Coupled Model Intercomparison Project Phase 5 (CMIP-5) models have been analyzed. All candidate models develop internal warm and saline biases approximately between a depth range of 100 and 800 m in long term simulations. These internal biases are found to have implications in large scale ocean dynamics via their linkage through baroclinicity of the ocean. The role of internal biases in the ensuing dynamics is correlated via relations between Brunt Väisälä frequency (N^2) and baroclinic wave speeds using both Sturm-Loiuville theorem and WKBJ approximation. The CMIP-5 models analysed here have a higher baroclinic speed compared to that of observations. Annual propagating modes in the ocean reveal higher speeds in most of the models, and that the phase reversal is taking place at lead or lag by a month or more as compared to observations. The study suggests that faster wave propagation in climate models due to subsurface biases in temperature, salinity, N^2 and baroclinicity have potential to impact simulated planetary scale events in terms of their life cycle, periodicity and seasonality. A corollary being a cautionary outlook on climate projections made by coupled models as long as the biases are persistent.

Abstract ID – 67

Recent changes in frequencies of moderate to heavy rainfall events and its teleconnections

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Abstracts

Summer monsoon rainfall (ISMR) over India contributes major proportion of the annual precipitation during June-September. This season is known to produce moderate to heavy rainfall events. It shows intra-seasonal as well as inter-annual variability.

Characteristic features of moderate to heavy rainfall event frequencies during summer monsoon season over Indian region have been studied for 115 years, 1901 to 2015 and changes in these events are examined for the recent period. For this purpose frequencies of rainfall events defined as seasonal count of days when rainfall exceeds both user defined thresholds values (1, 2, 3, ... mm) and percentile based threshold values (1, 2, …........percentiles) have been computed using India Meteorology Department daily gridded data. This data product has a very high spatial resolution daily gridded rainfall data (0.25 × 0.25 degree). The changes in frequencies for each threshold is further studied in relation to El Niño, Indian Ocean Dipole being interacting components of climate systems with Indian summer monsoon rainfall. Events are also studied in relation with circulation parameters.

Spatial aggregate of frequency of moderate rainfall events and spatial aggregate of frequency heavy rainfall events show opposite characteristic features. Recent changes in these events show considerable spatial variability and its relationship with sea surface temperatures varies with threshold value.

Abstract ID – 68

Indian Summer Monsoon Onset signatures on the Tropical Tropopause Layer

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Theme:Observations in Climate Variability and Changes

Abstract

Over the Indian region, changes in the tropopause parameters during pre-monsoon to monsoon seasons have been reported. However, no study exists to date dealing with the Indian Summer Monsoon (ISM) onset signatures on the tropopause parameters. In the present study, the climatological structure of the tropical tropopause layer during the onset phase of ISM is delineated by using long term (2006 to 2017) radiosonde observations from Gadanki (13.5°N, 79.2°E). A prominent transition in the tropopause parameters from pre-monsoon to monsoon is noticed and the transition is initiated from the day of ISM onset. Continuous decrease (increase) of tropopause altitude (temperature) is perceived after the ISM onset. The ozonesonde observations clearly show the strong enhancement in the ozone mixing ratio in the lower stratosphere (~18-20 km) after the ISM onset. This clearly demonstrates the instantaneous warming of the tropopause region after the ISM onset. Transitions from pre-monsoon to monsoon in the tropopause parameters are influenced strongly by onset of ISM which was attributed as seasonal changes earlier. These results provide strong evidence on the ISM onset signatures on the tropical tropopause parameters.

Key words - Indian summer monsoon, onset, tropopause layer and STE process.

Abstract ID – 70

Seasonal variations of Raindrop Size Distribution in different rain typesat a tropical coastal site

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Abstract

Rain is the result of many combined and complex microphysical cloud processes. Macro-physical processes(e.g., wind) also modify the size and number of raindrops. To understand the cloud and precipitation processes, a moderate volume of continuous rain data is essential. If the interest is on micro physical processes involved in drop formation and its traverse, the need for drop size distribution (DSD) arises, that too in a good frequency (sampling interval). In many meteorological applications,DSD is crucial (eg. radar meteorology, parameterisation of cloud physical processes, modelling studies etc).

Thiswork focuses on DSD variation at a tropical coastal site. For this analysis, one minutesampled DSDdatarecorded by an impactdisdrometer operational atThiruvananthapuram (NCESS campus) isused.Eachsample is categorised into four differentrain types based on rain intensity (RI). Therain types areStratiform, Convective, Transition and Mixed. The DSD spectrum is averagedover each rain typeand fitted with Gamma function,$N_D = N_0 D^{\mu} \exp(-\lambda D)$toestimate the3 physically meaningfulfit parameters(N_0,μ and λ). Variation of these fit parameters with respect to RI in different rain categories are analysed and studied. Normalization of DSD is also attemptedto compare DSD between six different types of rain. The above exercise is repeted forfour different seasons, namely: Winter (January & February), Pre-monsoon (March to May), Summer monsoon (June to September) and Post-monsoon (October to December). These seasons are chosen according to the IMD's classification of monsoon seasons in the identified rain types.

Specificvariations are observed in(N_0,μ and λ)with respect to RI in all seasonsfor different rain types.The charestrestics of these fit parameters are analysed and described for all rain types in the four seasons.

Abstract ID – 71

Identifying the best probability distribution of rainfall for drought monitoring in India

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Abstract

For drought and rainfall monitoring percent of normal is most widely used technique. I percent of normal it is assumed that the rainfall is having Gaussian or normal distribution. But in actual weekly/monthly rainfall of particular place or region is rarely having normal distribution. Thus the assessment based on normal distribution usually generates wrong interpretation in most of the cases. In the present case we have analyzed annual along with seasonal precipitation data over 36 rainfall sub-divisions of India from the year of 1901 to 2017 to determine the best fitted model in representing the type of statistical distribution. Various statistical parameters are calculated for 117 years rainfall data. Three distributions are tested, namely exponential distribution, gamma distribution and Weibull distribution. Probability density functions and cumulative distribution functions for one and two parameters for exponential distribution whereas two and three parameters for gamma and Weibull distributions are calculated. The best fitted model is chosen based on the minimum error produced and ranking by the three goodness-of-fit (GOF) tests used, which are Kolmogorov-Smirnov (KS) tests, Anderson Darling (AD) test and Chi-Squared test. This study suggests the best statistical distribution for various sub-divisions of India for drought analysis viz. standardized precipitation index, standardized precipitation evaporation index etc.

Keywords -Best fitted, Drought, Distribution,Exponential,Gamma, Weibull,Goodness-offit, Kolmogorov-Smirnov,Anderson Darling, Chi-Squared, drought.

Abstract ID – 72

Comparative study of district wise monsoon rainfall in recent years over Maharashtra

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Theme:Observations in climate variability and changes

Abstract

Typical monsoon climate with hot rainy and cold weather prevail over the State of Maharashtra. The tropical monsoon pattern varies from region to region. Rainfall particularly concentrates to Konkan-Goa / Sahyadrian region ; central Maharashtra receives less rainfall, while eastern Vidarbha receives good rainfall under influence of Bay of Bengal. The study of monsoon rainfall pattern during recent years , district wise has got huge importance especially in agricultural sector, which tempted for this study . Four meteorological sub-divisions *viz*. Konkan-Goa, Madhya Maharashtra, Marathwada and Vidarbha consist of 8, 10, 8 and 11 districts, respectively. The objectives of the study are : to study and compare district wise rainfall variation in recent years and thus to identify their potential. 5 years (2013-2017) daily rainfall data were collected during monsoon period and by cumulating, weekly data were computed. Mean for each year for each of the 37 districts was computed and the mean for the study period was also computed for each district / meteorological sub-division. The study revealed that the spatial (district to district) and temporal (year to year) weekly monsoon rainfall varied widely among the districts of different meteorological sub-divisions. The mean monsoon rainfall of Ratnagiri, Rajgad, Sindhudurg,and north Goa districts during the study period was the highest, while Solapur, Sangli,Ahmednagar, Aurangabad, Beed and Jalna districts recorded the lowest monsoon rainfall. Among the meteorological sub-divisions the mean monsoon rainfall (Fig. 1) was the highest over Konkan-Goa (around 3000 mm.) during 2013 to 2017, followed by Vidarbha region (around 960 mm) , Madhya Maharashtra (around 750 mm), while the lowest rainfall was recorded over Marathwada (around 600 mm). Among the years studied, 2015 was the worst monsoon period, while 2013 recorded the best monsoon rainfall over the State. It was also noticed that the July rainfall during most of the study period recorded the highest weekly rainfall in different meteorological sub-divisions.

Key words – District wise rainfall, Maharashtra,Meteorological sub-divsiions, Monsoon period, Spatial, Temporal.

Literature cited

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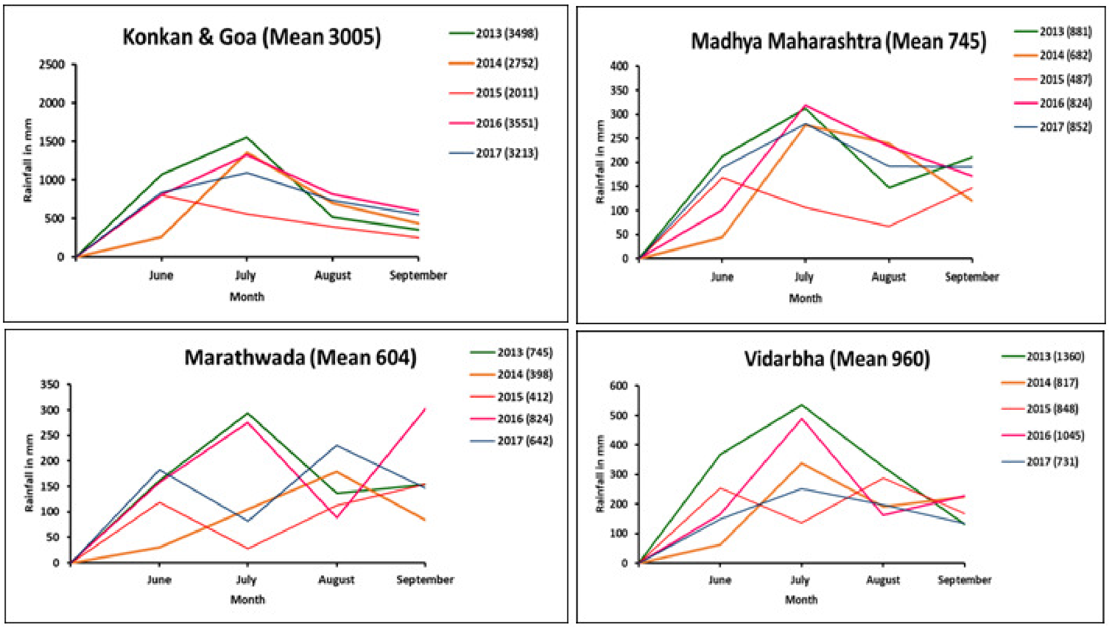

Fig.1.Meteorological sub-division wise rainfall variability over Maharashtra State

Abstract ID – 80

Impact of Geostationary Clear Sky radiances assimilation on the wind field over the Indian Ocean region

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Abstract

The impact of Water vapor (WV) channel derived Clear Sky Brightness Temperature (CSBT) from geostationary satellites in the 4D variational (4D-VAR) assimilation systems are vivid in the humidity field. In the variational assimilation systems, the change in one variable cannot happen in isolation; the change in humidity field can affect both temperature and wind fields as well. This paper discusses a series of Observing Simulation Experiments (OSEs) analyzing the impact of the radiance from Spinning Enhanced Visible and Infra-Red Imager (SEVIRI) onboard Meteosat-8 satellite, that provides the Indian Ocean Data Coverage (IODC) service. The assimilation and forecast system used in this study is NCMRWF's Unified Model (NCUM). NCUM operationally assimilates both SEVIRI CSBT and the AMVs from Meteosat-8 along with other conventional and satellite observations. NCUM routinely assimilates INSAT-3D sounder CSBT and the AMVs derived from INSAT-3D Imager. Since both Meteosat-8 and INSAT-3D have approximately same geographical coverage, INSAT-3D observations, both CSBT and AMVs are restrained in the OSEs to quantify the impact of CSBT and AMVs from Meteosat-8. OSEs are designed in such a way that along with other global observations, i) CSBTs (EXP1), ii) AMVs (EXP2), iii) both CSBTs and AMVs (EXP3) from Meteosat-8 and iv) no CSBTs and AMVs (EXP4) from Meteosat-8. The fourth one is considered as the baseline experiment and the impact of CSBT and AMVs are analyzed in terms of the baseline experiment in both assimilation and forecast system.

Keywords -4D-Var, NCUM, Numerical Weather Prediction, CSBT.

Abstract ID – 85

Characterization of the impact of hyper-spectral radiances in the 4D-VAR assimilation system

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Abstract

Accurate Numerical Weather Prediction (NWP) requires detailed knowledge of the state of the atmosphere and these details are mostly coming from the satellite observations. Unlike multispectral instruments onboard many satellites, the hyperspectral instruments provide wide coverage of the atmosphere with fine spatial and temporal resolutions. There are four operational hyperspectral instruments onboard different satellites, Atmospheric Infrared Sounder (AIRS) on-board NASA-AQUA satellite, Infrared Atmospheric Sounding Interferometer (IASI) aboardboth MetOp-A and MetOp-B and Cross track Infrared Sounder (CrIS) on-board Suomi-NPP satellite. AIRS and CrIS have 2378 and 2211 spectral channels respectively, whereas IASI has 8461. Though there are thousands of channels in the hyperspectral instruments, NWP cannot benefit the fullest of these instruments, only a few hundred channels which are very essential for NWP can be assimilated. This study presents the overview of Observing System Experiments (OSEs), carried out to assess the impact of the four hyperspectral instruments in the NCMRWF's Unified Model (NCUM) assimilation and forecast system. Two OSEs are designed such that i) along with all other conventional and satellite observations, the four hyperspectral radiances are assimilated (EXP) and ii) the hyperspectral radiances are denied (CNTL) for a month period, May 2018. The impact of hyperspectral radiance in the assimilation system is analysed in terms of the improved assimilation of radiances from other infrared and microwave instruments. 5-day forecasts are computed based on 00 UTC initial condition of each day, and the impact of these radiances in the forecast system are analyzed in terms of skill scores.

Keywords -4D-Var, NCUM, Hyperspectral, Numerical Weather Prediction.

Abstract ID – 93

Information System of IMD: Role in understanding Weather and Climate Variability

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Abstract

Understanding the weather, its forecast and research in the area requires regular observational information about various parameters/ elements depending upon the type of weather and its extension (viz. local/ regional/ global scale). Moreover weather forecast has also got various ranges (viz. short/ medium/ long range). Forecasting of any weather event requires data from various sources, locations to be collected efficiently in almost real time for producing the forecast products and disseminating the information to various stakeholders. Climate study requires data / information about the area for longer duration. India Meteorological Department (IMD) has setup state of the art technology information system for collection/ exchange of meteorological data/ products at national/ regional/ global level almost in near real time through its communication network as well as GTS (Global Telecommunication System). Present article describes the information system of IMD, its features/ facilities, its role in weather forecast/ alert/ warning generation and dissemination. The dissemination system includes the approach to serve the society by timely warning/ alert/ advisory etc reaching to the public/ concerned authorities engaged in disaster mitigation/ taking suitable action for minimizing the loss of life and property. With the implementation of GISC (Global Information System Centre) and Mirror RTH (Regional Telecommunication Hub) at Pune under the framework of WIS (WMO Information System) compliance, IMD has become one of the Global Dissemination Centre out of 15 GISCs. The features/ facilities of WIS/ GISC have also been highlighted in the article.

Abstract ID – 99

A phenomenological paradigm for mid-tropospheric cyclogenesis in the Indian Summer Monsoon

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Theme:Observations in Climate Variability and Changes

Abstract

Mid-tropospheric cyclones (MTCs) are a distinct class of synoptic disturbances, characterized by quasi-stationary cyclonic circulation in mid-tropospheric levels, which often produce heavy rainfall and floods over western India during the summer monsoon. This study presents a composite and diagnostic process study of long-lived (>5 days) mid-tropospheric cyclonic circulation events identified by the India Meteorological Department (IMD). Reanalysis data confirm earlier studies in revealing that the MTC composite has its strongest circulation in mid-troposphere. Lagged composites show that these events co-occur with broader-scale monsoon evolution, including larger synoptic-scale low-pressure systems over the Bay of Bengal (BoB) and east coast, and the active phase of regional-scale poleward-propagating intraseasonal rain belts, with associated drying ahead (north) of the convectively active area. Diabatic heating composites, in particular the TRMM latent heating and MERRA-derived radiative cooling in the dry inland areas of Southwest Asia north of the rain belt, are used to drive a nonlinear multi-layer dynamical model in a forced-damped reconstruction of the global circulation. Results show that the midlevel circulation is largely attributable to top-heavy latent heating, indicative of the prevalence of stratiform-type precipitation in mesoscale convective systems in these moist, active larger-scale settings. Both the west coast and BoB latent heating are important, while the radiative cooling over Southwest Asia plays a modest role in sharpening some of the simulated features. A conceptual model encapsulates the paradigm based on this composite and diagnostic modeling, a diabatic update of early theoretical studies that emphasized hydrodynamic flow instabilities.

Abstract ID – 106

Tropical upper tropospheric humidity variation and plumes due to potential vorticity intrusions over Indian sector

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Theme: Observation aspects of Weather & Climate Extremes

Abstract

Potential vorticity (PV) intrusions shows consistent increase in ERA-interim relative humidity (RH) by more than 50% in the upper troposphere (200-250 hPa) over tropics at the eastward side of the intrusion region. The increase in RH is confirmed with the spaceborne microwave limb sounder observations and radiosonde observations over Gadanki (13.5°N, 79.2°E). However some PV intrusion events over Indian sector, which trigger convection lead to the generation of tropical plumes (TP) are presented. It is noted that the spatial extent of convection is large in these cases and is similar to the TP structures commonly present over eastern Pacific and Atlantic sectors during northern winter. The Meteosat IR imagery also confirms the occurrence of tropical plumes over Indian sector. The TPs play major role in the transport of moisture from lower latitudes to higher latitudes. The ERA-interim specific humidity averaged for 200-300 hPa shows large scale moisture transport from lower to higher latitudes tracking the plume structure. Apart from these, interannual and seasonal variations of the occurrence of TP in connection with the PV intrusion events over Indian sector for the years 2000-2014 are presented. It is found that the number of occurrence of TP is more during February-April and all the PV intrusions do not lead to the TP structures. The life time of majority of TP over Indian sector is found to be 1-2 days and all the TP are not precipitative. Unlike reported earlier, the PV intrusions having broad trough are also leading to TP over Indian sector, whereas the PV intrusions having narrow trough (less than 3° longitude band) do not lead to TP. Besides, the occurrence of TP does not relate to even the depth of penetration of PV trough. It is demonstrated that the occurrence of TP is due to the poleward advection associated with the PV intrusion.

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Abstract ID – 108

The Rainfall Analysis over Rainfed Areas over Marathawada&Vidarbha

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Abstract

The study of precipitation trends is critically important for a country like India whose food security and economy are dependent on the timely availability of water. Marathawada & Vidarbhaare the two regions in central India which are famous for its recurring drought situation. These two regions are the part of Maharashtra state which plays a major role in country's economy. Marathawada covers 8 districts viz.Aurangabad, Nanded, Beed, Osmanabad, Latur, Jalna, Parbhani, Hingoli and & Vidarbha covers **Amravati**, **Akola**, **Bhandara**, **Buldhana**, **Chandrapur**, **Gadchiroli**, **Gondia**, Nagpur, **Wardha**, Washimand **Yavatmal** respectively. Climate in this region is dry and moderately extreme in nature. Annual rainfall ranges from 675 to 950 mm.

Marathwada&Vidarbha are repeatedly affected by the scanty rainfall; this region is included in Drought Prone Areas (DPA) of India. Keeping this in view, the present study focuses on the time series analysis of historical monthly rainfall in Marathwada&Vidarbha so as to analyse historical drought events and to predict the future drought events. To analyse the drought events, various drought indices are developed by various researchers. As the present study is based on rainfall analysisof Marathwada & Vidarbha, rainfallbased drought indices are evaluated by Rainfall Departure (RD), Standardized Precipitation Index (SPI), Rainfall Decile based Drought Index (RDDIso as to identify characteristics of the drought events.

The characteristics evaluated by these all drought indices are the also compared in this study. In order to be prepare for droughts, it is highly important to get an alert about upcoming drought well in advance. Like rainfall forecast, Drought forecasting is the most important thing in this regard. In this study, an attempt is made to predict the drought situations by tracing the trends (SPI) in rainfall over Marathwada & Vidarbha. For this purpose data is calibrated and validated against historicalrainfall data.

Keyword - Rain fed, Drought, Marathwada, Vidharbha, Standardised Precipitation Index.

Abstract ID – 114

Variability of Indian Summer Monsoon during solar activities

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Abstract

An attempt is made in present study to have animproved understanding of physical mechanism responsible for variability in Indian Summer Monsoon due tosolar forcing. Maximum (19) and minimum (21) sunspot activity years are extracted from Sunspot number time series (1953-2012) data. Further, National Center for Environmental Prediction and National Center for Atmospheric Research (NCEP-NCAR) reanalysis data is used to showthe time averaged composite anomalies of various variables. Higher amount of rainfall is observed during minimum sunspot activity as compared to maximum solar activity over Indian region. A stronger Bay of Bengal branch of Somali Jet at 850 hPa along with the intensified and strengthened Tropical Easterly Jet at 200 hPa were seen during minimum sunspot activity. A vertically heated atmospheric column which holds the moisture for longer period and hence precipitates lesser is observed during maximum sunspot activity while opposite pattern is found during minimum activity. Positive anomalies of latent heat flux are also observed during maximum solar activity. The local Hadley circulation having a stronger ascending branch mostly around Central India along with higher wave flux has been observed during minimum solar activity.

Keyword-Sunspot number, Rainfall, Hadley cell, Wave-flux.

Abstract ID – 117

Ascent and descent rates of inflated meteorological balloons and some observations

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Abstract

Ever since the start of scientific ballooning, upper atmospheric and meteorological observations in-situ, are being obtained using floating balloons in the air. For this hydrogen or helium filled rubber balloons or plastic balloons are released into the atmosphere carrying payloads for atmospheric sounding from the surface of the ground to the upper layers in the atmosphere reaching even 40km height from mean sea level. The atmospheric data sensed in-situ, by the meteorological sensors tied to the ascending balloons, is modulated and transmitted to the ground and the data is collected by the ground based receivers. Actual sensor data is retrieved suitably from the received data.

Apart from the balloon borne sensors' data received on the ground, the balloon track data also is made available by the ground based tracking radars or GPS receivers. From the time tagged base data of tracking parameters, three dimensional positional coordinates of the air borne balloon are estimated. Time rate of change of these positional coordinates provide three dimensional velocity information of the balloon. The vertical component of the upward moving balloon is known as ascent rate of the balloon.

The buoyant balloon, inflated by known amount of hydrogen or helium gas is supposed to ascend with a uniform rate of ascent, is perturbed by non-uniform scales of turbulent eddies embedded in the atmosphere causing irregular three dimensional motion of the balloon. This causes a fluctuating vertical profile of the rate of ascent of the balloon.

Based on the GPS track data of indigenously developed Pisharoty GPS-RS instrument, tied to a helium filled rubber balloons and released from Bangalore University, Jnanabharathi campus, the height based balloon ascent rate profiles are obtained. Balloon ascents were taken twice a day at 00Z and 12Z for a week during the satellite launch campaign periods of SDSC-SHAR. A total of 78-ascent and descent profiles are analyzed for period from April 2017 to April 2018, and results are presented.

Various hidden details of the atmospheric motions and certain weather phenomena of different height scales are observed from the rate of ascent profiles. The extent of statistical smoothing required to obtain a reliable smoothed rate of ascent profiles is studied and presented in the paper.

Abstract ID – 120

Climatology of WaterVapourand temperature variation in Delhi and Bangalore – A study from eight years of Total Precipitable Water Vapour derived from GPS receiver

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Abstract

This paper contains the results and discussion of monthly diurnal variation of total integrated precipitable water vapour (IPWV) in Delhi (2007-2014) and Bangalore (2007 to 2015). Remote sensed hourly IPWV data estimated in near real time from earth based GPS receivers at India Meteorological department (IMD) Delhi and half hourly IPWV data obtained from IISC-Bangaloru have been used. A distinct diurnal variation of water vpour is observed in both the stations. In general, IPWV increases during day time and maximum value is observed between 0900 (1430) and 1100 UTC (1630 LST) in Delhi whereas in Bangalore it was observed in the late evening between 1215 (1745) and 1745 UTC (2315 LST). The minimum IPWV is observed between 0215 and 0445 UTC in Bangalore whereas in Delhi noticed between 0200 and 0300 UTC in winter and pre-monsoon season, and between 1600 and 1800 UTC in monsoon season. From the monthly diurnal variation of temperature, maximum (minimum) temperature is observed between 0830 (0030) and 1000 (0200) UTC at Delhi and 0845 (0015) and 1015 (0115) UTC in Bangalore, suggesting that in Delhi the diurnal cycle of water vapor is affected by the intensity of incident solar radiation and monsoon wind. In Bangalore however the amount of water vapour present in the atmosphere is affected both by insolation and advection of moisture in the late evening from nearby plains. It is also observed that during monsoon season the range of diurnal variation of moisture is more on intense rainfall days than non-raining days in both locations.

Key words -GPS Meteorology, Precipitable water, Diurnal variation of precipitable water, Diurnal variation of temperature, advection.

Abstract ID – 122

An analysis of Snow Cover changes in the winter season over the Western and Central Himalayan region (2000 – 2018)

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Abstract

Snow cover in the Himalayan range plays a significant role in the regional and global climate system. Also, it is an important water resource for rivers in the adjoining land masses. Global Climate change plays a pivotal role in the decrease in snow cover in the western and central Himalayan region. In this paper Level 3 monthly snow cover data derived from Moderate Resolution Imaging Spectroradiometer (MODIS) sensor (on-board Terra) at a spatial resolution of 0.05° X 0.05° has been used to study the changes in snow and glacial cover during the period 2000-2018 over the Himalayan region (25-40°N and 70-88°E). The entire region has been equally divided into six different elevation zones named as Zone A (1000m – 2000m), Zone B (2000m – 3000m), Zone C (3000m – 4000m), Zone D (4000m – 5000m), Zone E (5000m – 6000m) and Zone F (6000m – 7000m). Annual snow cover variability and trend analysis show an overall decreasing trend over the study area for each of the elevation zones during the winter months (December, January and February) except for Zone B and Zone F during the month of February of December respectively.

Keywords -Snow cover, Himalaya, MODIS, Trends

Abstract ID – 132

Analysis of the three dimensional structure of winds and precipitation of Cyclone "Ockhi"

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Abstract

Our study is on the Cyclone Ockhi that had originated as a low pressure system over the eastern Andaman sea and grew into a very severe cyclonic storm. We study the variability of the winds and precipitation in a lagrangian frame of reference from the time it started as depression over the south-west Bay of Bengal off coast Sri Lanka on 29th of November, developed into a Very Severe Cyclone over the Eastern Arabian sea and till its land fall on 5th of December. Our preliminary results show that there was increased rainfall just before Ockhi developed into a Severe Cyclone. This anomalously copious amount of rainfall was not observed even after Ockhi developed into a very severe cyclone. Also wind speeds show an abrupt increase just before landfall. Presently we are working on WRF simulations to validate our results.

Abstract ID – 134

Occurrence of Cirrus clouds and its effect on the thermal structure of tropical tropopause layer (TTL)

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Abstract

Two year extensive observations of micro pulse lidar over tropical station, Chennai (12.82N, 80.04 E), India has been utilized to study the occurrence of cirrus clouds its effect on the thermal structure of tropical tropopause layer (TTL). Cirrus clouds and its top and base heights occurrences are estimated and found that they occur about ~77% of times. The occurrence of cirrus clouds shows a pronounced seasonal variation with maximum occurrence ~86% during monsoon while minimum occurrence ~41% during winter season consistent with earlier reports. Optical thickness of cirrus is also obtained using two-way transmittance method in order to distinguish different types of the cirrus clouds. Out of total, about 70% of the cirrus clouds have optical thickness less than about 0.4 and their width is found to be lesser than 2.5 km. The relationship of cirrus clouds occurrences and TTL thermal structure are investigated using Chennai IMD radiosonde operated twice a day during 05:30 IST and 17:30 IST and hourly INSAT-3D/3DR temperature collected over SRM MPL is investigated. The details of the quantitative relationship between occurrence of cirrus cloud near and TTL thermal structure will presented during the conference.

Key words -Cirrus Clouds, Tropical Tropopause Layer, Micro Pulse Lidar, INSAT 3D/3DR.

Abstract ID – 137

Is the Spatial Hurst Exponent Method for Detecting a Changepoint Reliable?

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Abstract

The reliability of using abrupt changes in the spatial Hurst exponent for identifying temporal points of abrupt change in climate dynamics is explored. If a spatio-temporal dynamical system undergoes an abrupt change at a particular time, the time series of spatial Hurst exponent obtained from the data of any variable of the system should also show an abrupt change at that time. As expected, spatial Hurst exponents for each of the two variables of a model spatio-temporal system -- a globally coupled map lattice (GCML) based on the Burgers' chaotic map – showed abrupt change at the same time that a parameter of the system was changed. This method was applied for identification of change points in climate dynamics using the NCEP/NCAR data on air temperature, pressure and relative humidity variables. Different abrupt change points in spatial Hurst exponents were detected for the data of these different variables. This suggests that the method cannot be used to reliably detect a change point in the dynamical system from the data of one variable only.

Abstract ID – 138

A study on the changes of Indian Summer Monsoon (ISMR) variability and its prominent patterns after 2000

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Theme: Observations in Climate Variability and Changes

Abstract

Indian Summer Monsoon Rainfall (ISMR) during the four months of June to September is the major source of water for the millions of people in the Indian subcontinent. It accounts for around 80% of annual mean rainfall and thus has an imperative role in agriculture and economy of the country. Hence understanding the causes for the long term and short-term changes in Indian summer monsoon rainfall (ISMR) has vital importance in Indian meteorological research. Rainfall observations over the country showed a trend toward less rainfall from 1951 to 2000 which was attributed to the global warming-related issues by many earlier studies. Simultaneously equatorial Indian Ocean was also warming monotonously throughout the period. Meanwhile, the ISMR trend changed to a significant increasing mode from 2000 onwards, even with continuous sea surface temperature warming over the Indian Ocean. There were many studies reported the increasing of heavy rainfall events in the recent period, which can account for some of the recent increasing trend. But the present study put forward some possible reason for the increasing trend of seasonal ISMR. (1) There is increased moisture availability in the pre-monsoon season itself in the recent period. (2) In the summer season there is increased easterly wind anomalies from the equatorial Pacific(which is the result of recent cooling there) increasing the low-level moisture convergence over Indian region. (3) Increased warming trend of Indian land region increases the land-sea thermal contrast over monsoon region resulting increased cross-equatorial flow from the Indian Ocean to monsoon region. These dynamical features along with the increased moisture supply will itself lead to increased rainfall and increasing trend over monsoon region. Along with the increasing trend, it has been observed that the interannual variability of ISMR is increased by around 32% in the 2000-2014 period. The study analyzed the changes in prominent patterns of IMSR in the recent period also. On the basis of results obtained from various analysis methods incorporated in the present study, the observed significant change in the ISMR trend can be attributed to the interannual variability, which is the prominent mode of Indian summer monsoon rainfall.

Abstract ID – 139

Variation of Surface Boundary Layer Characteristics during Active and Weak Phases of Southwest Monsoon over Kochi

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Abstract

This study explores the variations in the surface boundary layer parameters over Kochi during active and weak phases of the southwest monsoon season. Classification of active and weak phases of monsoon is made on the basis of monsoon organized convection over the region. When the monsoon organized convection is over (away from) Kochi, the day is considered as an active (weak) day. The study primarily utilizes sonic anemometer data. Diurnal variation of surface wind, temperature, surface fluxes and turbulent kinetic energy (TKE) during active and weak conditions are examined. It is found that monsoon clouds spread extensively over large area stabilizes the surface layer. A drastic decrease in sensible heat flux is observed during the active monsoon condition. The average value of momentum flux and TKE decreases, surface layer becomes stable, and Atmospheric Boundary Layer (ABL) height lowers during active monsoon phase. A significant oscillation of 3.5 hour periodicity is found embedded in the momentum flux and in the wind speed, which is attributed to the penetration of the low level monsoon circulation. Weak monsoon phase is characterized by higher values of fluxes and TKE with higher amplitude of diurnal variation, which is due to local heating and sea breeze circulation. Unstable condition between 00:00 IST and 01:00 IST and stable conditions in the early morning are observed during both active and weak phases.

Abstract ID – 140

Variability of latent heat flux over the bay of bengal and arabian sea and its connection to IOD events

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Abstract

In the present study, An attempt is made to see variability of Latent Heat Flux(LHF) over the Bay of Bengal and Arabian Sea. Latent Heat Flux and Sea Surface Temperature has been considered during the data 1991-2016 for the study region which covers the North Indian Ocean (Arabian Sea and Bay of Bengal). Monthly averaged Tropflux Latent heat flux data from 1991-2016 utilized to analyze the spatio-temporal variability of LHF over Arabian Sea and Bay of Bengal, Climatology also analyzed here. Monthly Sea Surface Temperature data taken from the Advanced Very High Resolution Radiometer (AVHRR) which has the high spatial (1km) resolution. Here we are trying to analyze monthly and annual variations of SST and LHF. The Indian Ocean Dipole Mode Index (IODM) was calculated by using SST data. During the study period, nIOD and pIOD years have been identified from the IODM. Variation of LHF during the IOD years over Arabian Sea and Bay of Bengal are analyzed. This analysis suggests that, in the North Indian Ocean, LHF variability is largely controlled by thermodynamic processes, It attains the peak just before the onset of the monsoon and reaches the lower values during the active phase of the monsoon. These observed LHF sensitivities are then used to speculate how the surface energetics and coupled feedbacks may change in a warmer world. Further analysis says that during the study period(26 years), strongest pIOD years are well correlated with LHF as well as SST.

Key words -Latent heat flux, Sea surface temperature, IOD, Monsoon, Thermodynamic processes.

Abstract ID – 142

Neural Network Model for prediction of Rainfall during North-East monsoon season using ocean parameters

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Abstract

North-East Monsoon (NEM) is one of the important component of Indian climate system. Like a summer monsoon, it plays a key role for agricultural as well as economic development.Changes occurred in Bay of Bengal (80°E:100°E,0-25°N)responsible for NEM rainfall season because of its unique features, like huge influx of fresh water from several major rivers and intense northeast and southwest monsoon winds. Southern peninsular of India (SPI) experienced NEM season during Oct-Nov-Dec. It mostlyaffects the five meteorological subdivisionssuch as Rayalseema, Kerala, Coastal Andhra Pradesh, Tamilnadu and South-central Karnataka. Among these subdivisions, Tamilnadu experienced more rainfall during NEM compare to southwest monsoon. The prediction of rainfall using ocean parameters useful to find out the effect of ocean on atmosphere and also observe the complex climate conditions. Weather data is non-linear data and it's a challenging task to handle a non-linear data for climate studies. The beauty of Artificial Neural Network model hasit deals with non-linear data and from few decades it becomes a popular technique for studying complex climate conditions. The advantage of using ANN in a climate forecasting method is that it minimizes the error using various algorithms and gives a predicted value which is nearly equal to the actual value.In the present work,use feed-forward backpropagation neural network model for prediction of rainfallover Tamilnadu (76°E:81°E,8°N:13°N) during NEM season (Oct-Nov-Dec) using ocean parameters of BoB such as sea surface temperature (SST), wind speed (WS), latent heat flux(LHF) which is extracted from Tropflux daily data and use as input neuron for neural network model. Rainfall data extracted from Global Rainfall Climatology Project daily data as a target data for Tamilnadu. Along with that also observe the complexity of proposed neural network model using last seven year data from 2011-2017.Also performance of model is test using performance analysis parameters like correlation coefficient, Root mean square error and Accuracy.

Abstract ID – 146

Regional variability of Indian summer monsoon and its influence on the lower tropospheric stability

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Abstract

Asian summer monsoon that mainly affects India and its surrounding regions during June to September and that contribute more than 75% of the annual total rainfall is the Indian summer monsoon. It exhibits large variability on temporal scale ranging from diurnal to multidecadal. In addition to the temporal fluctuations, rainfall exhibits spatial fluctuations manifesting the higher amount of rainfall in the west coastal belts and northeast regions of India and less amount of rainfall in the northwest and southeast regions. These variabilities are influenced by many factors from topography to oceanic and atmospheric factors including teleconnections. So studying the variability of summer monsoon rainfall especially in regional scale is very important and useful to the Indian society and thus to the economy. This paper mainly aims to explore the regional variability of Indian summer monsoon rainfall especially over west coast, northeast, northwest and central India for the period 1948-2016, by identifying its relationship with the lower tropospheric stability (LTS). LTS is calculated using potential temperature at different atmospheric levels form NCEP/NCAR reanalysis data set during the period 1948 to 2016. The variations in LTS have a major impact on cloud fraction and thus the summer monsoon rainfall.We used CRU rainfall data for the same period to evaluate the variability during the summer monsoon season. We found that the linkage between the LTS and rainfall is nonlinear in space and time. The LTS is negatively correlated with rainfall over Western Ghats, however, positive correlation is observed with rainfall in other Indian regions. Therefore, it can be concluded that relation between lower tropospheric stability with monsoon rainfall during the monsoon period is different over different regions with different influencing mechanisms.

Abstract ID – 152

Evaluation of satellite based Evapotranspiration estimates over Kosi River Basin, India

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Abstract

Evapotranspiration (ET) is one of the principle components in the hydro-meteorological applications**.**Despite its importance, from the decade's accurate estimation of ET remainsas a major challenge in the ungauged basins.This study evaluates the performance of satellite-based ET from Moderate Resolution Imaging Spectroradiometer (MODIS) with India Meteorological Department (IMD) data using Harmon's method over the Kosi River basin.To aseess the performance of the MODIS estimated ET with the observation data (IMD) quantitatively, a set of statistical metrics were computed. The result found the poor agreement of MODIS estimated ET, withCorrelation of coefficient (r) of 0.615, and Bias and Root Mean Square Error (RMSE) of -31.78and 36.894 respectively in comparison to IMD. The scaling issues and cloudy atmospheric effects (especially in monsoon seasons) could be the main reasons for the poor performance of MODIS ET.

Abstract ID – 159

On the dynamics of the Chennai floods-2015

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Abstract

In present study, an attempt has been made to understand the role of Easterly Waves in intensification of synoptic systems and associated heavy rainfall activities over southern peninsular India during North East monsoon 2015. Easterly wave characteristics are identified using time - longitudinal Hovmoller diagram of daily meridional winds, OLR and precipitation over 10 ^{o}N. Typical characteristics of weather associated with trough in easterlies were evident during events. Passage of EWs over southern peninsular India and its interaction with already developing synoptic systems of different scales had been studied using analysis of an anomalous time evolution of streamline and relative vorticity at 700 hPa over the region. One of the intriguing results from present analysis is the passage of trough in easterlies associated with these events. It further demonstrates that, trough in Easterlies plays an important role in intensification of the already existing synoptic system, which can further lead to heavy rainfall during North East Monsoon -2015.

Abstract ID – 164

Impact of Rossby wave breaking on Indian summer monsoon depressions and ISO

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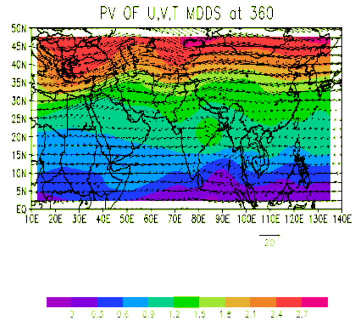
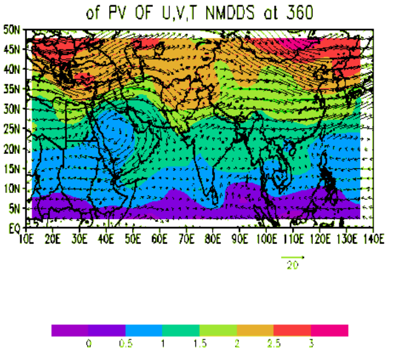
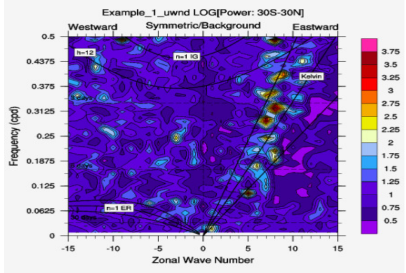
Abstract

The dynamics of the rapid northwest propagating anomalous Rossby waves from the central Bay of Bengal toward northwest India and decoupling of the eastward propagating anomaly are two extremely vital elements that determine the transition from an above normal phase to a break phase of the ISM and also help maintain the mutual competition between convection over the Indian subcontinent and that over the equatorial Indian Ocean. The structure of the monsoon depressions differs markedly from that of the Caribbean type of easterly waves. The main aim of the study is to identify the Rossby wave breaking impact on MDS, ISOs. To understand the influence of the rossbywave breaking on monsoon depression with special reference to intraseasonal oscillations. We have used NCEP/NCAR reanalysis daily datasets like geopotential heights, zonal, meridional wind, air temperature ,specific humidity are considered for the study period 1990-2014. Later potential vorticity is calculated for identification of Rossby waves at different isentropic levels 340, 350, and 360 K respectively. space time spectra technique is used to identify the frequency, wave number and propagation of rossby waves for the study period, it is found that rossby wave breaking also one of the reason decreasing number of monsoon depression days by appearance of antycyclonic blocking high over AS. because. The monsoon cell is characterized by easterly jets aloft and south-westerlies near the surface; it is separated from the circulation in middle latitudes by the monsoon trough at the surface and by the Tibetan anticyclone above the mid-troposphere. This study will helpful to understand the dynamics breaks of the ISMR.







2002

Abstract ID – 174

Impact of Indian Summer Monsoon on Post-Summer Monsoon Tropical Cyclones

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Abstract

Our study is on the impact of Indian Summer Monsoon on the frequency of Tropical Cyclones in the Bay of Bengal during the post-monsoon (October- November) period. The Bay of Bengal receives a large amount of freshwater through river runoff from the major Monsoon-fed rivers. Our study shows that the frequency of cyclonic activity during post-monsoon period is higher (lower) following a heavy monsoon (drought) period. The increase (decrease) is stronger during October and November months with no effect during December. The large influx of freshwater strengthens the Barrier Layer and forming a shallower Mixed Layer Depth (MLD) over the Bay of Bengal. Shallower MLD indicates lesser volume of seawater to be heated from the same amount of solar insolation. This indicates a greater heat retention in the MLD thereby increasing the frequency of cyclones. Calculation of the Tropical Cyclone Heat Index (TCHP) confirms our findings of increased (decreased) in cyclonic activity post heavy rainfall (drought).

Abstract ID – 179

Rainfall Estimation OverOceans UsingGlobal Precipitation Mission (GPM) Microwave Imager and Dual Frequency Radar Observations

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Theme:Observations in Climate Variability and Changes.

Abstract

Estimation of rainfall is difficult, due to its high variability on spatial as well as temporal scales. To measure rainfall, scattering and emission based methods are often used with satellite microwave (MW) observations. In this present study, scattering index (SI) based rainfall estimation for Oceans surrounding India[35° S - 25° N and 25° E - 140° E] has been done. SI is depression in the 85 GHz brightness temperature (BT) due to scattering by hydrometeors. The non-raining 85 GHz BT is approximated by non-scattering low frequency channels (19 and 22 GHz). To develop the algorithm, we have generated a collocated data set of BT observations from Global Precipitation Measurement Mission (GPM) Microwave Imager (GMI)and near surface rainfall measurements from Dual-frequency Precipitation Radar (DPR). GMI is a passive microwave radiometer and DPR is an active sensor onboard GPM. Dataset is divided in two parts, training and test dataset.Using the training dataset SI is developed with BT measurements from GMI at frequencies 18.7, 23.8 and 89 GHz for the non-rainy and rainy pixels. These SI values are used against rainfall measurements from DPRto develop a new regional relationship between SI and rain rateover the study area. A non-linear relationship is established between SI and rain rate. An intercomparison of estimated rain is carried out with rain rates from GMI as provided in the operational dataset from NASA using GPROF algorithm. Comparison showsa correlation of 0.57, bias of -0.39 and root mean square difference (rmsd) of 3.77 mm/hr for rain rate <40 mm/hr.

Keywords -Brightness temperature, Scattering index, Rain rate, Microwave.

Abstract ID – 192

Wave climate variability and estimation of wave energy along coastal seas of India

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Abstract

As a viable renewable resource of energy, the assessment of wave energy potential is of great importance to provide sustainable energy in the future. To identify the feasibility of wave energy extraction, the knowledge of the spatial and temporal variability of wave energy is an essential requirement. This necessitates the study of wave power potential of Indian seas. The present study addresses the analysis of climate variability and estimation of wave energy.The comprehensive analysis of long-term wave climate using significant wave height (SWH) and means wave period (MWP) parameters and also derive the wave power. Based on thecomparison with in-situ buoy observations obtained from National Institution of Ocean Technology (NIOT) Chennai, WAM model data with a spatial resolution of 0.125 º x 0.125 º grids from 1979 to 2017 (39 years) is utilized. The numerical WAM model shows a good correlation of 0.97 with the in-situ observations. The wave power is estimated over a grid covering 65º - 90º E longitude and 30º - 2º N latitude. Based on the distribution of annual mean wave power 30 locations were selected in the Arabian Sea (AS) and Bay of Bengal (BoB) along with Indian coast at about a depth of ~200 m. The locations at AS and the southern tip of India has annual mean wave power >10kW/m. The monthly mean wave power for seven locations is observed to be above 20kW/m for almost 4 months (June to September). Two locations at the southern tip of India shows the monthly mean wave power to be more than 10kW/m throughout the year. All locations in BoB along Indian east coast exhibit very low monthly mean wave power compared to that of AS. The study identified two potential regions, northern AS and the southern tip of India, which can be used to set up a wave energy plant. The northwestern coast of India can be a suitable region which receives very high wave power for four months in a year. The second potential area is located at the southernmost point of the Indian peninsula which receives a fair amount of wave power throughout the year.

Abstract ID – 193

Exploring the satellite rainfall behavior over Western Ghats of India using GPM and TMPA products

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Abstract

India is a good test platform for the evaluation of satellite-derived precipitation due to its unique geography, complex topography and monsoon activity. As Indian monsoon is tele-connected with different oceanic and land surface phenomena its best spatio-temporal exploration by satellites is always viewed in the greatest interest.As mountains pose challenge to satellite retrieval of rainfall, a thorough study was carried out on the satellite rainfall characteristics over Western Ghats of India having elevation > 500m in contrast with a flat region over central India with elevation < 500m. We have used TRMM Multi-satellite Precipitation Analysis (TMPA)/ Integrated Multi-satellitE Retrievals for GPM (IMERG) and India Meteorological Department (IMD) gridded rainfall data sets for the period 1998-2016. Different periodicities over terrain and flat regions by the two data sets triggered to study the Intra-seasonal Oscillation (ISO) include Madden Julian Oscillation (MJO) and Quasi Biweekly Oscillations. When MJO is in Indian Ocean during both strong and weak Madden Julian Index (MJI) days satellite inferred rainfall and IMD rainfallare in relatively better agreement over terrain than that of flat region. Despite of higher seasonal bias over terrain (~155 mm), linear association between IMD rainfall and satellite retrieve rainfall is better over terrain, evidenced by correlation coefficient 0.35 over terrain and 0.23 over flat. Satellite underestimates precipitation (> 8mm/day) over terrain. The days when wind at 200 mb / moist static stability exceeds their climatology linear association between the two rainfall data sets ate 0.73 /0.90 over terrain showing better agreement that flat. The overall study suggests that the capability of satellites in estimating the rainfall over terrain regions can be improved by utilizing the above-mentioned hypothesis andit will help the scientific community to study/model the landslide phenomena using satellite rainfall over Western Ghats.

Keywords - Satellite derived rainfall estimates, Intra-seasonal oscillations, Western Ghatsof India.

Abstract ID – 200

Characteristics of zonal and meridional winds above Maitri, Antarctica

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Abstract

The Movable Atmospheric Radar for Antarctica (MARA) has been operating at the Indian research station Maitri, located at a low-level site near the coast at 71°S, 12°E since 2014. MARA is a wind profiler radar operating at 54.5 MHz and provides continuous measurements of full height profiles of winds, turbulence, waves, and diverse atmospheric features starting from the troposphere to the mesosphere. The present study focuses on the zonal and meridional winds above the Maitri station up to the height of 7km (height resolution of 75m and 150m) for the period 2014 to 2018. The annual cycle of the zonal and meridional winds are generated using the available data. Observed tropospheric zonal winds are westward throughout the year with occurrence of intermittent eastward wind bursts. Meridional winds are generally poleward, although brief episodes of equatorward flow are observed. The zonal winds are in the range of 10 – 15 m/s whereas the meridional winds are within the range of 5 – 15 m/s.

Abstract ID – 205

Estimation of turbulence parameters using spectrum width observed by the 205 MHz Radar at Cochin

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Abstract

Small scale turbulence is an important process of atmospheric dynamics. Turbulent kinetic energy dissipation rate and eddy diffusion coefficient are usually used as measures of turbulence intensity, and have very practical application to aviation safety. MST radars are particularly used for studies of the turbulence in the lower atmosphere. There are different methods of estimating turbulent diffusivity from radar observations. The relationship between the spectrum width measured from Doppler radar and eddy dissipation rate has been established for decades. In this work, we use the Doppler spectral-width method, for the estimation of turbulent kinetic energy dissipation rate and eddy dissipation rate in tropospheric and lower stratospheric regions over Cochin (10.04^{o} N, 76.33^{o} E) during pre-monsoon, monsoon and post-monsoon seasons. This method make use of the relation between the doppler width to dissipiation rate (ϵ_k). For this study, high resolution data is collected from the 205 MHz Stratosphere Troposphere (ST) Radar established at the Advanced Centre for Atmospheric Radar Research (ACARR), situated at Cochin University of Science and Technology campus, Cochin, India. The measurement of spectrum width is determined not only by the Doppler velocity and density distribution of the scatterers within the radar resolution volume, but also other radar observation parameters like beam width, pulse width, antenna rotation rate, etc. We make suitable corrections to the Doppler spectral width before estimating energy dissipation rate and eddy diffusion coefficient. The dependence of turbulence on the background wind conditions are studied during pre-monsoon, monsoon and post-monsoon seasons.Turbulence is higher during pre-monsoon season at boundary layer, but are higher above 2.5 km during monsoon season. Higher values of turbulence parameters at lower troposphere during monsoon season partly may be due to higher values of wind shear.

Abstract ID – 229

Use of OLR for tracking of Maximum Cloud Zone and the ITCZ over Indian region during SW Monsoon

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Abstract

INSAT-3D is an indigenous advanced dedicated meteorological satellite in geostationary orbit, which was launched on 26th July 2013. INSAT-3D was declared operational by IMD on 15th January 2014. INSAT-3D has four payloads namely: IMAGER, SOUNDER, Data Relay Transponder (DRT) and Satellite Aided Search, Aid and Rescue.IMAGER is an advanced six spectral channels Very High-Resolution Radiometer (VHRR) in, Visible (VIS), Shortwave Infrared (SWIR), Mid Infrared (MIR), Thermal Infrared 1 (TIR1), Thermal Infrared 2 (TIR2) and Water vapour (WV) part of spectrum covering following bands: VIS (0.55 µm -0.75 µm), SWIR (1.55 µm -1.70 µm), MIR (3.8 µm -4.0 µm), WV (6.5 µm -7.1 µm), TIR1 (10.2 µm -11.3 µm) and TIR2 (11.5 µm -12.5 µm).

The INSAT-3D Outgoing longwave radiation(OLR) geophysical product (GP), a fast-delivery level-2 product at pixel resolution, is being generated operationally from every half hourly acquisition of Imager Payload of INSAT-3D. The OLR is estimated from the radiance observations in the infrared windows (TIR1: 10.3 –11.3µm, TIR2: 11.5 - 12.5µm) and water vapor (WV; 6.5 – 7.1 µm) channels of INSAT-3D Imager. An attempt has been made to present use of INSAT-3D Satellite derived OLR for tracking of Maximum Cloud Zone and the ITCZ over Indian region during South West Monsoon. For this study,four monsoon seasons from 2014 to 2017 are analyzed.The daily binning of these half hourly acquisitions is performed.In addition to this daily product, Weekly binning products with week ending on Sunday and Thursday are also generated. All these products are then resampled to a fixed grid over full disk, Asia and Core Monsoon Zone. The analysis of these three products is performed on latitudinal and longitudinal analysis. An attempt is made to analyze all seasonal features, cloud movement, life cycle for MCZ, month to month variation, seasonal transitions, active and break monsoon features, associated with MCZ and ITCZ as per the hypothesis proposed by DR Sikka&Sulochana Gadgil (1980). In addition to South West Monsoon, it is shown that, Outgoing Longwave radiation product is also used to capture signatures of MJO, Western Disturbances, Heat waves and Duststorms etc.

Keywords -SW Monsoon, OLR, INSAT-3D, ITCZ.

Abstract ID – 274

The affect of raindrop size sorting on radar parameters

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Theme: Observations in climate variability and changes

Abstract

This paper presents the retrieval of raindrop size distribution (DSD) parameters from micro rain radar (MRR) measurements made at coastal station Thumba. The retrieved DSD profiles are divided into separate rain regimes (convective, transition and stratiform), based on classification scheme, to examine salient microphysical characteristics and the vertical variability of DSD in different precipitation regimes. DSD parameters estimated using gamma fit method revealed a systematic variations of DSD in three different rain regimes namely (convective, transition and stratiform). From the observed vertical variation of DSD parameters and the median volume diameter various microphysical processes like drop sorting, coalescence, evaporation and breakup were assessed. Although size sorting is most apparent and dominant process in the convective and transition rain regimes, results demonstrate that size sorting is widespread in occurrence and is possible in stratiform regime also. Present results have a significant impact on the polarimetric radar variables, most notably ZDR along a gradient of ZH. Also, special care must be taken in attempts to assimilate polarimetric radar data into numerical weather prediction models, especially ZDR in cases of ongoing size sorting. The significance of the present study lies in validating the indigenously developed C-band Doppler weather radar installed at Thumba.

Abstract ID – 275

Distinct Atmosphere-Ocean coupling processes over Tropical Indian Ocean Associated with Onset phase of Indian Summer Monsoon and its Progress during 2017 and 2018 using SCATSAT data

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Theme:Observations in Climate Variability and Changes.

Abstract

Monsoon onset over Kerala is a coupled Ocean-Atmosphere phenomenon characterized by large scale features of precipitation, wind and Outgoing Long-wave Radiation. As per IMD, the MOK during 2017 is May 30th and during 2018 is May 29th, just 2 days and 3 days before Normal date (June 1st) of monsoon onset. Even though, these two onsets have it's own distinct features with each other and by analysing these years, we tried to understand the potential predictors of MOK in perspective of atmosphere-ocean influence. The OLR pattern area averaged over IMD's Kerala region from 15 days before onset to 15 days after onset shows nearly 4 to 5 days forward shift (i.e., about one pentad) during 2018 comparing with 2017 and the value of OLR is above 200 W/m2 during the onset date. The response from ocean over Arabian Sea in terms of Latent heat flux and wind stress just after one pentad, the onset is week on 2018 MOK compared to the strengthening trend of these parameters during 2017 MOK. The signals over Tropical Indian Ocean begins to visible from 3 pentad before onset during 2017 is observed only after one pentad i.e., two pentad before onset in 2018 MOK. The analyses suggests that the conditions are not favourable for sustaining the precipitation after MOK during 2018 and this leads to a conclusion that about one pentad delayed ocean-atmospheric response over North Indian Ocean especially over Arabian Sea causes not to occur a good monsoon onset during this year. The Latent Heat flux and ocean surface wind stress over Arabian Sea are very essential factors that controls the intensity of MOK.

Abstract ID – 301

On the Association Betweenthe Western Pacific Convective Systems, Strength of ElNino/LaNina and the Indian Summer Monsoon Activity

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Abstract

The summer monsoon rainfall over India, exhibits a large interannual variability in terms of the onset of monsoon over Kerala (MOK), the amount of rainfall received over various meteorological sub divisions and also the monsoon activity(active and break spells).The association between the intensity of El Nino/La Nina (weak, moderate, strong and very strong) and Indian summer monsoon rainfall activity over the Indian subcontinent has been studied for the period of 1957-2017 (61 years). The intensity of El Nino/La Nina is determined based on the Oceanic Nino Indexsea surface temperature.The characteristics of the convective systems such as frequency, duration and direction of the movement of themover the Bay of Bengal and the Western Pacific region have been studied using the data from the UNISYS website(http://weather.unisys.com) and their association with the monsoon activity over the Indian subcontinent. During the study period, the earliest MOK date was on the 14thMay 1960(neutral phase) and most delayed was on 18thJune, 1972 (Strong ElNino). The delayed onsets were in general associated with strong and very strongEl Nino years; whilst La Nina years were associated with early MOKs. Further, La Nina years, in general had equal number of active and break spells. El Nino years on the other hand had, very less number of active spells.In order to bring out the differences in geographic location, duration and tracks of the convective systems over Bay of Bengal and Western Pacific, composites for weak, moderate, strong and very strong El Nino, La Nina and Neutral conditions were plotted. A study oftracks of the convective systems formed over the Western Pacific region showed a significant change in the tracks during the El Nino years as compared to Neutral and La Nina years, indicating their predominant role on the monsoon activity over the Indian subcontinent.

Key words -Convective systems, Monsoon, Bay of Bengal, Western pacific, El Nino, La Nina.

Abstract ID – 304

Study on Cn2 over Bengaluru using Pisharoty GPS-RS data

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Abstract

Earth's atmosphere, a mixture of gases including water vapour, is a medium of propagation for electromagnetic radiation (EMR). Atmosphere is characterized by continuous minor fluctuations in its composition and so are the variations in the refractivity of the medium effecting the propagation of EMR. Water vapour in the atmosphere plays a significant role in the variations of refractive index. Refractive index is a function of atmospheric pressure, temperature and water vapour content (measured in terms of specific humidity or relative humidity).

Atmospheric layers are embedded with pockets of irregularities due to fluctuations in the pressure and temperature fields of atmosphere called turbulent pockets which cause the irregularities in the layer refractivity. These irregularities cause part of the incident EMR to echo back towards the source of EMR like clear air radars or wind profilers. These echoes provide vital clues on the state of the atmosphere. Thus turbulence in an atmospheric layer is estimated using refractivity structure constant (C_n^2). Thus a profile of C_n^2 over a region is considered as an index of refractivity structure constant and the information is one of the inputs used in the design phase of a wind profiler to arrive at optimum design parameters.

During April 2017 to April 2018, intermittent week long daily twice GPS-RS ascents were taken from Bangalore University, to collect upper air data using Pisharoty GPS-RS instruments developed by ISRO. The base data at 1 Hz sample rate was processed to obtain high resolution vertical profiles of atmospheric pressure, temperature and relative humidity at 300 meters height resolution. This data has been used to estimate C_n^2 vertical profiles over the Bangalore region.
In the present study, over all height variations of C_n^2, diurnal variations in different months with specific cases of weather disturbances are presented. The regional information on the vertical variations of C_n^2 can be used as a guide line during the design phase of wind profiler.

Abstract ID – 306

Climate Change over Eastern India:Impact of Land Use and Land Cover Changes

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Abstract

Land Use and Land Cover (LULC) changes can alter surface energy fluxes, that in turn can modulate atmospheric thermal structure and mesoscale weather pattern and regional climate. However, global warming compounded with the change in LULC has made it difficult to seggregate these signatures in the meteorological parameters. In this study we attempt to quantify the signatures and influences of LULC changes over Eastern India using surface based and space borne observations along with reanalysis products from India Meteorological Department (IMD), Advanced Wide Field Sensor(AwiFS),Moderate Resolution Imaging Spectroradiometer (*MODIS*), National Centers for Environmental Prediction (NCEP) etc. We found that during 2001-2010 there is a change in the cropping pattern where the Kharif crop which is generally cultivated during the summer monsoon has decreased by ~20% in the Eastern India (specifically North Eastern Odisha) contrast to ~100% increase in the Rabi crop which is a post monsoon type of cultivation. Also, urban regions have expanded significantly. Impact of these changes on Diurnal Temperature Range (DTR), defined as difference of maximum to minmum temperature, a widely used variable to quanitfy surface signature in temperature have been accessed. It is observed that the night-time temperature has been increasing at a much faster rate than the day time, leading to reduction of DTR over Eastern India. We also found that temperature has increased by ~0.4^{o}C only because of LULC changes over the region which contributes ~50% of the total temperature rise during 2001-2010. Such signatures are responsible for the overall change in the climate dynamics of the region which is exclusively influenced by LULC change.

Keywords -DTR, LULC, Eastern India.

Abstract ID – 317

Long-term trends of various winter precipitation events over Northwest India

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Abstract

In this study, we analyzed long-term climatology, variability, and trends in the daily precipitation events of ≥1 mm during winter season (Dec–Feb) over the northwest India (NWI) and its related 9 subdivisions using a new high resolution (0.25° × 0.25°) data of India Meteorological Department (IMD) from 1901 to 2013. The association of teleconnections (such as, NAO, Nino3.4 SST and SOI) of winter precipitation with the various intensities of daily precipitation (DR) events like, light rainfall (LR≥1–5 mm), moderate rainfall (MR≥5–10 mm), heavy rainfall (HR≥10–15mm) and very heavy rainfall (VHR≥15 mm) events have examined. The frequency of DR events and its seasonal precipitation over the NWI indicates, on average 140 grid points per day received measurable DR events of >1mm out of 1480 grid points. Nearly, half of the events were LR, but more than 53% contribution of precipitation to season is only from VHR. There are more than 50% of DR events have occurred only in Jammu &Kashmir, in which region having maximum precipitation. In the recent period (1957-2012), the seasonal mean of DR (4/day) events increased as compared to the earlier period (1901–1956) and its results tend to increase the 8% of seasonal precipitation over NWI. The frequency of various DR events is highly correlated with seasonal precipitation and the values of LR, MR, HR, VHR and DR events are 0.68, 0.79, 0.87, 0.95 and 0.89 respectively. The daily mean of various DR events and its precipitation for the whole study period (1901-2012) increased from December to February for all subdivisions as well as the whole NWI region. In the recent period, these DR events and associated precipitation has drastically decreased in January and increased in February. On the whole season, it is slightly increased. The positive linear trends are highly significant over Jammu & Kashmir, while the rest of subdivisions in negative linear trends. In this study, it clearly noticed that, in the recent decades, the relationship of various DR events and associated precipitation over NWI is weakening with NAO/AO and strengthening with Nin˜o–3.4 region SST/SOI (ENSO). Therefore, the high-resolution daily gridded precipitation data is very useful to understand the variability trends in the local climate and its global teleconnections for a long-term risk management in various sectors and for technology adaptation to the changing climate.

Keywords -Daily precipitation events, Trend analysis, Teleconnections, Winter season, Northwest India.

Abstract ID – 344

Long-term Trend and Variabilities in the North East Monsoon Rainfall over India

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Abstract

The long-term variabilities and tendencies of North East Monsoon Rainfall (NEMR) over India are studied by employing multivariate regression analysis on the India Meteorological Department 1°×1° gridded rainfall data for the period 1958-2017. The southern east coast and adjoining interior regions and Northeast India get rainfall mainly due to this monsoon. There is an increasing trend in the southern east coast around 11.5°N, whereas there is decreasing trend of 33 mm/year at south tip of Indian peninsula. Most of northeast India shows increasing trend in NEMR. The south India below 15°N shows moderate response to solar cycle whereas east coast above 15°N shows negative response. The eastward QBO winds at 30 hPa in October favours NEMR at south tip of Indian peninsula, whereas the NEMR response to MEI is negative. The southern east coast shows negative response to QBO and MEI. The northmost part of India shows negative response and northeast India shows mixed response to MEI and QBO. It is 30 found that most of the rainfall deficient years are solar maximum with westward QBO phase at 30 hPa. Extreme rainfall over southernmost part of Indian peninsula (Tamil Nadu) is influenced mostly by strong El Niño and La Niña. After 1980, excess rainfall has occurred in the beginning year of El Niño and ending year of La Niña.

Abstract ID – 372

A historical study of decreaseing trend in convective parameters during tropical cyclones over Bay of Bengal

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Abstract

It is observed that there is a significant decrease in trend in number of Tropical Cyclones (TCs) over Bay of Bengal (BOB) region from 1900 to 2010, with a much greater fall from 1953-2002. In this study, we have considered a total of 453 cyclones out of which 14 occurred during winter season (JFM), 78 during pre-monsoon (AM), 124 during Monsoon (JJAS) and 236 during North-East Monsoon season (OND). For each Cyclone, we have determined the formation, peak, landfall and dissipative stages by considering the cyclonic parameters. The reasons behind the decrease in trend in TCs over BOB have been investigated with the help of convective parameters computed using ECMWF data sets. The parameters like CAPE, CINE, LCL, LFC, SST, Surface Pressure (SP), MSLP, Winds, Temperature (100hPa, 500hPa and minimum) and RH (600hPa, 700hPa) were shown significant increasing/decreasing trend (during Annual as well as Seasonal periods) at different stages of TCs. It is found that the increasing trend in SST and RH leads to widespread convective systems of longer duration associated with stronger rain bands leading to enhanced rainfall. The decreasing trend in LCL and LFC leads to decrease in CINE, tending to decrease in cloud base height, increase in Rapid convection; and decreasing trend in CAPE, SP and MSLP leads to reduce deepening of clouds. The decreasing trend in Horizontal Wind tends to decrease Rapid Intensification probability in formation stage whereas the increasing trend in Horizontal wind tends to increase the lifetime of TCs over land in Dissipation stage.

Key words -Tropical Cyclone, Bay of Bengal, CAPE, Wind, SST.

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Abstract ID – 373

Climatological Characteristics of Tropical Cyclonic Systems forming near to East Coast of India during North-East Monsoon

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Abstract

In the present study we have investigated the Tropical cyclonic systems forming overBay of Bengal, particularly in October-November-December Season (OND) whichpossesses strong Rain Bands leading to the enhancement North-East Monsoon Rainfall (NEMR) activity over South-East Indian Coast as well as Tamil Nadu and Kerala.In general, the land fall of these cyclonic systems during OND period will occur at Odisha, West Bengal, Bangladesh and Arkan Coasts.Here, we have classified the Cyclonic systems formedduring OND with the help of IMD Rainfall, Cyclone track, and the other atmospheric parameters from observation, satellite and model based datasets;into three categories depending on their origin formation as: (1) synoptic scaleconvective systems pushed from South China Sea, (2) Cyclonic Systems forming within 85°E-95°E longitude, (3) Cyclonic Systems forming to the west of 85°E longitude. It is found that the Type 3 Cyclones may possess very strong rain bands and gives torrential rainfall over East Coast than those cyclones ofType 1 and Type 2.Since, Type 1 and Type2 cyclones are more often windy and associated with strong mesoscale convective systems, tends to maximum rainfall under its Central Dense Overcast (CDO). It is found that Type3 cyclonic systems have access to the following initial conditions like: (A) maximum relative humidity (RH in %) West of 85°E at 700 hPa levels than in mid Bay of Bengal (B) relatively more temperature at 100 hPa level to the west of 85 Ethan in mid Bay of Bengal, (C) relatively less amounts of Vertical Wind Shear (VWS) to the West of 85E than in mid Bay of Bengal. The recent events of Ogni-2006 and Nisha-2008; depression 96B over BOB during November 2015 are the examples of Type3 category which are related tothe extreme rainfall events during NEMR period.

Key words -Cyclonic systems, Bay of Bengal, North-East Monsoon, rainfall.

Acknowledgements:One of the authors (MSA) is thankful to SERB, DST, Govt. of India for providing SERB-NPDF to carry out this research work.

Abstract ID – 379

Role of meso network of observations in real time analysis and nowcasting during Very severe Cyclonic storm VARDAH

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Abstract

To meet the requirements of weather critical space launch operations, Meteorology Facility of SDSC SHAR located over South East Coast of India is equipped with diverse meso-network of observations like meteorological towers, Pisharotysonde ascents, wind profiler, atmospheric static electric field mills, Doppler Weather Radar (DWR), automatic weather stations, etc. Along with Numerical Weather Predictions (NWP) at medium range and short range forecast scales, network of meteorological observations and satellite observations plays a major role in real time monitoring and nowcasting of cyclonic storms over South Bay of Bengal which is concerned to SHAR region. In this paper we discussed the real time observational analysis and nowcasting of very severe cyclonic storm VARDAH (6th to 13th Dec. 2016) using meso-network of Meteorological observations for SDSC SHAR space launch operations. The maximum peak wind of 99 kmph at 10m level and 153 kmph at 100m level, which were historical highest recorded values at SHAR region since 1990 were observed during VARDAH. Vertically west ward tilting of the storm during its landfall which was a salient feature of this storm was observed by Win profiler of SHAR on 12th Dec. 2016. During this storm a lowest station level pressure of 995 hpa were recorded over SHAR region. Due to the westward movement of the storm during landfall, most of the cloud mass was confined to left forward sector of the storm and gave very heavy rainfall in North Tamilnadu districts (380 mm recorded at Satyabama University. SHAR region which was in the right side of the storm during landfall received relatively less rainfall (164 mm), however it experienced a prolong period (1100-2100 hrs on 12th Dec.) of strong winds (>100 kmph) which caused uprooting of many historic trees over the region.

Abstract ID – 385

New avenueforairborneatmospheric research in India

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Abstract

Need of Airborne Observations

An aircraft allows the scientist to target a specific atmospheric phenomenon, to follow it while it is moving in the atmosphere, and to sample its properties in situ. Indeed, such measurements will be bridging the gap between ground and satellite derived observations from the micro to the continental scale to investigate atmospheric phenomena.

The airborne atmospheric research over several European, American and Asian countries have started in the late 1980s and more than 100 research aircrafts are being utilized worldwide to address various unanswered atmospheric problems.

National Facility for Airborne Research (NFAR)

Under the leadership of IITM, the National Facility for Airborne Research (NFAR) is being established by the Ministry of Earth Sciences (MoES), Govt. of India to boost atmospheric research by providing an airborne platform for studying various atmospheric processes such as cloud-aerosol interactions, cloud microphysics and precipitation processes, atmospheric chemistry, dynamics and thermodynamics of the atmosphere, cloud-aerosol-radiative feedback mechanisms associated with the climate variability and change over the Indian sub-continent. Such a facility will help to meet the challenges of the expanding subject and to be at par with other atmospheric research communities in the world. A medium size twin engine turboprop pressurized aircraft is being procured for this facility. The airborne platform serving as a national facility will be managed by IITM.

Research Aircraft and Hangar

A medium size twin engine turbo prop pressurized aircraft is being procured with service ceiling limit of 30000 ft. and will fly with minimum lowest operating altitude as 500-1000 ft over sea. The aircraft will carry scientific payload of 900 kg -1200 kg with 4 scientists and range will be 2500 km or endurance will be about 5 hr.

State-of-art airborne instruments will be installed onboard to measure all the meteorological parameters, cloud microphysical properties, physical and chemical characteristics of aerosols, trace gases, radiation and turbulence.

A hangar is planned at Aurangabad airport for maintenance and repair of aircraft, development, installation, calibration and modifications of scientific instruments onboard. Depending on the research objectives, the aircraft operations will be conducted in different seasons and bases in the country.

NFAR Operations

The airborne platform will cater the scientific need of several national research and educational institutions in the country. Various research activities/ problems will be addressed at local/regional/ national context.

The scientific proposal will be called well in advance from various national institutes/ universities engaged in atmospheric research for airborne measurements to be conducted next year. Scientific Advisory Committee (SAC) will scrutinise these proposals and approve the NFAR flying program for coming year.

Abstract ID – 386

Analysis of Forecast Upper Winds at Sriharikota Island during the launch Clearance

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Abstract

Sriharikota being a coastal station in Peninsular India, it encounters tropical maritime climate. Prediction and study of upper winds are essential for launch missions like PSLV, GSLV and pre-launch day-to-day activities at SatishDhawan Space Centre, Sriharikota (SDSC SHAR).In this study, Weather Research and Forecasting (WRF) model, Global Forecast System data (NCEP GFS) and SHAR radiosonde data is predicted/analyzed surface and upper winds over Sriharikota island .Based on the radiosonde ,NCEP GFS & High Resolution WRF model data over SHAR we have collected for every Launch since PSLV-C28 on words. In addition to we have collected Europian Center for Medium Range Weather Forecast (ECMWF) data up to 12 km upper winds both Zonal &Meridional winds for GSLV & PSLV launch campign activity.Therefore regional meso scale models such as the Advanced Weather Research version of the Weather Research and Forecasting (WRF-ARW) models are often used to provide various parameters at fine grid spacing .The results of the model were compared with the observations of the Sriharikota station. The comparison showed good performance for upper winds and acceptable performance for predicting of windtendencies.

Abstract ID – 412

Indian Ocean SST and Indian monsoon rainfall: Relationship and variability during IOD years

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Theme:Observation in Climate Variability and Changes.

Abstract

Sea Surface Temperature (SST) and precipitation over Indian Ocean and Indian Continent for the period 1901-2006 are analysed to understand the relationship of the above parameters with respect to Indian Ocean Dipole (IOD) event. Monthly mean SST data from the NOAA Extended Reconstructed Sea Surface Temperature (ERSST) V4 with a resolution of 2° × 2° has been used following Huang et al., 2015, while monthly mean of 1°× 1° grided rainfall dataset from the Global Precipitation Climatology Centre (GPCC) over land surface following Becker et al., 2013, IITM Pune precipitation data for all India region and Dipole Mode Index (DMI) SST dataset following Saji and Yamagata, 2003 are also used. Classification of IOD years are based on DMI data and its standard deviation following Mahala et al., 2015. Out of the 106 years study period positive IOD, negative IOD and non IOD years respectively identified as 16, 15 and 75 years. All India IITM precipitation exhibits positive correlation with DMI SST in positive IOD years while; negative in negative IOD and non IOD years and correlations are significant at 0.01 level. All India Summer Monsoon Rainfall (AISMR) of IITM precipitation is negatively correlated with DMI SST having significance at 0.05 level. 10-year running correlation between yearly mean DMI SST and IITM precipitation indicates an increasing trend for the period 1901-2006 with negative correlation from 1901 to 1972 and positive correlation thereafter. Insignificant correlation prevails during 1902-1935, 1943-1951 and 1962-1982, while significant correlation exists during 1936-1942, 1952-1961 and 1983–2006. 10-year running correlation between ERSST V4 and GPCC dataset indicate maximum significant correlation during the period1901 to 2006 except for the periods 1909-1917, 1932, 1940, 1948, 1953-1956, 1993 and 2001-2003. Correlation between ERSST V4 and GPCC is negative and show an increasing trend for the period from 1901-2006 having significance level 0.05. ERSST V4 SST shows negative and significant correlation with GPCC precipitation in all the IOD years including the south-west monsoon season. The study examines in detail the relationship between SST over Indian Ocean and Precipitation over India at seasonal, interannual and decadal time scales.

Keywords -Indian Ocean Dipole, Precipitation, Sea Surface Temperature, India.

Abstract ID – 426

Observed Multidecadal see-saw of ENSO-Monsoon relationship over India and West Africa

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Abstract

The simultaneous linear relationship between El Niño/Southern Oscilaations (ENSO) and Indian Summer Monsoon (ISM) precipitation is known to have undergone significant changes on the inter-decadal time scale. While these decadal changes are often attributed to shift of the climatic patterns, it may also arise from the natural variability of the two random time series. In the present study, we show that the strength of the association between ENSO and West African Summer Monsoon (WASM) precipitation has also undergone significant decadal changes. Using the observation datasets we show that, while the ENSO-ISM relationship weakened during past seven decades, ENSO-WASM relationship strengthened to above 95% significance level. We also propose a common mechanism to explain the multidecadal see-saw of the ENSO-Monsoon relationship of India and West Africa.

While the association between ENSO and mid-latitude temperature anomaly was strong and concentrated over north-west of Indian region before 1980s, the anomalies are spatially discontinuous and weak after 1980. Moreover, the location of the anomaly shifted westward to over Africa after 1980s, helping strengthen the ENSO-WASM relationship.

Further, we show a significant change in the relationship between Atlantic Niño and ENSO before and after 1980s. While before 1980s ENSO did not have much impact on Atlantic Niño index-3 (ATL3), after 1980s El Niño (La Niña) is coincidental with negative (positive) ATL3 index. Since a negative (positive) ATL3 reduce (enhance) WASM by increased southwesterly moisture flux, the ENSO-WASM relationship strengthen post 1980s.

Using a suite of CMIP5 simulations in the historical time, we show that GCMs also capture the out-of-phase impact of ENSO on Indian and West African summer monsoon. This study suggests that the decadal variations of ENSO-ISM and ENSO-WASM relationship is governed through physical processes and possibly could not be due to pure noise in the time series.

Keywords -El Niño/Southern Oscillations, Indian summer monsoon, West African summer monsoon, Decadal Variability.

Abstract ID – 436

Study of thermodynamic indices and parametersin association with pre-monsoon thunderstorms/Nor'westers over North East India during 2014-2018

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Abstract

In the tropics, most of the extreme weather events areconvective in nature. Forecasters across the country routinely make subjective assessments of convective potential for their forecast area based on the values of various atmospheric parameters and indices. Many parts over the Indian regionexperience thunderstorms at higher frequency duringthe pre-monsoon months (March–May), when the atmosphere is highly unstable because of high temperatures prevailing at lower levels.The weather systems that predominantly affect the north-eastern parts of India during the pre-monsoon summer months (March-May) are severe thunderstorms, locally named as 'Kal-baishakhi' or 'Nor'westers . The storms are devastating in nature particularlydue to strong (gusty) winds, heavy rains and hails associated with it. Although these storms arewell known for its power of causing damages, studies on them are relatively few due to their smallsize and sparse network of observations over the region.

In this paper an attempt has been made to investigate different stability indices and parameters likeShowalter index,Lifted index , K index ,bulk Richardson number (BRN),Severe WeatherThreat index, Total Totals index, Convective Available Potential Energy,Equivalent Potential temperature at 850 hPa level,Dew point temperature at 850 hPa level, Relative Humidity at 700 hPa level for Dibrugarh(27.47° N, 94.91° E), Guwahati (26.10°N, 91.58°E) and Agartala (23.88°N,91.25°E) for the year 2014, 2015,2016 and 2017 during pre-monsoon summer months (March-May) using 0000 UTC radiosonde data in order to determine the threshold values of these indices for occurrence of thunderstorms/nor' westers over the region. Validation of the suggested threshold values of indices and parameters was also conducted onthe days of thunderstorm activity for the year 2018. Attempt has also been made to compare the values of thermodynamic indices with the predefined threshold values of the indices and parameters for occurrence of thunderstorms/nor'westers over the region.

The detail results of the analysis will be presented in the conference.

Abstract ID – 438

A pilot study on the energetics aspects of the Very Severe Cyclonic Storm OCKHI over north Indian Ocean in 2017

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Abstract

The 2017 North Indian Ocean cyclone season was a below average event in the annual cycle of tropical cyclone formation. This season produced only three named storms, where one only intensified into a Very Severe Cyclonic Storm Ockhi (29 Nov 17 - 06 Dec 17). This was the fourth cyclonic storm developing over Comorin Sea (south of Kerala and Tamil Nadu and west of Sri Lanka). However, cyclone, Ockhi did not cross Tamil Nadu and Kerala coast and moved across Lakshadweep Islands. It was a rare cyclone with rapid intensification in genesis stage. It intensified from deep depression into a cyclonic storm over Comorin area within six hours. An attempt has been made to study the different salient dynamical features of this VSCS '***OCKHI'*** from an energetics perspective. For that, different energetics parameters, viz., eddy Available Potential Energy (A_E), Zonal Available Potential Energy (A_Z), Zonal Kinetic Energy (K_Z), Eddy Kinetic Energy (K_E) and their generations and inter conversions i.e. $G(A_E)$, $G(A_Z)$, $C(A_E, K_E)$, $C(A_Z, K_Z)$, $C(K_Z, K_E)$, $C(A_Z, A_E)$ have been computed on day to day basis during above mentioned period over the region bounded by 2.5°N to 40°N latitudes and 40°E to 110°E longitudes. NCEP reanalysis data have been used for the above-mentioned grid and 12 atmospheric pressure levels starting from 1000 hPa to 100 hPa to compute above parameters.Day to day quantitative analysis of these parameters has been studied critically during the various stages of the cyclones. Analysis of the variations in the energy terms have been carried out for the duration of the formative, intensification and dissipation stages of the cyclones.

Following salient results have been found:

(i) The maximum intensification of OCKHI appears to be due to the generation and increase in the value of eddy kinetic energy, which again is due to the barotropic and baroclinic energy conversation to eddy kinetic energy.

(ii) Baroclinic energy conversion was more dominant during the intensification of the cyclone and during the mature stage the barotropic conversion to the eddy kinetic energy was much prominent.

(iii) Mid latitude baroclinic circulation doesn't appear to have significant influence on the intensification of OCKHI.

Abstract ID – 457

Surface wind and Lightning association over Himalayan regions

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Abstract

The processes involving in the lightninggeneration and its association with local meteorology and dynamics are quite complicated. Lightning is positively correlated with deep and strong convection occurred due to unsaturated air on the ground with respect to moisture. The sources of unsaturated air on the ground are, may be,surface temperature, land surface inhomogeneities, soil, mountain valley-plateau wind, and thermally driven wind. In addition, two air masses i.e. cold-moist and dry-hot, coming from deferent direction force to rise where they converge or flow together, and generate convectionover the region. In this study, wind and lightning flashes are considered for Tibetan Plateau and Himalayan foothill region Bay of Bengal to bring-out the relationship between them. Satellite data such as LIS,MODIS and MERRA for lightning and weather parameter, such as humidity, winds, and brightness temperature etc., of the clouds is used for the period of 2000-12. It is found that deep cloud with cloud top temperature less than -70 ^{0}C is formed over the IGP region where two air masses, i.e. warm-dry air masses coming from north-western IGP and cold-moist air masses from the Bay of Bengal, are coinciding. A channel of deep cloud along with converging zone of these two air masses from Bay of Bengal to south Indian penusula Kerla and karnatka is revealed. Huge lightning over this region is found. Huge lightning is also found during cyclonic winds over Tibetan Plateau. It is seen that westerly winds is blowingparallel to each other without interfacing during January to Marchover the region. During that period lightning is found either very less or zero over the region. The considerable lightning is, however, observed from April to September, when the pattern of wind is unlike of these months. In April, westerly winds are deflected from its path begin to merge together (i.e. converge) over mid of eastern TP, considerable lightning has been observed over the region. This deflection has become more prominent in May; enormous lightning is found over the region. North-westerly wind is high in June and July, and flows in cyclonic motion found high density of lightning over the regionduring the month. Similar activities is also seen during August and September with less intensity of lightning and winds. On an account, nearly 92% lightning is found during April-September followed maximum during May-July (58%) over TP region.

Abstract ID – 469

Ground Based and Space Borne Observations of Lightning over Maharashtra

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Abstract

Lightning is a global phenomenon which can be used to measure of the key variability in global change. The lightning activity is associated with thunderstorms and heavy rainfall. The type (IC/CG discharges) and frequency it is intimately related to the microphysical, kinematic properties of the cloud systems and to its environment. Lightning information is also useful for monitoring evolution of tropical cyclones and it's weakening/intensification.

IITM has installed a Lightning Location Network (ILLN) over Maharashtra and around 20 sensors are currently operational to monitor occurrence of lighting in real time in the past 4-5 years. This network uses wideband sensors in the frequencies range VHF to HF. The processing algorithm uses received electromagnetic wave forms from theirtime of arrival and shape to locate and classify the lightning flash either as IC (Intra Cloud) or CG (Cloud to Ground). The lighting Imaging sensor (LIS) was onboard TRMM, in non-sun synchronous low earth orbit since 1997 and was operating since April 2015. After a gap of two years similar instrument is currently flying with Internal Space Station (ISS) for a period of three years. Unlike ILLN sensors LIS has CCD camera which detects optical pulses from lightning flashes in the near infrared (777.4 nm) wavelength during both day and light. The detection threshold is influenced by background radiation and hence time of observation.

ISS-LIS flash data is a very recent product and not yet quality controlled and well validated. Similarly, ILLN is a new initiative and not used so far in cross validation activities. In this work LIS flash data from ISS and TRMM were used along with ILLN to find out detection efficiency and location accuracies of LIS sensors.

Abstract ID – 474

Studies on characteristics of monsoon clouds measured using compact lidar at a tropical coastal station, Kochi (9.9° N, 76.2° E)

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Theme: Aerosols, Atmospheric Chemistry and Weather/Climate

Abstract

This paper describes the development of a compact lidar system and preliminary results of the experiments carried out at a tropical coastal station, Kochi during the onset of south west monsoon in 2018. A compact lidar system has been designed and developed indigenously at Laser Science and Technology Centre (LASTEC), Delhi by using minimal number of off-the-shelf components. It uses Nd: YAG laser operating at 1064 nm with pulse energy of 3-5 mJ, pulse width of 6 ns and PRF of 20 Hz as a transmitter and 100 mm diameter Cassegrain optical telescope with 3 nm interference filter as a receiver. The system has the capability of transmitting laser radiation in vertical direction as well as elevated slant path. Experiments were carried out using this system during onset of south west monsoon at Kochi. The backscattered signals from the near field to maximum detectable range of 8-9 km were obtained during daytime. Since most of the experiments were conducted during daytime, the sky conditions were also monitored visually. Our visual inspection revealed the presence of low-level rain bearing clouds and our experimental site also received intermittent rainfall during experiments. The total backscattered lidar signal is basically characterized by the nature of cloud and other species in the atmosphere i.e. humidity, drizzle and aerosols. The cloud signal to noise ratio is large and the retrieval of cloud heights (i.e. base and top) from single profile is not difficult. The cloud base and heights have been derived from the measured signal profile at different times.The measured profile showed the presence of different layers of clouds at various heights. Three layers have been seen in the region from 700 m to 1700 m and fourth layer between 3700 and 3900 m, fifth layer between 4700 and 4800 m, sixth layer (dense cloud) between 6700 m and 7700m. We have also observed the rain phenomena occurred within the cloud layers. On 29 May 2018, we have measured the height of the rain bearing clouds. The laser beam was sent at an angle of 17 degree (slant angle) in the atmosphere and measured the multiple scattering from raining clouds. The base of the cloud was determined from data, which was extending from 146 m to 600 m above the ground. Real time detection and monitoring of movement of clouds with their occurrence height and multiple layer information is very much required for safe operation of aircrafts and helicopters at airbase stations. We have validated our system performance with commercial Ceilometer (M/s. Vaisala). Results are in good agreement with each other.

Abstract ID – 483

Assessment of PaleoclimaticChanges in Lower Baitarani Basin, Odisha, East Coast of India

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Abstract

Climate on the earth has always remained dynamic with most apparent changes in climatic history experienced in during of glaciation and de-glaciation. This periodic thaw and freeze has influenced coastal climate significantly and thus some of the most important traces of climate change are well preserved in the sediments of coastal environment. Geochemical proxies has provided vital tool to analyze and interpret the past climate as well as processes. In this study we have tried to elucidate the paleoclimate of Lower Baitarani Basin, East Coast of India using geochemical proxies. Subsurface sediment samples have been retrieved from two locations along the river. The estimation of major and trace elements has been done using Energy Dispersive X-ray Fluorescence (EDXRF) spectrometry and total organic carbon has been determined using Walkley-Black method. Geochemical proxies i.e. Al_2O_3, FeO, MgO, TiO, Cu, Zn, Ba and Co has been used to assess variability in detrital flux. In-situ productivity has been estimated on the basis of $CaCo_3$, and CaO/Al_2O_3. For the analysis of salinity variation MgO/(CaO+MgO) has been examined. Along with these, the chronology of the deposition has been done through Accelerator Mass Spectrometry (AMS). The results have indicated significant deviation in detrital flux, productivity, salinity condition as well as age of deposition in the study region.

Key words -Climate, Geochemical proxies, Detrital flux, Paleo-productivity, Salinity.

Abstract ID – 509

Near-surface observations of high resolution turbulent latent and sensible heat fluxes and momentum from research ship during the Bay of Bengal Boundary Layer Experiment (BoBBLE)

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Abstract

Observations of latent and sensible heat fluxes and momentum flux have been made with ship-borne instrumentation to examine air-sea interaction and boundary layer processes in the southern Bay of Bengal (BoB) during the Bay of Bengal Boundary Layer Experiment (BoBBLE) field expedition. For that purpose, a high-frequency eddy covariance flux measuring system and oceanographic sensors were deployed on CSIR-NIO (CSIR-National Institute of Oceanography) research vessel RV SindhuSadhana for a month (June-July 2016) to collect surface turbulent flux variables and sea surface data. An eddy covariance flux measuring system included sonic anemometer/thermometer, Infrared Gas Analyser, tilt, and acceleration, and four components of radiation sensors (shortwave in, shortwave out, downwellinglongwave and upwelling longwave). Radiosondes were launched to collect atmospheric data to describe the marine atmospheric boundary layers over the BoB. Data collected from the eddy covariance system permitted the direct computation of turbulent latent and sensible heat fluxes and wind stress using eddy correlation method (ECM). The ECM results are validated with the bulk aerodynamic method (BM). Analysis of data suggests that the latent heat flux (LHF) variation was in the range of 40-260 Wm-2 while the sensible heat flux (SHF) varies between -10 Wm-2 and 20 Wm-2. The wind stress value ranged between 0.05 Nm-2 and 0.45 Nm-2. Hourly averaged net heat flux (Qnet, i.e., net heat flux at the sea surface) was observed maximum around 700 Wm-2, and the minimum less than -200 Wm-2. At the time series location, Qnet remained positive till 15 July and contributed to the increase in SST (sea surface temperature). The last part of the cruise experienced deep convection, and the associated decrease in the incoming solar radiation made Qnet negative. The atmospheric boundary layer (ABL) height H is estimated using radiosonde data. Here H is determined from the radiosonde data derived potential temperature (θ, resulting temperature when an air parcel at a given level is compressed/expanded to 1000 hPa pressure adiabatically) profile. There are different ways of defining H, and here it is defined as the lowest altitude where the rate of increase of potential temperature with height exceeds 2.5 K km-1. H typically varied between 0.5 and 1 km. Observed low values of H around 15 July are related to atmospheric convection and precipitation. Following rains, atmospheric boundary layer collapses, and its recovery depends on the surface SHF and data suggests that H recovers in about 12 hours. The field experiment data are also compared with RAMA (Research Moored Array for African–Asian–Australian Monsoon Analysis) buoys data for climatology. RAMA buoys were first deployed at 8 N 90 E in 2007, and continue to provide data. Climatology of daily SST measured by RAMA buoy suggests SST reaches a peak in April and then cools continuously. Cruise period is characterized by small variations in the mean SST albeit a slight cooling trend is present. During the BoBBLE, SSTs increased past the climatological values at the time series location.

Abstract ID – 515

District-wise Assessment ofVulnerability and Risksdue to Climate Change for the Indian Himalayan Region (IHR)

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Abstract

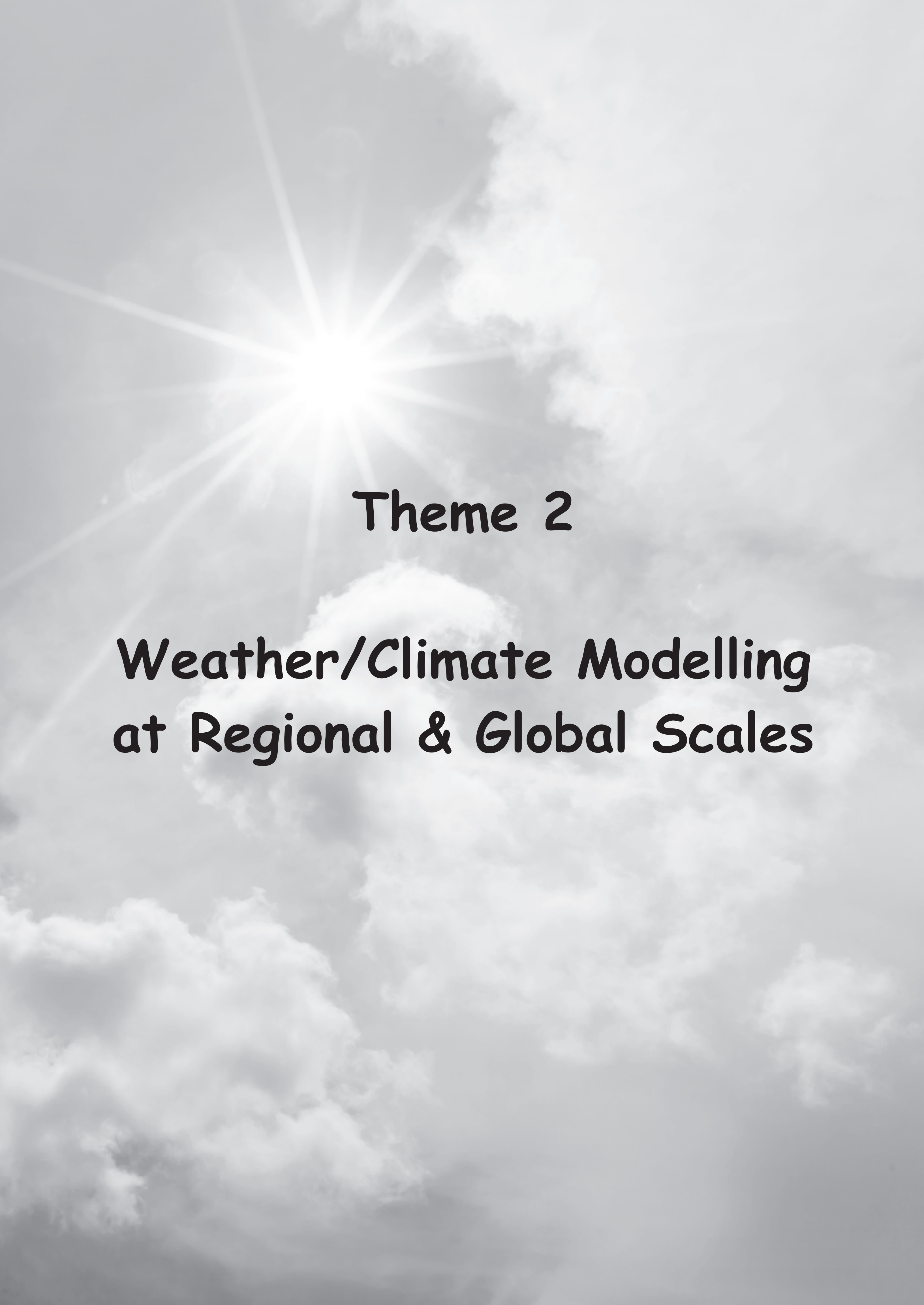
The Himalayan range is one of the youngest and loftiest, mountain ranges that harbor a complex & diverse ecosystem vital to the ecological security of Indian land mass. Himalayas support some 1.5 billion people in south-east Asia dependent for water, food, energy and other ecosystem services.In recent times, climate change is emerging as the key driver behind the rapid changes to both natural and socio-economic system.

The Indian Himalayan Region (IHR) like other ecological regions of the world is facing significant challenges whiledealing with the adverse impacts of climate change.The Indian Himalayan Region is impacted by climate change in terms of its socio-economic, biological and geophysicalsystemsthat includeagriculture, hydro-geological resources, forests, biodiversity, food, energy, health, tourism and livelihood. The vulnerability and risk associated to these sectors and communities varyacross the region depending upon the degree of susceptibility and ability to cope with the adverse impacts.

In order to address adaptation needs and to reduce the vulnerability of the communities living in potentially affected regions, the National Mission on Sustaining Himalayan Ecosystem (NMSHE) being implemented by the Department of Science and Technology (DST) is targeting an integrated vulnerability and risk assessment covering the Indian Himalayan Region (IHR). The assessment will serve as an important basis for prioritizing, planning and implementing adaptation measures at district or sub-district level.

DST has established State Climate Change Cells (SCCCs) in 11 out of 12 States of the Indian Himalayan Region for implementing NMSHE related State CC Action Plans. One of the major objectives of these SCCCsis toassess thevulnerability and risk due to climate change at district or sub-district level using a common frameworkand develop a seamless pan Himalayan vulnerability map.

The paper presents DST’s initiatives to develop a framework and guideline for vulnerability assessment in the IHR, the progress so far and wayforward.



Theme 2

Weather/Climate Modelling at Regional & Global Scales

Abstract ID – 8

Ensemble – based Sensitivity Analysis for a heavy rainfall event over Uttarakhand State

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Abstract

In June 2013, Uttarakhand witnessed a flood whose conditions were different from those of the recent floods happened over the Himalayan region. The Uttarakhand heavy rainfall case, on a synoptic scale, was characterized by the merging of a midlevel trough in the westerlies with a monsoon low resulting in the advection of large amounts of water vapour into the Uttarakhand region.The study analyses the sensitivity of the heavy rainfall event using an ensemble - based sensitivity approach. Ensemble sensitivity analysis is applied to Uttarakhand rainfall during June 2013 using the Advanced Research version of the Weather Research and Forecasting (WRF) model DART based Ensemble Kalman Filter to understand the forecast uncertainty. The sensitivity analysis quantifies the changes in the forecast metric to the changes in theinitial conditions. A statistical estimation of the forecast sensitivity is carried out using the ensemble sensitivity analysiswhich estimates the relationships between forecasts and initial conditions.Initial results are encouraging and the sensitive patterns are obtained which suggests that forecast variable is sensitive to the initial conditions over that region.

Abstract ID – 12

Impact of flow - dependent ensemble error covariance in the three – dimensional variational data assimilation method in a limited area model over the month of July 2013

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Abstract

This study compares the performance of a hybrid ensemble – variational (HYBRID) data assimilation (DA) method with the traditional three – dimensional variational (3DVAR) DA system in a monsoon month using a limited area model. The data is continuously cycled using both the DA systems at every 12 h between 1 – 31 July, 2013 0000 UTC over a domain spanning over Indian subcontinent. The performance of both the DA systems are evaluated through the verifying the forecasts at 12, 24, 48 and 72 h initialized twice daily from the analysis of each methods using radiosonde observations and high resolution ERA Interim analysis. Results show that the analysis and forecasts from the HYBRID DA system has consistently improved and outperformed the results from the 3DVAR system. Root mean square error calculated for different meteorological variables show smaller error in the forecasts initialized from the HYBRID as compared to the 3DVAR system. The forecast skill for precipitation is validated through equitable threat score and bias. Both the validation methods depicts advantages in quantitative precipitation forecasts for HYBRID DA system.

Abstract ID – 19

Impact of sea-spray induced flux on tropical cyclone: A cause study during Vardahcyclone over the Bay of Bengal using COAWST model

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Abstract

The strong winds associated with tropical cyclones(TC) lead to the wave-breaking activity that produces sea-spray droplets from the air-sea interface. These droplets release water vapor to the near-surface atmosphere by evaporation and modulate heat fluxes between atmosphere and ocean. The sea-spray droplets affect to the air-sea turbulent fluxes by altering the mean state of the air-sea interface.The TC is a coupled atmosphere-ocean weather phenomenon where the ocean is the main source of the energy to afford the heat for TC. Therefore, without coupling the atmosphere to the ocean, the real-time feedback of exchange the heat at the surface remains absent. In the present study, we utilized the coupled ocean-atmosphere-wave-sediment transport (COAWST) model to simulate atmospheric and oceanic conditions during Vardah cyclone from 10th December to 15th December 2016 over the Bay of Bengal (BoB). The aim of the study is to assess the impact of sea-spray induced fluxes on the TC track and intensity. In order to investigate this impact,two numerical experiments along with dynamic sea-surface roughness scheme were performed. The parameterization of dynamic sea surface roughness was based on the wave age parameters (following Drennan scheme). A validation of model simulated wind speed, wind direction, and mean sea level pressure against the buoy measurements shows the better simulation capability of the coupled model when the sea-spray induced flux parameterization was included in the coupled model. Further, the model experiment with sea-spray flux parameterization shows a significant improvement in cyclone track and intensity as compared to other experiments.

Abstract ID – 28

Boreal summer tropical rainfall climatology simulation using state-of-the-art climate coupled models

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Abstract

State-of-the-art global coupled models used in seasonal prediction systems and climate projections have unrealistic simulation of boreal summer tropical rainfall climatology (e.g., Indian monsoon, inter-tropical convergence zone, ITCZ), which also illustrate our incomplete understanding of the key mechanisms controlling the position of the ITCZ during boreal summer. This has serious implications as it will lead to deficiencies in future monsoon projections as well as seasonal monsoon forecasts. The dry land monsoon and Pacific double ITCZ biases are commonly attributed to too coarse horizontal atmospheric resolution, atmosphere-ocean coupling errors in coupled models and deficiencies to represent sub-grid scale processes in too coarse atmospheric models. However, the role of land surface parameters (albedo, emissivity, roughness length, moisture, vegetation etc.) on these tropical rainfall biases in coupled models has received less attention. Hence our primary objective here is to show the pivotal role of land surface albedo (background) and temperature errors in regulating the tropical rainfall biases in current coupled models.

Abstract ID – 43

Structure, characteristics, and simulation of monsoon low-pressure systems in CFSv2 coupled model

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Theme:Weather/Climate Modelling at Regional &Global Scales.

Abstract

Indian Summer Monsoon (ISM) synoptic scale systems (low-pressure systems, LPS) are knownto produce increased rainfall over central India (CI). Fidelity of the Climate Forecast System version 2 (CFSv2)at simulating the LPS and their characteristics is evaluated in this study using a feature tracking algorithm.The model is able to reproduce the clustering of LPS by monsoon intraseasonal oscillations and the associatedprecipitation over eastern-central India. It is found that mean biases in circulation and moisture stemfrom cold sea surface temperature (SST) bias in the model which results in weak LPS linked rainfall eventsover central India. Two sensitivity experiments were carried out to study the effect of coupled dynamics oftropical basins on LPS. Suppression of active dynamics of the tropical Indian Ocean in CFSv2 causes a reductionin cold SST bias and enhanced cyclogenesis in the northern Bay of Bengal. The reduced low-level anticyclonicbias and enhanced moisture availability result in a better simulation of LPS structure, andassociated precipitation over CI. Suppression of active ocean dynamics in tropical Pacific Ocean causes a perennial El-Nino type bias which restricts LPS propagation over the Indian landmass, possibly due to timemeansubsidence induced by remote El-Nino forcing. Sensitivity experiments indicate the need for improvementsin the representation of tropical Indian Ocean coupled dynamics as well as convective parameterizationschemes in the model for subsequent improvements in the simulation of ISM at various time scales.

Ankur Srivastava, Rao, Suryachandra A., Rao, D. Nagarjuna; George, G., Pradhan, M. (*2017*) Structure, Characteristics and Simulation of Monsoon low-pressure systems in CFSv2 coupled model. ***Journal of Geophysical Research: Oceans***, 122, 6394–6415, doi:10.1002/2016JC012322.

Abstract ID – 51

Seasonal prediction of Indian summer monsoon rainfall in NCEP CFSv2: forecast and predictability error

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Abstract

A detailed analysis of sensitivity to the initial condition for the simulation of the Indian summer monsoon using retrospective forecast by the latest version of the Climate Forecast System version-2 (CFSv2) is carried out. This study primarily focuses on the tropical region of Indian and Pacific Ocean basin, with special emphasis on the Indian land region. The simulated seasonal mean and the inter-annual standard deviations of rainfall, upper and lower level atmospheric circulations and Sea Surface Temperature (SST) tend to be more skillful as the lead forecast time decreases (5 month lead to 0 month lead time i.e. L5–L0). In general spatial correlation (bias) increases (decreases) as forecast lead time decreases. This is further substantiated by their averaged value over the selected study regions over the Indian and Pacific Ocean basins. The tendency of increase (decrease) of model bias with increasing (decreasing) forecast lead time also indicates the dynamical drift of the model. Large scale lower level circulation (850 hPa) shows enhancement of anomalous westerlies (easterlies) over the tropical region of the Indian Ocean (Western Pacific Ocean), which indicates the enhancement of model error with the decrease in lead time. At the upper level circulation (200 hPa) biases in both tropical easterly jet and subtropical westerlies jet tend to decrease as the lead time decreases Despite enhancement of the prediction skill, mean SST bias seems to be insensitive to the initialization. All these biases are significant and together they make CFSv2 vulnerable to seasonal uncertainties in all the lead times. Overall the zeroth lead (L0) seems to have the best skill, however, in case of Indian summer monsoon rainfall (ISMR), the 3 month lead forecast time (L3) has the maximum ISMR prediction skill. This is valid using different independent datasets, wherein these maximum skill scores are 0.64, 0.42 and 0.57 with respect to the Global Precipitation Climatology Project, CPC Merged Analysis of Precipitation and the India Meteorological Department precipitation dataset respectively for L3. Despite significant ElNiño Southern Oscillation (ENSO) spring predictability barrier at L3, the ISMR skill score is highest at L3. Further, large scale zonal wind shear (Webster–Yang index) and SST over Niño3.4 region is best at L1 and L0. This implies that predictability aspect of ISMR is controlled by factors other than ENSO and Indian Ocean Dipole. Also, the model error (forecast error) outruns the error acquired by the inadequacies in the initial conditions (predictability error). Thus model deficiency is having more serious consequences as compared to the initial condition Also, the model error (forecast error) outruns the error acquired by the inadequacies in the initial conditions (predictability error). Thus model deficiency is having more serious consequences as compared to the initial condition error for the seasonal forecast. All the model parameters show the increase in the predictability error as the lead decreases over the equatorial eastern Pacific basin and peaks at L2, then it further decreases. The dynamical consistency of both the forecast and the predictability error among all the variables indicates that these biases are purely systematic in nature and improvement of the physical processes in the CFSv2 may enhance the overall predictability.

Keywords -Indian summer monsoon rainfall ·Predictability error Forecast error · CFSv2.

Abstract ID – 53

Prediction of Visibility over Indian Region using Regional Configuration of NWP Model during Fog

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Abstract

Accurate prediction of visibility during winter months especially in December and January over Indo-Gangetic (IG) plains of India are important because even a short duration of dense fog can cause disruption in air and highway traffic. Accurate forecasting of fog is still a challenge as the genesis and development of fog is governed by multiple of processes. Visibility forecasts available from regional Unified Model operational at National Centre for Medium Range Weather Forecasting (NCMRWF) known as NCUM-Reg are utilized to predict fog. NCUM-Reg has a grid spacing of 4 km and is set up over domain covering Indian region. The initial conditions of global NCUM-G with horizontal resolution of 17 km are downscaled to 4 km in the nested regional model. The lateral boundary conditions from NCUM-G are provided at an interval of three hours in NCUM-Reg. Hourly forecast of visibility is available everyday for a forecast length of three days from the model. The predicted visibility is verified over IG plains of India during winter months of December and January. The results indicate that model can capture a significant variability in the observed fog.

Abstract ID – 57

Impact of Different Ocean Conditions and its Response in the Bay of Bengal using HWRF-HYCOM idealized Frame-work for Tropical Cyclone Prediction

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Abstract

Ocean-atmosphere coupled tropical cyclones (TCs) forecasts are performed using idealized representations of the ocean and atmosphere to study the impact of different oceanic conditions present in the Bay of Bengal (BoB) on predicted intensity and also the ocean response due to the TC interaction. The atmospheric model Hurricane Weather Research Forecast (HWRF) is initialized with an idealized vortex with highly conducive background environment. Initially, eight different climatological mean temperaturesalinity profiles in the BoB are used to initialize the idealized horizontally homogeneous ocean representing pre- and post-monsoon conditions over northern, central and southern BoB and also averaged over the entire bay. As the climatological conditions are highly favorable for the TCs to attend their maximum potential intensity and modest impact on intensity evolution. The strongest storm is formed in the southern BoB pre-monsoon case which has the highest initial SST and heat content relative to the 26°C isotherm. For all the cases, weaker storms were formed for post-monsoon compared to pre-monsoon. In all cases, intensity evolution was closely related to the time series of enthalpy flux averaged over the inner-core region of the storm where this flux is largest. By contrast, intensity was less closely related to SST averaged over the inner core region, and poorly related to total SST cooling that occurred within the cold wake. It is therefore critically important to evaluate the physical realism of coupled prediction systems within this inner-core region, which will require simultaneous collection of high-quality observations of atmosphere, ocean, and surface fluxes. Two additional experiments were performed to assess extreme ocean conditions within the BoB, and also to assess the impact of warm eddy and cold eddy present in the ocean with same salinity profile. The ocean response to the TC passage analyzed from HYCOM outputs showed mixed impact of barrier layer and thermal structure with deeper upwelling near the storm center in pre-monsoon southern bay condition.

Key words -Tropical cyclones, SST, ocean-atmosphere coupled, barrier layer, enthalpy flux, intensity.

Abstract ID – 77

Unfolding the mechanism of coupling between cloud and large scale circulation during Indian summer monsoon revealed from CFSv2 model experiment

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Theme:Weather/Climate Modelling at Regional & Global Scales.

Abstract

The interaction between cloud and large scale circulation is much less explored area in climate science.The exploration of this interaction between these two parameters is imperative for improved simulation of Indian summer monsoon (ISM) and to reduce imprecision in climate sensitivity of global climate model. It has already been established that one of the parameters of global climate model (here CFSv2), the critical relative humidity (CRH) can play a seminal role in modulating the large scale system like Indian monsoon by representing the realistic cloud modification in CFSv2.The improved cross equatorial flow and the most realistic eastward and northward water vapour flux (WVF) over the Indian region are the possible dynamical reasons for realistic modulation of ISM rainfall (ISMR) simulated in modified CFSv2 model with the variable CRH profile during the contrasting season. Now the question arises – what are the underlying processes of the model that link the cloud modification with the variability in large scale circulation? As the cloud is nonlinearly related with circulation it may be hypothesized that the internal dynamics of monsoon may play a crucial role for this linkage and is evaluated by the nonlinear scale interactions among dominant scales in frequency and wavenumber domain. The mean-wave and wave-wave interactions among the seasonal mean, low frequency (10-20day and 30-60day) and high frequency (3-5day) oscillations are computed at lower troposphere (850hPa) for reanalysis wind field as well as for the model winds obtained from three different versions of CFSv2 model with three CRH profiles during good(2003) and bad(2009) monsoon years in frequency domain. Whereas, the systematic error energy and its growth rate and different inertial terms responsible for error growth are computed in wavenumber domain showing triad interactions among planetary (wavenumber range 1-4), large (wavenumbers 5-10) and synoptic and small (wavenumbers >10) scale waves. Study reveals that the variable CRH in CFSv2 has improved the nonlinear interactions between high and low frequency oscillations in wind field and modulates realistically the spatial distribution of interactions over Indian landmass during the contrasting monsoon season compared to existing CRH profile of CFSv2. The wind error energy in variable CRH simulation of CFSv2 shows minimum due to the reduced nonlinear convergence of error to the planetary scale range from long and synoptic scales compared to as observed from other CRH experiments in normal and deficient monsoons. Hence, the interplay between cloud and large scale circulation through CRH may be manifested as a change in internal dynamics of ISM revealed from scale interactive quasi-linear and nonlinear kinetic energy exchanges during the monsoon period that eventually modify the internal variance of CFSv2 model. Conversely, the reduced wind bias and proper modulation of spatial distribution of scale interaction between the synoptic and low frequency oscillations improve the eastward and northward extent of WVF over Indian landmass that in turn give feedback to the realistic simulation of cloud condensates attributing improved ISMR in CFSv2. This work has paved the way for linking cloud with large scale circulation which is missing in climate model.

Abstract ID – 78

Understanding the genesis mechanism of Severe Cyclonic Storm Mora and its prediction

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Abstract

Severe Cyclonic Storm Mora was a strong TC that caused widespread impacts by devastation and severe flooding across Sri Lanka, Andaman and Nicobar Islands, Bangladesh, Myanmar and Northeast India in May 2017. In this study we have tried to understand the genesis mechanism of Mora using observation and reanalysis data. We have also evaluated operation GFS forecast in predicting the genesis.

The KALPANA IR images indicate the genesis of pre-Mora disturbance has taken place from a northward moving disturbance within the ITCZ region. The organization of convection started on 24th May and thereafter cloud patch remained intact and became depression on 28th May. Our aim is to understand the processes which evolved from less organized convection till 23rd to organized convection on 24th and further intensification to become depression on 28th May. Which processes helped in making this convection intact and develop it further?

Existence and maintenance of relative vorticity 20th May onwards at mid-level seems with the support for large scale updraft and heating seems to be playing important role in genesis of positive vorticity at lower levels on 24th May which might have helped to organize the convection and gave birth to the Pre-Mora depression on 28th May 2017.

The operation GFS-1534 model could predict this positive mid-level relative vorticity and heating at 5 days lead time. The process of genesis is well captured but there are location errors in the prediction.

Abstract ID – 87

Sensitivity of WRF model, using different combination of cloud microphysics and planetary boundary layer schemes to simulate features related to thunderstorm event over north east India

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Abstract

Thunderstorm of pre-monsoon season, has been a major problem for north east region due to the natural hazard like heavy rain, flash flooding and lightning associated to it. Good prediction of thunderstorm related parameter could be of significance in avoiding or reducing the damage which could be caused by it. NWP models like WRF have been used earlier to predict features related to thunderstorm but due to its small spatial and temporal extent, it has been a challenging task but with higher computing facility it could be achieved. An NWP model have many sets of physical schemes, but the selection of right set of schemes for a particular region is very important in order to improve the model performance. For our study we have used WRF model and examined its sensitivity with different combinations of Cloud Micro Physics (MP) scheme and Planetary Boundary Layer (PBL) scheme to simulate thunderstorm related features over north eastern region. Two dates (8th April, 2017 and 15th April, 2017), were selected for this study, on which severe thunderstorm events were observed over north eastern region. For MP schemes we have taken Morrison, Thompson, WSM6 and WDM6, while for PBL schemes, YSU, MYJ and MYNN3 were considered for this study. In total 12 combinations of MP and PBL schemes were used to simulate features like Maximum Reflectivity, CAPE, CIN, K-Index, Precipitation and Relative humidity. Observed maximum reflectivity obtained from DWR stationed at cherrapunjee was used to examine the simulated reflectivity from model. Lateral shift was observed in max reflectivity toward southwest direction in general, moreover temporal shift was also observed in few simulation. However, there were few combination where, no temporal shift or spatial shift in the system was observed. Similarly simulated CAPE and Precipitation data was also compared and their RMSE plots were generated against ERA-interim and GPM data respectively. Root mean square error (RMSE) plots of CAPE show higher RMSE value for northern Bangladesh, Sikkim ,western Meghalaya , western Assam and Bay Bengal region. While lower RMSE was observed for upper Assam and eastern Arunachal Pradesh. Similarly RMSE plots of precipitation reveals that all the simulations shows high value of RMSE over Western Assam, Eastern Aarunachal and southern Bangladesh region while for Mizoram Manipur and Nagaland RMSE values were lower comparatively. A comparison of simulated vertical profile of RH with all 12 combination against sounder data was also done for three stations (Guwahati, Agartala and Dhaka). Apart from this a quantitative comparison of CAPE, CINE and K-index was also done with the observed sounding data. Two dates of simulations was insufficient to draw some meaningful conclusion, however it was observed that no individual scheme is good for resolving all the parameters simultaneously.

Abstract ID – 88

An apparent relationship between the Interannual variability of the 10-25 & 30-60 day variation during Indian summer monsoon season

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Theme : Observations in Climate Variability and Changes.

Abstract

Intraseasonal variability (ISV) dominated Indian summer monsoon rainfall. Climatologically, the convection over the Indian regions becomes active in mid-May and the active convection continues until late September with active ISV. ISV over Indian region is known to have two components, one with periods 10-25 days and another with 30-60day variability. The relative activity of these modes are known to play an important role in IAV monsoon precipitation. This study investigated the interannual variations (IAV) of the ISV over the Indian Region with a special focus on the relationship between the 10– 25- and 30 –60-day variation. Intensity of ISV is calculated as variance of 10-25 and 30-60 day filtered OLR data over the region. Interanual variance of this intensity is used to represent IAV of ISV. Results show three main regions of prominent IAV over the Indian monsoon domain and considered in the study, namely (A) Arabian Sea (AS: 60°– 70°E, 10°– 20°N), (B) Bay of Bengal (BOB : 80°– 90°E, 10°– 20°N) and (C) Indian Ocean (IO: 80°– 105°E, 0°– 15°S). Relationship between the two ISV modes in these regions is further explored. Results show significant negative correlations during early (June-July) monsoon period over AS & IO regions and in contrast there are significant positive correlation during late (September) in A. However, no significant correlations are found between these two modes in BOB. The results indicates that both the ISVs need not necessarily have to be anti-correlated throughout the season i.e they both can be active over a region simultaneously (September) unlike other basins of South Asian summer monsoon.

Abstract ID – 89

State-of-the-art high resolution mesoscale modelling in prediction of intense vortices over Bay of Bengal

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Abstract

The high-resolution meso-scale models, Advanced Research version of the Weather Research andForecasting (ARW) model and Hurricane Weather Research and Forecasting (HWRF) model are evaluated for prediction of tropical cyclones (TCs) over the Bay of Bengal. The evaluation is based on 30 forecast cases from 5recent TCs with unique features such as recurving, skirting the coast (movement-wise) and different intensity evolution. Error metrics related to movement, landfall, and intensity are computed against best estimates of India MeteorologicalDepartment (IMD). In terms of track prediction, track error ranges up to 400 km in ARW, whereas HWRF model shown marginally less error of 350 km up to 96h forecast length. After that error ranges up to 600km in HWRF. Similar errors are noticed for landfall position by both the models. The intensity error ranges up to 20 knots for ARW while, it is 13 knots for HWRF up to 108 h forecast length, indicating superior performance in intensity prediction. It hasbeen found that the HWRF model is able to produce improved convective warming, stronger vertical motions at the right location/height, relative to ARW predictions when compared to the observed intensity. This work highlights the capability of ARW and HWRF models in predicting TCs. Further emphasizes the importance of the ensemble prediction of these two models in TC forecast guidance over Bay of Bengal region.

Key words -Tropical cyclone, Bay of Bengal, High resolution numerical models, Real time prediction.

Abstract ID – 96

Impact Analysis of dynamical downscaling on the treatment of convection in a regional NWP model COSMO: A case study during the passage of a cyclonic storm

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Themes : Weather/Climate Modelling at Regional & Global Scales, Weather and Climatic Extreme Events.

Abstract

One of the significant sources of uncertainty in predicting severe weather events by Numerical Weather Prediction (NWP) models lies in the parameterization of sub-grid scale convection. It becomes even more difficult in the tropical regions, as tropical convection is governed by processes of the order of hundreds of meters to about 10 km, which are difficult to be simulated using coarse resolution regional models, and have to be parameterized. As the resolution of the NWP models becomes finer, parameterization of convective processes becomes obsolete as the model attains the potential capacity for explicitly simulating convection and associated sub-grid scale processes. However, it has to be noted that there is still an ambiguity regarding the resolution at which the convection parametrization scheme can be "switched off" in the model. This is further complicated by the fact that the different parameterization schemes employed in a model are linked with each other. Any error in the treatment of one scheme will be reflected in the others. Hence careful considerations are required to downscale the grid resolution in NWP models.

In order to explore these issues, a set of simulations of atmospheric conditions during the passage of the tropical cyclone "Ockhi" has been performed using the NWP model COSMO (COnsortium for Small scale MOdelling) at different resolutions with and without a convection parameterization scheme. The features of precipitation as predicted by the model for these different setups are discussed in detail by comparing it with the European Center for Medium Range Weather Forecast (ECMWF) reanalysis data. The possible improvements as well as the limitations of the increased resolution are discussed, with respect to the Tiedtke mass-flux convection parameterization scheme employed in the model.

Keywords -Convection Parameterization, Downscaling, Tiedtke mass-flux scheme.

Abstract ID – 97

Wave-Current Interaction studies using a Coupled ADCIRC-SWAN model for a Hypothetical Bathymetry in the Gulf of Mannar featuring Setu Samudram Navigation Channel through Adam's Bridge

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Abstract

Wave climate over the North Indian Ocean have experienced a paradigm shift in the recent past indicating an increase in the extremes. In addition the climatology of both wind-waves and swell activity has shown an increasing trend over this region. This has a direct impact in context to coastal vulnerability for the Indian mainland as well the Sri Lankan Island. Also, the recent reports indicates on increased cyclonic activity in the south-west Arabian sea directing the threat towards the southern part of Indian land mass and the northern portion of Sri Lankan island. However, this region is known to have lesser impact from waves due to the sheltering effect of Sri Lankan landmass. In a changing climate scenario, keeping in view of increased wave activity and their consequences along the coastal zone, there is a need and necessity to perform numerical modeling of wave-current interaction for this region using state-of-art hydrodynamic models. In this context, the coupled ADCIRC-SWAN would be the best and ideal choice to perform this exercise. The ERA-Interim wind will be used to force the coupled ADCIRC-SWAN model during the monsoon period to understand the wave activity over the study region. In addition, the study also performs numerical simulations to comprehend the impact of extreme waves for Madi cyclone as a case study. Another major objective of the study focuses on the coastal resilience of this region in presence of Adam's Bridge which is known to be the submerged connection between the Indian mainland with the Sri Lankan island. Motivated by one of the recent classical theory which explains the wave propagation over trenches, the present study constructed a hypothetical bathymetry assuming a navigation channel through the Adam's Bridge which was proposed in the Setu Samudram project to understand the changes in wave climate in the region in presence of the navigation channel. A virtual trench/navigation channel of different width and depth is constructed in the mesh comprising the intermediate water bordering India and Sri Lanka through Adam's bridge. Numerical experiments were carried out using coupled ADCIRC-SWAN model both in absence and presence of the navigation channel. The analysis indicates higher wave activity in the region in presence of the navigation channel which is illustrated using the classical wave transformation theories.

Abstract ID – 100

Rainfall pattern inferred from CORDEX-SA domain models for future warming scenarios over Northwest Himalayan region

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Theme: Weather/Climate Modelling at Regional & Global Scales

Abstract

The climatic condition in the Indian subcontinent is highly influenced by the Himalaya as it defends rain-bearing south-westerly monsoon to give up maximum precipitation in that area in monsoon season. From the economic point of view monsoon plays an important role as Indian economy is predominantly dependent on cultivation and India receives more or less 80 % annual rainfall in the monsoon season. From the recent study it can be said that, there will be an anticipation in the rainfall pattern under the global warming scenarios. The rainfall pattern over the North West Himalayan (NWH) region become more unpredictable as there is a difference in the amount of rainfall and duration of monsoon; rainfall become more intense with shorter duration. So, it is very difficult to project rainfall pattern under the different warming scenarios over the mountainous NWH region. The extreme weather condition such as cloud burst, heavy precipitation, flash floods, landslides etc. are happening regularly now a days over that region. In that context, the rainfall pattern over that region can be predict by utilising finer resolution Coordinated Regional Climate Downscaling Experiment (CORDEX) domain models. CORDEX is a WCRP-sponsored international coordinated framework to improve regional climate change projections globally. It's the output of the regional models which take the boundary conditions from global models. The present study has planned to investigate the rainfall pattern from CORDEX domain models in a consistent framework for the time period of 2076 to 2100 under the different future warming scenarios compared to reference historical time frame 1976 to 2000. The ability of four well known driving models (i.e., MIROC5, MPI-ESM-LR, GFDL-ESM2M and IPSL-CM5A-LR) from CORDEX South Asia (CORDEX-SA) domain have been studied according to their simulation capability of the spatio-temporal distribution of rainfall over the NWH region in rainy season. The modelled data has been validated with the ground-based IMD gridded rainfall data set. It is noted from the analysis, that the models like MIROC5 and MPI-ESM-LR provide the best spatial distribution of rainfall, although CORDEX domain models are unable to simulate the intensity of rainfall at daily scale compared to IMD data over the North West Himalayan region. More details will be discussed during the conference.

Key words - Rainfall, CORDEX, Future warming scenarios, MIROC5, MPI-ESM-LR, NWH.

Abstract ID – 103

A study on Sea-breeze circulation using COSMO model over Thumba coast during winter months

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Theme:Weather/Climate Modelling at Regional & Global Scales

Abstract

Sea-breeze circulation is a paradigm of mesoscale meteorological phenomenon that occurs at coastal locations throughout the world. The circulation plays a significant role in modulating the weather over the coastal area. It provides relief from scorching hot weather, triggers thunderstorm and brings oceanic air to the land and thus modulates the air quality. Sea-breeze circulation is characterized by its onset, vertical extent, inland penetration and its diurnal variability. Some aspects of sea-breeze circulations are not extensively studied using various observational platforms, due to limitations in conducting experiments as well as due to lack of proper measuring insturements. Under such conditions numerical atmospheric models becomes an indespensable tool to understand the various features of sea-breeze circulation.

The present study utilises a non-hydrostatic three dimensional atmospheric model COSMO (COnsortium for Small scale MOdelling) to investigate the structure and dynamics of sea-breeze circulation in a coastal station Thumba (8.5^0N,76.9^0E). It aims at the characterization of sea-breeze circulation during the month of February, 2018 when this mesosacle circulation is prominent in this region. The two main components of the sea-breeze circulation cell, the sea-breeze flow in the lower level and the return flow in the upper level is clearly modelled.

The evolution of sea-breeze circulation is studied using COSMO model simulations with forecast fields extracted at selected three grid points in the model domain. One is at Thumba coast(8.5^0N-76.9^0E), second one is an inland point (8.5^0N-77.18^0E) which is about 28 km away from the coast, third one is an ocean point (8.5^0N-76.68^0E) which is also at same distance away from the coast. Model simulations shows onset of sea-breeze at first over the Thumba coast and followed by land and ocean grid points. Temporal variation of sea-breze circulation is studied during the study period using the model. A clear temporal variation of sea-breeze cell is observed over Thumba coast and the selected land point, but such variation is not clearly seen over the ocean grid point. Vertical and horizontal extent of sea-breeze flow over the three grid points is also studied. Performance evaluation of the COSMO model in simulating the sea-breeze circulation is examined. For this, available observation from ICARB (Integrated Campaign for Aerosol and Radiative Forcing) ship campaign and observations from Thumba coast are used. Evaluation of COSMO model performance shows that model is able to capture the features of sea-breeze circulation over Thumba coast and nearby oceanic regions, though there exists a marginal difference in magnitude.

Keywords -COSMO, Sea-breeze Circulation, ICARB.

Abstract Id – 104

Performance evaluation of COSMO model during ICARB field experiment

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Theme: Weather/Climate Modelling at Regional & Global Scales

Abstract

Weather forecasting is the prediction of weather in advance using numerical atmospheric models. Uncertainities in initial conditions and model deficiencies leads to errors in model forecast. It is prime important to understand the performance of a model before the usage of forecast products. In order to study the performance evaluation of a model the forecast fields must be compared with the realistic observations and the differences must be studied in a systematic way. The present study investigates the performance of numerical weather prediction COSMO (COnsortium for small Scale Modelling) model over Arabian sea and Bay of Bengal during the winter season. In order to study the performance of COSMO, the present study utilizes the data obtained from the ICARB (Integrated Campaign for Aerosol and Radiative Forcing) ship campaign. Basic model parameters including temperature, humdity and wind componenets are comapred with the radio sonde observation during the campaigns. The dependence of COSMO model on initial conditions is examined by making use of radio sonde observation from the same campaign. The errors in the COSMO model performance are pesently attributed to misrepresenation of clouds and initial bias in land surface temperature. The present study extensively studied the surface energy budget over ocean, partitioning of incoming solar raditions into sensible, latent and ground heat fluxes. Modelling study on surface energy budget over the study domain has not been addressed in the past. The study attempts to address these outstanding issues also.

Keywords -COSMO, ICARB.

Abstract ID – 107

Now-cast of Thunderstorm event over Delhi NCR with assimilation of Doppler Weather Radar data in ARPS Model

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Abstract

Thunderstorm / Dust-storm are disastrous extreme event that develop& transform and lost only within few hours. Indian region experiences thunderstorms at higher frequency throughout the year except during the winter months. The annual frequency of thunderstorm days is highest over northeastern parts of country followed by southern peninsula and northern parts of country. Lowest frequency of occurrence is over the western parts of country. During monsoon season, the thunderstorm activity is generally noticed along and over the area north of mean position of the monsoon trough zone.

It is a great challenge for the forecasters to nowcast such hazardous extreme weather events. For this study, Mesoscale model (ARPS) with real-time assimilation of DWR data has been operationally implemented at India Meteorological Department (IMD) for real-time now-cast of weather over Indian region. The ARPS model is developed by the Center for Analysis and Prediction of Storms (CAPS). ARPS is a high-resolution non-hydrostatic model, which uses all available observations, including Doppler radar data, satellite data, and traditional sounding and surface data in the data assimilation system. It consists of advance technique ARPS Data Assimilation System (ADAS) with cloud analysis for assimilation of data.

In this study,Thunderstorm event of May 02, 2018 is considered to demonstrate the capability of ARPS(Advanced Regional Prediction System) model to now-cast the extreme weather event over Delhi region. In the present study, analysis and observations are carried out to now-cast thunderstorm activity using ARPS Model with Doppler weather radar data assimilation of 02May 2018 event over Delhi NCR. Model and actual observation have shown nearly similar results of weather event on 02May 2018 over Delhi. We have successfully processing of radar data and initial and boundary condition of GFS data and assimilation of radar (DWR) data using data assimilation technique of ARPS model.Model is able to capture location and intensity of the storm and also able to predict the movement and direction (south-eastward) of the cell. Model also depicts the formation of a new cell at west of Haryana at 10:30 UTC, which is moving eastward and approaching towards Delhi.Finally, we can conclude that Model has predicted that thunder cell will be weaken after two and half hour but in actual observation (DWR) cell weakens after three hours. This is nearly close to actual observation of DWR.

Keywords -Now-cast, Thunderstorm, Doppler weather radar, ARPS Model, ADAS, DWR data assimilation.

Abstract ID – 112

Characteristics of winter precipitation and associated dynamics over north west India using CORDEX-South Asia Experiments

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Abstract

Winter precipitation over northwest part of India contributes one third of annual precipitation over the region which is mainly associated with synoptic system known as Western Disturbances(WDs). Winter (December, January and February: DJF) precipitation is important for the mass balance of glaciers, growth of Rabi crops and Himalayan climate. Snow accumulated all along winter season over high altitude region of Himalaya melt during spring season provides water to major rivers of North India and is important for the hydrology of the region. Lack of observation data is a hindrance to study WD activity over this region. In this scenario climate models are the only available tool to study the climate variability over the region. Higher resolution and inclusion of sub grid scale topography used in Regional Climate Models (RCMs) are useful to understand complexities of winter precipitation. The present study assesses the performance of 10 Coordinated Regional Climate Downscaling Experiments in South Asia experiments (CORDEX-South Asia) along with their ensemble to produce winter precipitation and associated dynamics over the region.Each experiment is compared with observational dataset to identify the bias in precipitation and found that all models along with their ensemble show wet bias over Jammu Kashmir and Karakoram region. Positive precipitation trend is noted in observation dataset but in the case of models some show positive trend while others show negative trend. Taylor diagrams are used to identify how the spatial pattern of winter precipitation are simulated by each model. Air temperature, wind and geopotential height are also calculated to assess the dynamics associated with winter precipitation.

Key words -WDs, CORDEX-South Asia,RCMs,Trend.

Abstract ID – 118

Study of 20-year simulations of monthly vertical wind profile and water vapour mixing ratio during Indian summer monsoon season over Arabian Sea

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Abstract

The purpose of this work is to study the monthly variations of monsoon circulations and moisture content at different atmospheric levels (850, 500 and 200 hPa) over Arabian Sea (ABS) during summer monsoon season. A reliable regional climate model (RegCM3) was used in this study and the experiments like Control (unperturbed SST) and sensitivity (perturbed SST by +0.5°C) were conducted to see the implications on monthly composite Vertical Zonal Wind Shear (VZWS) and Water Vapour Mixing Ratio (WVMR) during Indian Summer Monsoon Season. Monthly wind profile over ABS in its domain (5°-15°N, 50°-80°E) has been studied. The month wise vertical distributions of the moisture content in terms of WVMR up to 200 hPa during summer monsoon season were also calculated over entire ABS centered at 62.5°E-67.5°E longitude and over Indian region centered at 75°E-80°E longitude. The analysis shows the wind shears between the atmospheric levels of 850-500 hPa and 500-200 hPa were increased in the warm SST run. The peak of the wind shear was obviously attained in July. The water vapours were found high at all atmospheric levels in July and August in the case of increased SST of ABS. In the experiments centered over the Arabian Sea (Indian region), we found maximum enhancement of moisture between 5°N-15°N (10°N-15°N) latitudes respectively. The model performance in perturbed SST state was found good in the months of July and August (representative months of Indian monsoon season). Simulated average zonal winds between 850 hPa and 500 hPa in June (September) were sharply increased (decreased) in the SST run. In the study of Indian Monsoon Index (IMI)as an indicator of the strength of monsoon circulations, it is found higher IMIs in the warm SST run in comparison to the Control (CTL) run.

Key words –Wind profile, Indian monsoon index, Water vapour mixing ratio, Sea surface temperature.

Abstract ID – 119

Interaction of Surface Heat Fluxes with Mid Level Vortex in the Tropical Cyclone Mora

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Abstract

The potential intensity of a Tropical Storm (TS) is mainly driven by oceanic heat fluxes. These fluxes depend largely on SST and ocean heat content and modulate the convection rate inside the storm. The present study evaluates the energy exchanges between surface and mid troposphere during TS Mora using a cloud resolving model. We performed different experiments with varying SST frequency to investigate their role in modulating the Latent and Sensible heat fluxes inside the storm system. In our study, we tried to investigate energy and momentum balance inside the storm after its genesis. We have also studied the interaction of these fluxes with mid level vortices and the induced heat fluxes due to inflow-outflow characteristics and cloud hydrometeor phase changes. It is important to see how the surface heat fluxes influence the kinetic energy of the storm and the resulting impact on the surrounding atmosphere. Our findings demonstrate that the low level fluxes play an important role in determining energy balances in mid troposphere but like the present situation, they need not always affect the storm intensity. It is expected that the investigation can be continued and the answers can be obtained further with the help of synoptic scale meteorology.

Abstract ID – 136

Parametrization of Surface fluxes in Atmospheric Models over Indian Region

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Abstract

Parameterization of the surface heat, momentum, and moisture fluxes in different wind and atmospheric stability regimes is required in various numerical models of the atmosphere. Most of the schemes for parameterization of surface fluxes are developed based on the observations collected over mid-latitude regions and are currently being used in operational weather forecast and air quality models over Indian sub-continent. A proper validation of these surface flux parameterization scheme is needed by utilizing the turbulence observations over an Indian region for an improved representation of surface atmosphere interaction processes in atmospheric models. The present study utilizes the year-long observations of surface fluxes collected over an Indian region Ranchi to evaluate the surface flux parameterization schemes currently used in various weather research and forecast models and general circulation models under variety of stability and wind speed conditions. The issues associated with the discrepancies between observed and predicted fluxes, and the inadequacy of current observational data for a more generalized evaluation and improvements in the surface flux parameterization scheme over Indian region are discussed.

Abstract ID – 149

Study on irrigation requirement of barley using decision support tool under warming climatic conditions in Punjab, India

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Theme: Weather/Climate Modelling at Regional and Global Scales.

Abstract

Moisture requirement of barley (*Hordeumvulgare* L.) during *rabi* 2016-17 for Ludhiana and Gurdaspur districts of Punjab were computed using FAO developed windows based decision support system namely CROPWAT (v. 8.0) involving various weather parameters. The experiment was laid out in split plot design with three replications comprising of three sowing environments D_1 (25th October), D_2 (10th November), D_3 (25th November); two varieties V_1 (DWRUB 52) & V_2 (PL 807) and three irrigation levels viz. I_1 (Recommended irrigation), I_2 (Skip at vegetative stage) and I_3 (Skip at anthesis stage). To pursue the study, the model was validated in Ludhiana conditions under varying hydrothermal environments and from regression analysis, it was found that the simulation model showed significantly higher correlation with D_1 (R^2=0.92) along with the most preferred moisture regimes I_1 having highest R^2value (88.27%) among different irrigation levels. ET_oalong with radiation use efficiency was also estimated for both the region and the value stayed higher for Ludhiana as compared to Gurdaspur. Ludhiana recorded $ET_o$and RUE 2.74 mm day^{-1} and 14 MJ/m^2/day respectively followed by Gurdaspur to the tune of 2.17 mm day^{-1}& 12 MJ/m^2/day respectively. With the existing temperature, average crop irrigation water requirement computed by CROPWAT using crop coefficient approach was found maximum for Ludhiana (299 mm/dec) than that of Gurdaspurdistrict (173 mm/dec). Taking the existing temperature as the base, the temperature enhancement trend from + 0.5 ^{o}C to + 2 ^{o}C as suggested by IPCC and various climate science governing body were used in the DSS tool to obtain the present and future water demand of barley in both the districts of Punjab. With the increase in maximum temperature in the coming future, the model predicted the increase in both seasonal irrigation water requirement and ET of barley for both Ludhiana and Gurdaspur region. Increase in temperature up to +2°C from the present state simulated the seasonal ET rate @ 2.85 mm day^{-1} for Ludhiana and for Gurdaspur region, the value was found @ 2.24 mm day^{-1}. Similarly, seasonal irrigation water requirement was increased from 299.9 mm to 316.6 mm for Ludhiana and for Gurdaspur, the same increased from 173 mm to 185.3 mm with the enhancement of temperature up to +2 ^{0}C from the existing conditions. Percent departure ofETo was also measured which stipulated that the irrigation requirement and ET of barley will be influenced significantly more in Ludhiana as compared to Gurdaspur region in the backdrop of prevailing climate change scenarios.

Keywords -CROPWAT, ET_o, IPCC, RUE, DSS, Irrigation water requirement

Abstract ID – 151

CMIP3 and CMIP5 simulated Summer Monsoon Rainfall and associated Wind Circulation over India

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Theme: Weather/Climate Modelling at Regional & Global Scales.

Abstract

In India, SummerMonsoon Rainfall (SMR) variability on intra seasonal to inter annual time scale has been largely influencing drought and flood conditions especially over northern India. The variability of SMR is manifestation of change inwind circulation and temperature distribution. Since, present and possible future changes in SMR are required for agriculture, water resources, disaster and health related study, therefore, in order to understand the changes in magnitude and pattern of SMR under warmer climate, it is also necessary to qualitatively and quantitatively the change ofassociated monsoon wind circulation.

For this purpose, Climate Model Intercomparision Phase 3 and 5 (CMIP3 & CMIP5) simulated wind and rainfall data is considered. For the validation of CMIP3 and CMIP5 models, NCEP wind at 850 and 200hPa and IMD rainfall is taken. In CMIP3, under A2, B1 and A1B emission scenarios during 2011–2040, future projected change in spatial distribution of SMR shows deficit and excess over the lower part of western and eastern coast of Indiain simulation of HadGEM1, ECHAM5, and MIROC (Hires) models which seems to be manifestation of anomalousanticyclonic flow at 850 hPa in Arabian Sea and anomalous westerly flow at 200 hPa. In CMIP5 models, under RCPs 4.5 and 8.5 during 2006-2050, excess and deficit of SMR is possible over monsoon regions of NWI, NEI, WCI, CNI and PIat 99% & 95% confidence levels. Such possible changes in SMR may be due to anticyclonic circulation over ArabianSea at 850 hPa and cyclonic circulation around 40° N,70°E-90°E at 200 hPa.

Abstract ID – 155

Satellite based approximation of Vertically Integrated Moisture Transport over the Indian ocean

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Theme: Weather/Climate Modelling at Regional & Global Scales.

Abstract

In the present study, Vertically Integrated Moisture Transport (VIMT) has been approximated using the space-based observations. In doing so, the relation of the vertically integrated moisture flux with the product of surface wind and total precipitable water (TPW) from the European reanalysis (ERA) data has been analyzed. It was found that a strong correlation exists between above two quantities viz., 0.94 and 0.85 for zonal and meriodional fluxes, respectively. Same was confirmed using vector correlation also.With this motivation this study is carried out to approximate VIMT fields over the Indian ocean (-30^{0}S-30^{0}N; 30^0-110^{0}E) at 0.25^0 resolution during summer monsoon months using analyzed surface winds from Scatterometer Satellite-1 (SCATSAT-1) and TPW from Special Sensor Microwave Imager/Sounder (SSMIS). In order to scale the approximated VIMT, regression analysis has also been carried using 10 years monsoon months (June to September) ERA data. The VIMT fields for pentads are then prepared for continuous monitoring of monsoon activities during the summer monsoon. The impact of VIMT on Indian summer monsoon rainfall has also been studied. Results clearly show theadvantage of using satellite based VIMT fields for real time monitoring of monsoon activities.

Keywords- Vertically Integrated Moisture Flux, Scatsat-1, SSMI, Total precipitable water, analyzed winds.

Abstract ID – 157

Impact of INSAT-3D and 3DR Imager radiances in the NCMRWF's Assimilation and Forecast System

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Abstract

This paper describes INSAT-3D and INSAT-3DR clearsk ywater vapor imager radianceassimilationin the National Centre for Medium Range Weather Forecasting (NCMRWF) Unified Model (NCUM) as simulation and forecast system. Imagers onboard both INSAT-3D and INSAT-3DR have the same configuration and provide multi-spectral images of the earth and the atmosphere at every 30 minutes interval. The image dissemination time difference between INSAT-3D and INSAT-3DR is 15 minutes; hence the combined images from both the satellites are of 15 minutes gap. Single observation experiments, 1D-VAR experiments, and global experiments are carried out to analyze the characteristics and impact of these two imagers. Since both the satellites have same geographical coverage area and same spatial resolution, observations collocated within a temporal resolution of 15-30 minutes are used in the single observation experiments. 1D-VAR simulation over the Ocean shows, the standard deviation of the retrieved humidity profiles are approximately same for both INSAT-3D and INSAT-3DR imagers and is less than the standard deviation of the background profiles. Hybrid-4DVAR assimilation system of NCUM is used in the global assimilation experiments. Hybrid-4DVAR and the combined high temporal resolution of 15 minutes of the set wogeostationary satellite radiances can be explored to provide information on the tropospherichumidity as well as the windfield.

Keywords -Hybrid-4DVar, NCUM, Numerical Weather Prediction, INSAT-3D, INSAT-3DR.

Abstract ID – 161

Impact of microphysics parameterizations and horizontal resolutions on simulation of "MORA" tropical cyclone over Bay of Bengal using Numerical Weather Prediction Model

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Abstract

A numerical weather prediction model, WRF (Weather Research and Forecasting model) version 3.8 has been used to simulate a severe cyclonic storm "MORA" observed over Bay of Bengal (BoB) during 28th -31st May, 2017. The initial simulation has been carried out over the region at 6 km horizontal resolution with 310×330 grid points in both north-south and east-west directions having 30 vertical levels. Initial conditions were used from National Centers for Environmental Prediction (NCEP) Final analysis (FNL) fields available at every six hours at a spatial resolution of 1°×1°. The model simulated features of this event were evaluated against Indian Meteorological Department (IMD) dataand reflectivity profiles by the Doppler Weather Radar (DWR) over the region.Sensitivity experiments were performed using six different microphysics schemes (Lin, Kessler, WSM3, Eta, WSM6 and Thompson) among which WSM3 scheme simulated track was close to the observed IMD track. The model with WSM3 scheme has efficiently captured many important features in simulating the occurrence of the storm accompanied with wind speed, reflectivity though there are some spatial biases in the simulation. After choosing the best microphysics scheme we looked into the model performance in simulating the storm at different horizontal resolutions, 4km and 9km with 480×510 and 210x210 grid points respectively. The results clearly revealed that cyclone track as well as other parameters related to the storm are sensible to horizontal resolution and has improved after finer resolution (i.e. 4 km) simulation.

Keywords - Tropical cyclone, MORA, Cyclone track, BoB, CS, SCS.

Abstract ID – 175

Simulation of the biogeochemistry of the Indian Ocean using an Ecosystem model

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Abstract

Basic physical processes that impact the biological activity are the near-surface processes such as upwelling, entrainment, detrainment, advection, and subsurface circulations (shallow overturning cells and sub-thermocline currents) areexamined in the present study over the Indian Ocean. The two different water masses in the northern Indian Ocean, namely the Arabian Sea and Bay of Bengal behave differently in terms of circulation due to seasonal reversal of monsoonal winds. This is more prominent in the Arabian Sea along the coast of Somalia and Oman. The biological productivity of Arabian Sea is very high as comparedto Bay of Bengal. Apparently due to the presence of river discharge, Bay of Bengal plays an important role in study of salinity and mixed layer dynamics of the ocean subsurface.During the time of upwelling,there exist phytoplankton bloomnear the coasts of Somalia and Oman whichresults in the faster development of other biological variables. From the previous studies it is clear that fresh water fluxes can also play an important role in the evolution of phytoplankton bloom in the Bay of Bengal as well as in the Arabian Sea. Due to the unavailability of observational data for the phytoplankton and related biological variables, the sub-mesoscale biophysical activities are not well explored. In order to have a detailed investigation of the chlorophyll, other biological variables andtheir seasonal variability are to be illustrated by the coupling biogeochemical model with the physical model.

Global ocean models are used as important tools to study the oceans and their variability. If the models are efficient enough to simulate the realistic features, they can be used for process studies and prediction purposes. In the present study we utilized the Regional Ocean modeling system (ROMS) model which is widely used by the ocean modelers globally. The ROMS model simulated physical parameters (sea surface temperature, salinity and surface currents) are validated against available observations. The main research interest is to couple the physical model with the biogeochemical model to understand the variability of the oceanic biogeochemistry over the domain of 30E-120E and 30S-30N in the Indian Ocean. The numerical experiments are performed with a high-resolution(1/4 degree in horizontal) so that it is efficient for resolving meso-scale features.The results from the numerical experiments are discussed in terms of the spatial and temporal variability in the biogeochemical parameters in the Indian Ocean.

Abstract ID – 178

Verification of Ensemble Forecasting of geopotential height

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Abstract

Verification is the process of assessing the quality of a forecast and essential in monitoring performance of a forecasting system. The present study focuses on the verification of global ensemble prediction system (NEPS) implemented at National Centre for Medium Range Weather Forecasting (NCMRWF). Everyday NEPS provides 10 days forecast based on the initial condition of 00UTC. It includes 45 ensemble members (44 perturbed + 1 control) and has horizontal resolution of ~33 km and 70 vertical levels extending up to 80 km. The initial condition perturbation is generated by Ensemble Transform Kaman Filter (ETKF) method and uncertainty in forecasting model is generated using a Stochastic Kinetic Energy Backscatter and Random Parameter schemes. The objective of the present study is to verify the performance of NEPS over northern part of India (18.15° E to 32.55° E and 68.175 N to 86.175 N). Model forecast of geopotential height at 500 hPa is verified against analysis field for the fifteen days period between 19th June and 3rd July, 2018. Following attributes are mainly focused for the verification of this ensemble prediction system: reliability (Reliability Diagram), consistency (Rank Histogram), bias (Brier Score) and discrimination (Relative Operating Characteristics (ROC)). In addition to these the growth of root mean square error of the ensemble mean forecast with time is compared with that of the ensemble spread. The reliability diagram measures the agreement between predicted probabilities and observed frequencies. The day1 probability forecast of NEPS show very good agreement with analysis but the forecasting system shows overconfidence in day3 and day5 forecasts. Rank Histogram checks consistency and diagnoses the average spread of an ensemble compared to observation or analysis. A flat rank histogram for day1 forecast suggests that the ensemble spread correctly represents forecast uncertainty. The day3 and day5 forecasts gives U – shaped rank histogram which implies that the ensemble spread is too small. At the shorter lead time RMSE is less than ensemble spread but as the lead time increases, growth of RMSE value becomes much larger than that of the ensemble spread. Low values of Brier Score for all the five forecast days indicate good accuracy of the forecast. The area under ROC curve lies in the range of (1.0 to 0.82) for all the five forecast. This suggests that the model has high resolution.

Abstract ID – 186

Simulation of precipitation associated with Western Disturbance over North Western Himalaya using WRF

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Abstract

Northern parts of India receive rainfall in the winter season (December to March) mainly due to the Western Disturbances (WD). WD are low tropospheric cyclonic vorticesmoving eastward in the mid latitudes from Mediterranean Sea or the mid-Atlantic ocean. The extent and magnitude of these disturbances are determined by upper tropospheric troughs in the zonal westerlies and are predominant during the northern hemisphere winter. WD are associated with heavy precipitation in North Western Himalayas (NWH) usually in the form of snow which trigger landslides and avalanches. Therefore accurate prognosis of WD is vital for the Himalayan region.Mesoscale models may be utilized for detailedstudy of regional weather features. In the present study, one month simulation from 1st to 31stof March 2017 was carried out using the National Center for Atmospheric Research (NCAR) Weather Research and Forecasting (WRF) model to assess its capability to simulate WD over the North Western Himalayas. Multiple nested domains of 45, 15 and 5 km resolution extending from 65° E to 92° E and 18° N to 40° N was simulated for thestudy but analysis was carried out only for the 15 km resolution domain. National Center for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) reanalyzed data are used for the initial and boundary conditions. The results show that temporal evolution of WD pattern for NWH region during one month are nicely captured by the model simulation.The first WD (7 - 11 March) extended from western Jammu and Kashmir (JK) to Uttarakhand, covering most of Himachal Pradesh (HP) and further moved eastward towards Nepal and eventually dissipated. The second WD (21-22 March) was observed over North Pakistan, western JK along with some parts of HP and the third WD (28-31 March) occurred over JK only. This corroborates spatially as well as temporally with the IMD reports. Validation ofdaily accumulated rainfall from the model is also carried out using high resolution GPM IMERG satellite dataset.The amount of rainfall in higher Himalayan region accompanying the WDs is over estimated but was able to capture the spatial structure fairly well. The study therefore reveals that high resolution mesoscale model can simulate the weather associated with WD with reasonable accuracy well in advance.

Keywords -Western Disturbance, North Western Himalayas, WRF, GPM IMERG, Winter Precipitation.

Abstract ID - 188

Dynamical Downscaling of Indian Monsoon Climate using Regional Coupled RSM-ROMS Model at 10 Km resolution

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Abstract

This study shows the impact of coupled air-sea interaction on the simulation of the Indian Monsoon from dynamic downscaling of global climate model simulation. More commonly, dynamic downscaling has been conducted with regional atmospheric models to generate relatively high-resolution regional climate of the Indian Monsoon. In this study we show that dynamical downscaling with a coupled regional ocean-atmosphere model has a significant impact on the hydroclimate of the Indian continental monsoon. Given the bias in majority of the global coupled climate models with very warm SST in the northern Indian Ocean, our study shows that the uncoupled (to ocean) regional atmospheric model overestimate (underestimate) the oceanic (continental) precipitation of the Indian monsoon. The analysis of this study reveals that air-sea coupling in the regional domain acts like a damping scheme on the atmospheric variability over the ocean and thereby modifying the regional Hadley cell to increase the atmospheric variability and rainfall over the Indian sub-continent. This damping effect comes from cloud radiative impacts on the surface as well as small scale eddies in the ocean that generate local upwelling of cold waters to the surface.

Abstract ID – 195

Importance of the Resolution of Surface Topography Vis-à-Vis Atmospheric and Surface Processes in the Simulation of the Boreal Summer Climate of Himalaya-Tibet Highland

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Abstract

As Himalaya-Tibet Highland (HTH), a spatially extensive and complex terrain, plays influentialroles in the regional and global climate, its representation in climate models is a decisive factorin climate simulations. It is established that higher spatial resolution improves the simulation ofseveral seasonal mean features over this region, but how much improvement comes from thebetter representation of surface topography and how much comes from the better modeling of theatmospheric and surface processes are still not clear. To understand this, three sets of 6-memberensemble simulations are conducted using the NCAR Community Atmosphere Model version5.1 (CAM5.1): (i) at 1.9º x 2.5º resolution (Coarse), (ii) at 0.47º x 0.63º resolution (Fine), and(iii) topography is prescribed at the Coarse resolution and rest of the model processes arecomputed at the Fine resolution (Hybrid). The Coarse resolution overlooks most of the intricatefeatures of the topography with a severe bias of ~1-2 km but Fine resolution does a much betterjob in their representations. Surface air temperatures are found to be strongly dependent on theresolution of topography. Rest of the variables, viz. seasonal mean, seasonal cycle andprobability distribution of precipitation; tropospheric temperature and moisture; Tibetananticyclone, show remarkable improvements with the increase in resolution of the atmosphericand surface processes. Influence of the resolution of topography is found to be limited to thepressure levels close to the surface and for higher levels, the resolution of the atmospheric andsurface processes is noted to play a more crucial role. By and large, most of the features of theHTH monsoon improve with the increase in resolution. Owing to the complex terrain of theregion, it is desirable to use the adequate resolution to capture the intricate regional features of the topography for realistic simulation and projection of surface air temperature, in particular.

Abstract ID – 197

Numerical study of Inertia gravity Waves observed over tropical station Cochin

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Abstract

Inertia-gravity waves (IGWs) are low-frequency gravity waves excited by restoring force of gravity and Coriolis force in response to a disturbance in atmosphere. Flow over topography, convection, and jet streams are the main source of gravity waves. IGWs effect the large scale circulation patterns and thermal structure of upper atmosphere by dissipation of their energy. QBO is modulated by convectively generated gravity wave in equator. So Numerical representation of gravity wave in Numerical model is important for the realistic simulation of Stratospheric circulations under changing climate. Representation of gravity wave in GCM is hindered by its coarse resolution and implicit representation of convective processes. So cloud resolving limited area model are used to study dynamics and generative mechanism of gravity waves. In this study we use cloud resolving Weather Research and Forecasting (WRF) model to simulate gravity wave and understand its possible causes . Simulations were done for six continuous days from 26 october 2016 with different horizontal resolution. Impact of different cumulus and microphysics schemes are also analysed. Fast Fourier Transform (FFT) and hodograph analysis were used to compute propagation characteristics of wave. This is compared against wave characteristics obtained from high resolution wind data obtained from wind profiler at cochin.

Abstract ID – 206

Impact of Surface Wind Assimilation in Track and Intensity Prediction of Tropical Cyclones over Indian Seas

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Abstract

Understanding genesis, intensity and movement of Tropical Cyclones(TCs) and associated adverse weather conditions like heavy rainfall, gale winds, storm surges and coastal inundation becameeven more indispensable with the advent of state-of-the-art mesoscale models and the improvement in data assimilation techniques. In recent times, India is experiencing unique TCs in terms of intensity (Phailin, Lehar, etc) and track (Madi, Roanu, Okhi etc) changes and it became a challenging task to improve the accuracy in track and intensity of these catastrophic disasters to save the life and property. The Indian Seas comprising of Bay of Bengal (BoB) and Arabian Sea (AS) is an active basin for the formation of tropical cyclones. The BoBTCsmaking land fallingover east coast of India are not mammoth in size and intensityas compared to that ofother TC basins over the globe, but perilous in nature and impacts the economic growth of the nation and responsible for the loss of causalities. Out of 10 recorded deadliest cases with very heavy loss of life (ranging from about 40,000 to well over 200,000) over the world, 8 cases were formed in the BoB and AS in the past three centuries. With the advancement of high resolution models with state-of-art-data assimilation and initialization strategies, TC predictions are improved over the basin. However, uncertainty exists in TC prediction and may be attributed to limitation of observations, understanding of physical processes, etc. The present study encompasses the first time assessment of surface data assimilation through the regional Gridpoint Statistical Interpolation (GSI) system. The Weather Research and Forecast (WRF) system is used to simulate a few unique TCs in terms of intensity and track changes formed over Indian Seas. In this regard, two sets of experiments are carried out, i.e. in first experiment, model simulation with GFS (Global Forecasting System) initial and boundary condition (hereafter, CNTL)and in second experiment, the 6hrly data assimilation cycle is updated with additional surface observational data through the regional GSI system (hereafter, SDA). The results are analyzed and compared with the best-fit observations of India Meteorological Department (IMD). The SDA experiments improves the rainfall prediction of the rapid intensified TC Phailin, however, not much improvement is noticed for the rapid decay cyclone Lehar. The landfall position for each TC is improved in the assimilation experiments.

Keywords -Tropical Cyclone, Indian Seas, Surface Data Assimilation, Intensity.

Abstract ID – 215

Simulations of vertical wind profile and water vapour mixing ratio during Indian summer monsoon season over Arabian Sea

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Abstract

The purpose of this work is to study the monthly variations in circulation fields and moisture content at different atmospheric levels (850, 500 and 200 hPa) over the Arabian Sea (ABS) during summer monsoon season. A regional climate model (RegCM3) was used for this purpose and two experiments like (a) Control (unperturbed SST) and sensitivity (perturbed SST by $+0.5^0$C) runs were conducted to examine the implications on monthly composite Vertical Zonal Wind Shear (VZWS) and Water Vapour Mixing Ratio (WVMR) during Indian Summer Monsoon Season. Monthly wind profile over ABS (5°-15°N, 50°-80°E) has been studied. Monthly vertical distributions of the moisture content in terms of WVMR up to 200 hPa during summer monsoon season were also calculated over entire ABS centered at 62.5°E-67.5°E longitude and over Indian region centered at 75°E-80°E longitude. The analysis shows that the the wind shears between the atmospheric levels 850-500 hPa and 500-200 hPa were increased in the warm SST run. The peak of the wind shear was obviously attained in July. The water vapours were found high mostly at all atmospheric levels in July and August in the case of increased SST of ABS. In the experiments centered over the Arabian Sea (Indian region), maximum enhancement of moisture was noticed between 5^0N-15^0N (10^0N-15^0N) latitudes respectively. The model performance in perturbed SST state was found appreciable in the months of July and August (representative months of Indian monsoon season). Simulated average zonal winds between 850 hPa and 500 hPa in June (September) were sharply increased (decreased) in the SST run. In the study of Indian Monsoon Index (IMI)as an indicator of the strength of monsoon circulations, higher IMIs was noted in the warm SST run as compared to the Control (CTL) run.

Key words -Wind profile, Indian monsoon index, Water vapour mixing ratio, Sea surface temperature.

Abstract ID – 219

Sensitivity Analysis of Cloud Microphysical Process on Monsoon Depression

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Theme: Weather/Climate Modelling at Regional & Global Scales.

Abstract

Indian summer monsoon (ISM) low-pressure systems (LPS) are synoptic scale disturbances which are defined as cyclonic regions of low pressure that are accompanied by cloudiness and rainfall. They commonly form over the Bay of Bengal and progress in a west to north-westward direction, often making landfall in mainland India. These LPS are the most important components of ISM as they produce majority of rainfall. Cloud microphysical processes are one of the major factors in modulating the LPS rainfall and sub grid scale cloud processes plays an important role in vertical transfer of heat, moisture and momentum. Understanding the details of these microphysical processes is pertinent for improvement of model prediction skill.

The present study has been an attempt to elucidate the sensitivity of cloud microphysical processes on LPS. The WRF-ARW model version 3.8.1 (Skamarock et al., 2008) is used to carry out numerical simulations. The simulations are carried out in two-way interactive manner up to 96 hours in a nested fashion with horizontal resolutions of 27 km, 9 km and 3 km respectively. Four microphysical schemes have been chosen for sensitivity analysis i.e. WRF Double Moment 6 class (WDM6, Lim et al. 2010), WRF Single moment 6–class Scheme (WSM6, Hong et al. 2006), Thompson Scheme (Thompson et al. 2008), Milbrandt–Yau Double Moment Scheme (Milbrandt et al. 2005). National Centre for Environment Prediction–FNL (Final) data at 1^0x1^0 resolution are used as initial and boundary conditions for the model. European Centre for Medium Range Forecasting re-analysis ERA5 data at 0.25° × 0.25° degree resolution are used for validation of model results for basic atmospheric variables. GPM 0.5° ×0.5° data is used for rainfall validation.

Plots for model forecast skills in terms of location of evolution of rainfall, maximum rainfall, intensity and distribution, relative vorticity, potential temperature, hydrometeor distribution,moisture convergence, water budget, liquid water profile, temperature profile, vertical structure of boundary layer, integrated water vapour content, precipitable water, humidity profileetcare currently being analyzed and results will be presented.

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Abstract ID – 220

Do stochastic parameterizationsinfluence the model uncertainties in the AGCM models?

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Abstract

In recent years, Ensemble Prediction System (EPS) uses the stochastic parameterization for better representation of the forecast probabilities and the initial perturbations are generated using bred vectors with the “perfect forecast model assumption”. Model uncertainties on the forecast error are very important and *Houtekamer et.al* first included these uncertainties in the ensemble prediction. High resolution global models uses the stochastic scheme for perturbing the parameterized tendencies and have improved the prediction skill. This paper discusses the stochastic perturbed parameterization tendencies scheme and the stochastic backscatter scheme in representing the model uncertainties. The study confinesto the stochastic schemes and its influence on the Indian Summer Monsoon rainfall.

Abstract Id – 237

Uncertainty of high resolution mesoscale model for rainfall prediction associated with tropical cyclones over North Indian Ocean

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Abstract

The rainfall has a major impact on human life, especially in the case of landfallingtropical cyclone (TC) which is considered to be a catastrophic disaster. Therefore, the prediction of heavy to very heavy rainfall associated with TCs are utmost important and pose challenge to the research and operational community. The objective of the present study is to assessthe skill of high resolution mesoscale model for rainfallprediction associated with TCs.Five recent TCs such as HudHud (2014), Roanu (2016), Vardah (2016), Marutha (2017) and Mora (2017) over North Indian Ocean (NIO) are simulated using high-resolution advanced research weather research and forecasting model (ARW) at 9 km horizontal resolution.

Verification of model predictions with IMD rain gauges and TRMM rainfall indicates the positive performance of ARW model for rainfall estimates. The categorical verification and continuous verification statistics helped us to assess the model estimates with the TRMM observations. The ARW predictions are more skillful when a TC is initialized at stronger stage (SCS and above stages) as compared to weaker stages (DD and CS). Overall results also indicate that shorter the forecast length, better the rainfall prediction by the model. Lesser the rainfall amount, better is the model skill. The accuracy skill of heavy rainfall category increases with forecast length. The RMSE of heavy rainfall category also increases due to overestimation of rainfall by the model. Detailed results will be discussed in the conference.

Abstract ID – 246

How well do current coupled models capture the Pacific-Japan pattern teleconnections to Indian summer monsoon rainfall?

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Abstract

The present study examines the impact of teleconnections of the Pacific Japan (PJ) pattern on the South Asian summer monsoon rainfall in the Asia-Pacific Economic Cooperation (APEC) Climate Center (APCC) coupled general circulation models (CGCMs) hindcasts. All the individual models (initialized with May ICs) and their average (MME) showed significant skill in predicting the PJ pattern at one month lead with correlation ranging from 0.35 to 0.6. The first empirical orthogonal function of 850 hPa vorticity is used to extract the PJ pattern over the Western North Pacific (WNP) region. The percentage of variance explained by this mode is higher in the models compared to the observations. Suppressed convection over the WNP region in response to the PJ pattern is well predicted by all the models. On the other hand, many models showed low skill in representing the enhanced rainfall over the southern peninsular India and Sri Lanka. Enhanced rainfall over this region corresponding to the PJ pattern is primarily due to north-westward propagatingRossby wavesin response to anomalous convection over the Maritime Continent. The circulation and rainfall patterns over the north Indian Ocean and south Asian region are well represented in MME, APCC and NCEP models compared to other models. Misrepresentation of the teleconnections of the PJ pattern to South Asian summer rainfall in majority of the current coupled models (such as NASA, MSC, MSC CANCM3, MSC CANCM4, PNU and POAMA) is due to the displacement in the Indo Pacific convergence/divergence zones. Further, the models' over dependency of the PJ pattern on El Niño Southern Oscillation and the unrealistic Sea surface temperature (SST) gradients over the tropical Indian Ocean in some models are found to undermine the relationship between the PJ pattern and South Asian monsoon rainfall.

Abstract ID – 249

Impact of Assimilation of Scatterometer Ocean Surface winds on the Simulation of Mekunu cyclone formed over the Arabian Sea

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Abstract

Assimilation of ocean surface wind measurements from satellite-based scatterometers improves the weather forecast, particularly during cyclone period. Currently there are four scatterometers onboard different satellites, the ocean surface winds from which are being routinely assimilated in leading global operational numerical weather prediction (NWP) centres. The four scatterometers are ASCAT onboard both MetOp-A and MetOp-B, Windsat onboard Coriolis satellite, and India's Scatsat. National Centre for Medium Range Weather Forecasting (NCMRWF) assimilates these scatterometer winds in its NWP models. This paper describes the impact of scatterometer winds on the simulation of Mekunu cyclone dring 21-25 May, 2018, over the Arabian Sea using NCMRWF Unified Model (NCUM) assimilation and forecast system. Two Observing Simulation Experiments (OSEs) are designed, in the first experiment, along with all other conventional and satellite observations, scatterometer winds are also assimilated (EXP) and the scatterometer winds are denied in the second experiment (CNTL). Five continuous 6-hourly intermittent data assimilation cycles from 00 UTC of 21 May, 2018 to 00 UTC of 22 May, 2018 and thereafter 5-days of forecast based on 00 UTC of 22 May, 2018 are carried out from both EXP and CNTL. Impact of scatterometer winds in the assimilation system is analysed in terms of the counts, Mean and RMSE of other assimilated observations. In the forecast system, the impact of scatterometer winds is visible from day-1 to throughout the length of the forecasts.

Abstract ID – 253

Investigation of impact of Climate Change on Monsoon inversion over Arabian Sea using 38 year downscaled simulations of WRF-ARW model

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Theme: Weather/Climate Modelling at Regional & Global Scales.

Abstract

A high resolution dynamical downscaling data for 38 years starting from 1980 to 2017 is used in this present study to identify the variability of the Monsoon Inversions (MI) that forms over Arabian Sea (AS) before the onset of Asian Summer Monsoon (ASM) season and persists through-out the ASM. As the MIs are mainly formed due to cross-equatorial winds and we have analysed the parameters that controls the formation and seasonal persistence of the MI. Weather Research and Forecast (WRF) model used to generate long-term high-resolution data by adopting continues re-initialization method. This high-resolution data enables us to explore the long-term trends and intermittent atmospheric phenomena over the Arabian Sea for the extended period containing the entire solar cycle, many cycles of ENSO and Quasi – periodic phenomena.Along with the WRF data, we have also collected and used the radiosonde data for five stations to explain the MI characteristics and frequency of occurrence. Further we have also used MetOp onboard IASI sounder observations of around 10 year period to study the MI characteristics. The statistical analysis between WRF and observations at the coastal station's indicates a drift in temperature, humidity and winds at a height of ~ 1 - 2 km, which is the height of MI's. The statistical significance of MI analysis from WRF data is at 95 % confidence level as per Mann-Kendall and Sen's slope estimator over the study area. A long-term trend analysis is also carried out to identify the effect of winds and inter-annual variability of MI. The Monsoon inversion has been forming during the monsoon season over Salalah at an average altitude of 0.5 - 2 km. The core of the low-level jet (LLJ) is at the height of around ~ 1.5 km. The climatological WAS winds at 950 and 850 hPa shows a decreasing trend in winds, decreasing trend in the MI strength, frequency of occurrence and also the height of the MI is decreasing. The trends computed from the spatial data clearly revealing that the negative trends over the central (high), western and eastern sea (moderate values). The decreasing wind speed across the Arabian Sea is responsible for the decrease of the MI intensity, height and the frequency of occurrences. The variability of the MI for two epochs of 1980 – 1998 and 1999 – 2017 indicates that in the first epoch, trend is constant and later epoch, it is significantly decreasing.

Abstract ID – 257

Study on the diurnal variability of NCMRWF model precipitation

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Abstract

At NCMRWF Unified Model (NCUM) is being used for generating numerical weather forecasts routinely.The NCUM system is upgraded periodically to adapt new scientific and technological developments for improving the global and regional numerical weather predictions. Uniqueness of the Unified model is its seamless modelling approach. For this study the hourly precipitation over each grid box of Global and Regional models are accumulated on daily basis over a month and then further accumulated over the summer monsoon seasons.

The climate of India is dominated by monsoon systems. During the northern hemispheric summer, southwesterly winds bring moisture from Indian Ocean. In addition to the seasonal fluctuations, Indian summer monsoon is modulated by diurnal fluctuations; nature of diurnal variation of rainfall varies from place to place and depends upon the locations, topography of the region. Diurnal variation of rain-rate, frequency of rain, conditional rain rate, and maximum and minimum rain occurrence is studied.

Over Indian tropical region, maximum rainfall over land and Bay of Bengal regions is observed during the late-afternoon and early-morning period, respectively. Drizzle or less rainfall occur frequently in the morning over most land areas, whereas convective activity occurs during the afternoon. We found that rainfall activity usually occurs over the mountains in early afternoon and over the valley in the late evening.

The model predicted diurnal cycle of precipitation peaks too early (~3h) and the amplitude is too strong over Indian land region and tropical ocean region. The hour of max precipitation computed from model forecasts amounts indicates the early release of convective instability. In addition to the global models (25 km, 17 km, 12 km) we have also examined the convective scale (4 km) model for few recent cases during the years 2016, 2017 and 2018; these results are also included in this abstract. The frequency of model precipitation in the model forecasts (day-1, day-3, day-5) increases from west to east as seen in the space-based observations. As a special case the characteristics features of composite of wet/dry conditions occurred during Jun, July 2018 are examined.

Abstract ID – 260

A Coupled Modeling Framework to Simulate Monsoon Depressions

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Abstract

As computing power has come of age, using high resolution state of the art models to assess the impact of coupled models on extreme weather events has become imperative. In this study a fully coupled modeling framework is implemented to assess forecast improvements of monsoon depressions over the Indian Subcontinent. Coupled Ocean-Atmosphere-Wave-Sediment Transport Chemistry model (COAWST-CHEM) comprises of Weather Research and Forecasting (WRF) as the atmospheric component, Regional Ocean Modeling System (ROMS) for the ocean, Simulating Waves Nearshore (SWAN) as the wave component and WRF-Chem as the atmospheric chemistry component. A monsoon depression is simulated over the Indian domain and validated against Global Precipitation Mission (GPM) for precipitation. Model shows improved forecast over the Bay of Bengal (BoB) and improved skill for various precipitation bins. Validation with 5 moored buoys over BoB is also in accordance with the model forecast. Statistically significant correlation is observed for surface dew point temperature, surface temperature and wind speed over the simulation domain using 1003 station datasets. Overall the model shows better forecast capabilities as compared to a standalone WRF model.

Abstract ID – 261

Hindcast improvement of climate forecast system (cfsv2) by using modified cloud scheme

Febin paulose

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Abstract

To check the reliability of the model, two sets of CFSv2 retrospective experiments are performed. The first experiment (EXP1) is same as the present working mode of the model. The second experiment (Exp2) includes major changes in terms of different cumulus parameterization scheme, modified cloud microphysics scheme and the variable critical relative humidity. These changes have already been captivated in the free run mode. These major changes have combined for the first time to see the overall enhancement in the model simulation in outlook of the seasonal forecast of Indian summer monsoon rainfall (ISMR). The major improvement is evident in the spatial distribution of the precipitation and the amplitude of the annual cycle of the ISMR. The peak of the annual cycle of ISMR in EXP2 has enhanced by 23% in EXP2 than EXP1 with respect to the observation. Due to the better stimulations of cloud and tropospheric temperature gradient, maximum precipitation has moved to northward upto 20°N in the EXP2, in EXP1 which is close to 25°N as in observation. This modification has also impact on all the other aspects of the ocean-atmosphere coupled interaction, namely, planetary scale Hadley and Walker circulations, air-sea interactions and all the facets of monsoon teleconnections. The skill of extended Indian monsoon rainfall region (65-95E, 5-35N) is increased from 0.41 in Exp1 to 0.67 in Exp2 and the same holds true for other regions as well. This skill enhancement is reflected in Nino 3.4 SST, from 0.58 in Exp1 to 0.67 in Exp2. The dynamical wind shear based monsoon performance indices also shows the surge in the skill score. The dominance of the EXP2 for seasonal forecast is evident from these improvements. The significant improvements of seasonal skill score across all the variables clearly shows the dynamical consistency. This work will be pivotal to develop new genre of monsoon forecasting model.

Abstract ID – 269

Simulation of severe thunderstorms over the Indian monsoon region

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Abstract

Severe thunderstorms are dueto intense localized convection associated withthunder, lightning, heavy rain (sometime hail) and strong winds causing massive destruction along the path. The eastern Indian region are frequently affected these thunderstorms particularly during pre-monsoon months. Prediction of thunderstorm with adequate accuracy in terms of location, timing, and intensity of rainfall with adequate lead time has always been a challenge for forecasting community. This may be due to the lack of unrealistic initial conditions incorporated in the forecasting models. Previous studies have shown, modest improvement in the prediction of these events with the assimilation of atmospheric and land observations.

The focus of this study is to evaluate the impact of assimilation of conventional and non-conventional data into high resolution mesoscale non-hydrostatic model on the characteristics of severe weather events with special thrust on heavy rainfall forecast skills up to 12hours lead time. In this study, Moderate Resolution Imaging Spectroradiometer (MODIS) water vapour and temperature profiles will be incorporated to the initial conditions of Advanced Weather Research Forecasting model (WRF ARW). In addition, High Resolution Land Data Assimilation System (HRLDAS) derived soil temperature and moisture will be used to improve the initial land state over the simulation domain. Four thunderstorm cases are selected and three experiments are designed for each of these cases i.e. control run (CTL), with incorporation of MODIS (MODIS) and with improved land state (HRLDAS). All four thunderstorm cases are simulated up to 24 hours with model resolution of 2 Km.The model results will be validated with available remote sensing and surface observations. Further, results related to understanding of triggering, sustenance and intensification mechanisms will be elaborately presented. The major dynamical and themodynamical indices such as lifting index, K index, humidity index, stability index will be thoroughly examinedto quantify the impact of moisture and land state on the characteristics of the thunderstorm.

Abstract ID – 277

Simulation of Princeton Ocean Model for Northern Indian Ocean: A study of Indian Monsoon events with simulated SST anomalies

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Theme:Weather/Climate Modelling at Regional & Global Scales.

Abstract

The Northern Indian Ocean (NIO) is unique in itself in more ways than one. NIO is divided into the Arabian Sea and the Bay of Bengal by the Indian subcontinent. Apart from the similarities between Arabian Sea and Bay of Bengal, like being in the same latitudinal region and receiving same amount of incident solar radiation, it is the dissimilarities that make up for most of the complexities in this region. The sea surface temperature, being one of the dissimilarities, is higher in the bay than in the Arabian Sea region, because of the difference in their heat budgets. The Indian Ocean Dipole is a very important phenomenon influencing the Indian summer monsoon. It is the difference in the SST's between the Arabian Sea and the Bay of Bengal. A positive IOD means a stronger monsoon but a negative IOD leads to a weaker monsoon.

The main aim of the present study is to analyze the simulated results from a numerical ocean model for positive and negative IOD events and consecutively relate these results to good monsoon years and bad monsoon years. Princeton Ocean Model (POM) is used for this study. After the spin up, the POM is simulated for a period from 1999 to 2009 with QSCAT real time winds as input. For the period from 1999 to 2009, 2002 and 2004 are considered as the bad monsoon years and 2006 and 2007 are the good monsoon years as notified by the India Meteorological Department.

The simulated SST anomalies for these study years were analyzed for positive and negative IOD events. It is observed that 2002 and 2004 (bad monsoon years) have negative IOD, -6°C and -16°C respectively and 2006 and 2007 (good monsoon years) have positive IOD, +11°C and +9°C respectively for the month of May (pre-monsoon month). POM is able to show the relationship between the IOD events and monsoon.

Index Terms: Indian summer monsoon, Indian Ocean Dipole, Numerical ocean model.

Abstract ID – 279

Role of land surface initialisation in sub-seasonal to seasonal scale forecasts

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Theme: Weather/Climate Modelling at Regional & Global Scales.

Abstract

Dynamical models used for weather and climate prediction that have developed to a great extent in the last decade and have demonstrated significant improvement in the prediction skill of the Indian summer monsoon rainfall; mostly because of improved skill in the forecasts of global sea surface temperatures used as slowly varying boundary conditions. Despite that, it is still much less than the upper limit achievable. Anomalies in land surface states of soil moisture and snow which evolve slowly and have persistence on the time scales of weeks to months, can also affect the evolution of the atmosphere.Therefore they are also a source of predictability beyond the deterministic limit for weather prediction, mainly on sub-seasonal to seasonal time scales. Furthermore, near accurate initial soil moisture states are also required for real time hydrologic forecasting. The traditional method of land surface initialization in regional and global models is either based on global reanalyses or climatological land surface states. In the present endeavour, the impact of 'realistic' initial land-surface states on the monthly to seasonal prediction skill of the Indian summer monsoon is investigated using a suite of hindcasts(1982-2009) made with the Climate Forecast System version 2 (CFSv2) operational forecast model. A significant improvement in the deterministic prediction skill of near surface temperature and soil moisture on monthly and seasonal time scales due to realistic land initial conditions is demonstrated, whereas improvements in the skill of precipitation are confined to relatively small areas. Errors in the parameterization of physical processes in the model contribute to the decay in potential predictability and skill attributable to land initial conditions. In addition, using another large-suite of offline simulations based on the Variable Infiltration Capacity (VIC) model, the impact of errors in initial soil moisture conditions on the skill of simulated soil moisture and streamflow for the Ganges river basin is also demonstrated. The potential role of accurate land surface initialization in improving sub-seasonal to seasonal scale forecastsof temperature, precipitation and streamflow is emphasized.

Abstract ID – 285

Enhancing the seasonal forecast of Northeast monsoon foragriculture

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Abstract

Rainfall is the major source of water for agriculture especially in dry land.North East monsoon season is the period of major rainfall activity over South Peninsular India. Though the predictability of South West monsoon is widelystudied, the North East monsoon prediction is hardly explored. The information on behaviour of rainfall would suffice the development ofcontingency crop plan to mitigate crop loss due to weather aberrations.For long range forecast, IMD issues forecast based on Monsoon mission Coupled Forecasting system and operational statistical ensemble forecasting system. The forecast skill of these models is not satisfactory, particularly in providing the details of spatial distribution of rainfall over country. The regional scale variability of land surface characters are not well represented in regional model due to its coarse resolution. The regional scale variability of land surface processes play important role in modulating regional climate. The land surface processes are strongly controlled by vegetative cover. Current land surface model represent vegetation climatologically based on past observations. The purpose of this study is to examine the temporal differences in simulation based on climatologically derivedGreen Vegetation Fraction (GVF) and near real time GFV obtained from Moderate Resolution Imaging Sepectroradiometer (MODIS).

In this view, an attempt was made to produce seasonal monthly scale simulation of North east monsoon using a non-hydrostaticregional model Weather Research Forecasting (WRF). The analysis data obtained from Climate Forecast System Version2 (CFSV2) were used forinitial and boundary conditions. The boundary conditions were updated for every six hour. The model resolution for peninsular India was 18 km with the inner nest 6km covering entire Tamil Nadu and adjoining states.The simulations were improved with the incorporation of satellite derived MODIS vegetation data over Peninsular India. This incorporation was restricted to inner nest considering computational resource limitations.

Initially, the experiment was used to simulate monthly precipitation of June, July, August, September for 2018 with two different initial condition to assess the forecast skill. The second numerical experiment was made for 2018 North East monsoon by incorporating near real time vegetative fraction in the model.

Abstract ID – 302

Evaluation of CMIP5 Models for Indian Summer-Monsoon Precipitation and Temperature

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Abstract

In this paper, the fidelity of 28 models under Coupled Model Inter-comparison Project Phase-5 is examined for the Indian summer monsoon for the historical period from 1975-2005. It is found that all models simulate the spatial distribution of the seasonal mean surface air temperatures (T_{as}) quite well (pattern correlation > 0.75). Simulation of precipitation is found to be relatively poor (correlation 0.1-0.7). Most models underestimate the T_{as} with more bias during winter and less bias during summer.In regard to precipitation, most models fail to capture the observed contribution ratio of convective and large-scale precipitation (LSP)and simulate more convective precipitation as compared to the LSP. Extremely large wet (dry) biases are noted in convective (large-scale) precipitation. The total precipitation is also noted to have a large dry bias in most models, which is mainly due to the large dry bias in the LSP. Contrary to the notion that better simulation of the contribution ratio would lead to better simulation of total precipitation or vice-versa, our results show that both of these notions are not valid for most models.In observations, the LSP dominates the annual cycle of the total precipitation, whereas, in models the convective component dominates. In few models, the annual cycle in the individual precipitation component is either weak or completely missing. None of the models are found to simulate the observed trend in precipitation and temperature. The model with the highest resolution, MIROC-4h, simulates many of the observed features better than the other models, thereby emphasizing the usefulness of finer resolutions in better simulations of Indian monsoons. A comprehensive list of models has been prepared on the basis of their skill in simulating characteristic features of the Indian summer monsoon. The multimodelmean of the better models identified is expected to produce more reliable projections of the Indian monsoon.

Keywords - Indian summer-monsoon, CMIP5 models, Convective precipitation, Large scale precipitation.

Abstract ID – 312

The unprecedented changes in the South Asian Monsoon precipitation in the future warming scenario

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Abstract

Monsoon exhibit the most significant seasonal variation and is responsible for the giant hydrological cycle that showers the whole South Asian region. They are the seasonal reversal of the wind circulation that arises as a result of the thermal contrast between the land and oceans. It is the major source of the fresh water for the entire region which supports the agriculture, hydropower, industrial development etc. It is still an immense challenge for the Climate Science community to accurately foretell about the future monsoon behavior. It isbecause of the physiography and the complex behaviorwhich show limitations for both global as well as regional model to simulate the mean monsoon climate. Using the suite of CMIP5 MMEs (Multi Model Ensembles) and coupled regional model simulations, the variability associated with the precipitation has been studied in the the three different time slices.This will give an insight that how the South Asian Monsoon precipitation will unfold in the future warming scenario. I have illustrated the number of wet days (annual as well as seasonal) and the observed associated changes during the summer monsoon over South Asia. The perception would lead us to know about the contribution of the precipitating days which, is subject to change in the annual precipitation accounting for the interannual variability. Thisstudy is only an attempt to understand the precipitation variabilitythat opens the door for the further studies to look in to the other drivers that are responsible for the changes in the monsoon circulation over decades.

Abstract ID – 322

Configuration and Validation of mesoscale model for urban extreme rainfall events for major metro cities in India

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Abstract

Hydro-meteorological disasters particularly the extreme rainfall events (EREs) and associated flash floods are very frequent over the major metro cities in recent years and most often they result in massive destruction to life and property which in long run make adverse socio-economic impacts over the country. One important, but difficult, scientific challenge which has great societal relevance and a need of the hour is the advance prediction of these hydro meteorological disasters over the urban cities.An approach combining modelling, computing and data analysis is essential for developing advanced warning system for preparedness during such disasters. Mesoscale models are considered as one of the most widelyused tools in the simulation and advance prediction of EREs. The prediction over an urban city is generally difficult using numerical models because of the challenges incapturing the effect of urban heating and local convection arising due to large spatial inhomogeneity caused by urbanstructure and activities. Here, we propose to configure and validate a mesoscale modeling system for advance warning of hydro meteorological disasters for metro cities Chennai, Bangalore, Mumbai and Delhi. An urban canopy model will be coupled with the mesoscale model to incorporate the urban induced effects. The model will be tested under real environmental conditions for validating the skill in future real time applications. The skill of the forecast system will be improved by conducting sensitivity experiments and optimizing initial conditions through data assimilation. The outputs from the forecasting system will be integrated on GIS platform for preparation flood alert warnings over the metro cities.

Abstract ID – 346

Improvements in Performance due to Configuration Changes in NCMRWF Ensemble Prediction System

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Theme:Weather/Climate Modeling at Regional & Global Scales.

Abstract

The ensemble prediction system of NCMRWF (NEPS) has been updated and operationally implemented on June 1, 2018. This ensemble prediction system is based on Met Office Global and Regional Ensemble Prediction System operational at Met Office, UK. Previous version of the NEPS had a horizontal resolution of 33 km and ensemble size of 45 (44 perturbed + 1 control) members. The horizontal resolution of the current operational NEPS has been increased to 12 km. The initial condition perturbations are generated by Ensemble Transform Kalman Filter method.Themodel uncertainties arerepresented by Stochastic Kinetic Energy Backscattering (SKEB) and Random Parameter (RP) schemes. Perturbations of surface parameters such as sea-surface temperature, soil moisture content and soil temperature are included in the 12-km NEPS to address the problem of lack of ensemble spread near the surface. The ensemble size of the 12-km NEPS is 23 (22 perturbed + 1 control) members.

The aim of the present study is to investigate the improvement in model performance due to the change in NEPS configuration. The verification of probabilistic forecasts from both 12 and 33 km NEPS is carried out by testing the reliability, consistency and accuracy of the prediction system. The ability of the NEPS to discriminate the situations leading to occurrence and non occurrence of events has also been investigated.

Abstract ID – 354

Implementation of a Very High Resolution (12 km) Global Ensemble Prediction System at NCMRWF

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Abstract

There are increasing efforts towards the prediction of high impact weather systems using state-of-the-art numerical models. The global Ensemble Prediction System of NCMRWF (NEPS)of12 km horizontal resolution has been operationally implemented recently to improve weather forecasts and services. The NEPS is based on the recent version of UK Met office Global and Regional Ensemble Prediction System (MOGREPS). The initial condition perturbations are generated by Ensemble Transform Kalman Filter (ETKF) method. The model uncertainties are taken care by the Stochastic Kinetic Energy Backscatter (SKEB) and Random Parameters (RP) schemes. The forecast perturbations obtained from 6 hour short forecasts of 22 ensemble members are updated by ETKF four times a day (00, 06, 12 and 18 UTC). Perturbations of surface parameters such as sea-surface temperature, soil moisture content and soil temperature are also included in the current NEPS. The NEPS aims to provide 10-day probabilistic forecasts using 23 ensemble members (22 perturbed + 1 control). As a12-kmglobalEPSis being implemented for the first time in the world, ETKF perturbations were not available at this resolution from other centres (UKMO, BoM, etc.) Therefore, NEPS members were cold-started from the same initial conditions. It is found that after 15-16 ETKF cycles; ensemble spread becomes nearly equal to the previously operational 33-km NEPS ensemble spread. The 12-km NEPS shows improvements in terms of forecast agreement among the members in comparison to previously operational 33-kmNEPS. The ratio between root-mean-square error of ensemble mean and ensemble spread as a function of lead time has improved in both north and southern hemispheres in the 12-km NEPS.

Abstract ID – 357

Shallow overturning circulation ofthe Indian Ocean in an OGCM: sensitivity to momentum flux and spatial resolution

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Abstract

The meridional overturning circulation in the Indian Ocean (IO) plays a significant role in the climate and variability of the Indian Ocean. It transports heat and mass fluxes from the north and tropicalIndian Ocean to southernlatitudes. The shallow overturning circulation is a part of this meridional circulation. Models in general have large discrepancy in simulating this shallow overturning circulation.Simulation of the mean shallow meridional circulation and its variability in IO using Ocean General Circulation Model (OGCM) therefore remain unexplored problem. This study attempts to simulate upper ocean meridional circulation using the OGCMModular Ocean Model version 5 (MOM5). In CTRL experiments, model is forced using Cordinated Ocean-ice Reference Experiments version 2 fluxes, for the period of 1959-2009 from the quasi steady state. Detailed analysis of model output reveals that model underestimates southward meridional current in to the top 100m and also underestimates its variability with respect to observed currents (Ocean Surface Current Analysis Real-time,OSCAR) as well as currents from the state of the arts ocean reanalysis (Ocean Reanalysis System 3,ORAS3). It is important to note that this discrepancy in simulation of meridional current is higher during northern summer (June to September) than during northern winter (December to February). To understand the role of accurate momentum forcing on simulation, second experiment is carried out using ERA(European Reanalysis) Interim vector winds. Analysis does not showany significantimprovement in the simulation of upper ocean meridional circulation. Further to understand the role of horizontal resolution on the accuracy of meridional current simulation, experiments are carried out with different spatial (horizontal) resolution (2°, 1°and 0.25°). Analysis of current bias does not show any significant improvement as well as variability of meridional current remains underestimated mainly during the summer season. The consequence of these biases in the meridional currents isthe accumulation of warm water over the mid latitudes and subsequenttransport of less heat to the high latitudes. This has resulted slower shallow meridional overturning circulation in the model, thereby supporting warm (cold)upper ocean bias in the mid latitude (higher latitude) of southern Indian Ocean with respect to the EN4 ocean analysis data. The contribution of geostrophic and ageostrophic current in the total bias of meridional current is further examined. Analysis of estimated geostrophic current from observations and model are found to be consistent with each other and their variability is also well captured by the model. This analysis concludes that model underestimates the ageostrophic component of upper ocean meridional current.This supports that upper ocean physics associated with ageostrophic current (Ekman physics) needs to be rectified for the proper simulation of meridional circulation as well as the shallow meridional overturning circulationin the Indian Ocean.

Abstract ID – 362

Simulation of INSAT-3D Imager Brightness Temperature

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Abstract

India's advanced weather satellite, INSAT-3D, the first geostationary sounder system over Indian Ocean, launched (located at 83°E) for the improved understanding of mesoscale meteorological systems. INSAT-3D carries a 6 channel imager and 19 channel sounder payload. Along with the other polar satellite soundings, INSAT-3D provides sounder and imager data of fine resolution over India and surrounding regions. In the present study, four channels namely Mid Infrared, Water Vapor, Thermal Infrared-1, and Thermal Infrared-2 of INSAT-3D imager Brightness Temperature (BT) are simulated using Radiative Transfer model (RTTOVS) during the occurance of North Indian Ocean Cyclone (NIOC) Komen. Cyclonic storm system Komen formed in head BoB was active from July 26 to August 2 2015.The initial input data to the RTTOV model is being given from GPFS(General Parallel File System)model of NCMRWF. HDF5 (Hierarchical Data Format) data model has been used for the simulation of the Brightness Temperature. In the present study, we have taken Temperature, Vertical profile of humidity, Longitude, Latitude and satellite azimuth as input to RTTOV for simulation. All the data that has been used in this study are selected at 0000GMT for each day. The resolution of the gridded data is 0.5^{o}. Platform id supported by RTTOV v7 in case of INSAT_3D is 22 and satellite id range in this case is 1-5. RTTOV sensor id for INSAT_3D imager is 38 and for sounder it is 39. RTTOV supported sensor channels (IR/MW only) for INSAT_3D imager is 3-6 => 1-4 and for INSAT_3D sounder it is 1-18 => 1-18. RTTOV supported channels (VIS/NIR/IR) for INSAT_3D imager is 1-6 => 1-6 and for INSAT_3D sounder it is 1-19 => 1-19. These all information are required while retrieving the data set. For comparison of simulation result with the observation, we have selected simulated results of 30^{th} of July and 31^{st} of July of 2015.Due to presumed clear sky condition in the simulation of RTTOV model and labeling of the observed and simulated brightness temperature on a uniform scale for the comparison purpose, it is not possible to locate position of Komen cyclone. However, there is deviation in simulated plot from the observed plot. This is indicative of radiance characteristics of the four channels for simulated and observed result. Simulated BT matches well with the observed BT. Use of real SST may improve the BT simulation over Ocean. This study has been carried out during disturbed weather conditions and without the removal of cloudy pixels, at the same time assuming clear sky conditions. Proper cloud clearance and simulation of BT during fair weather conditions may give good picture of the quality of observed BT.

Key words -Simulation, Brightness Temperature, INSAT-3D Imager, RTTOVS model, GPFS model, HDF5 data model, NIOC.

Abstract ID – 365

Performance of regional climate model RegCM4 over India to simulate summer monsoon season

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Abstract

The sensitivity to model resolution and domain size of the regional climate model RegCM4 is examined in simulating a deficit (1987), excess (1988), and normal (1989) Indian summer monsoon (ISM) rainfall. The initial and boundary conditions are prescribed by the European Centre for Medium-Range Weather Forecasts (*ECMWF*) Interim reanalysis at 1.5°×1.5° (EIN15). The model simulated precipitation is compared with India Meteorological Department (IMD) gridded precipitation data (0.25°×0.25°) and other parameters are compared with EIN15. In the present study, eight different horizontal resolutions such as 60, 55, 50, 45, 40, 36, 27 and 18 km are used whereas four different domain sizes (D01, D02, D03, and D04; largest to smallest)centered at the Indian landmass are considered to investigate the model performance. Results illustrate thatthe RegCM4 has the capability to depict the important semi-permanent features of the ISM, however, skills vary with the resolutions and domain sizes. Experiments with different resolutions reveal that the lower (850 hPa) and upper (200 hPa) tropospheric circulations are stronger over the Arabian Sea and Bay of Bengal in the 36 and 40 km grid-spacing simulations and closer to EIN15, however, it is weaker in the high-resolution simulations at 27 and 18 km grid-spacing. The biases in vertically integrated moisture transport (VIMT) are positive in the model simulations with resolutions from 36 to 60 km, but, it is negative with 27 and 18 km grid resolution. The simulated precipitation intensity increases as one moves from coarse to higher resolution till grid spacing 36 km. The model efficiency reduces to simulate higher precipitation intensity over the maximum precipitation zones of India during summer monsoon season when grid spacing 27 km and 18 km are used. The overall performance is better with the use of 36-40 km grid spacing than other resolutions in simulating ISM and associated rainfall. The sensitivity of domain sizes is examined by confining the model resolution at 40 km. The model simulated meteorological parameters, as well as derived parameters (such as pattern and intensity of precipitation, geopotential height, relative humidity, air temperature, wind, and CAPE), are represented better in D02 than other domains.The present study proposes a Comprehensive Rating Matrices (CRM) to evaluate the model performance considering all experiments (horizontal resolution and domain size) and different homogeneous regions, including errors obtained using different statistical methods. The CRM and statistical based skill score (SS) suggest that the performance of RegCM4 is the best at 40 km horizontal resolution followed by 36 km and 45 km grid-spacing and the D02 domain is suitable for ISM simulation.

Abstract ID – 368

Understanding spatio-temporal variability of the chlorofluorocarbon (CFC11, CFC12) over the Indian ocean using high resolution coupled ocean biogeochemical modelling

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Abstract

A coupled ocean biogeochemical model with a horizontal resolution of 10 km is used toinvestigate the abundance and distribution of the Chlorofluorocarbon (CFC11 and CFC12) inthe Indian Ocean [40E-120E; 20S-25N] during the years 1998-2007. The model simulatedphysical and biogeochemical properties are compared against the available observations. Thequality controlled four-dimensional model data of CFC11 and CFC12 shows significantspatio-temporal variability and matches well with the observations. The lowest CFC isobserved in the spring season. On the other hand, CFC remains highest (~ 2.1x10-9 mol m-3)during the summer monsoon season and autumn season. The upper Bay of Bengal andwestern Arabian sea during winter and southern Indian ocean during all the seasons representhigh CFC regions, whereas, near the equator and in the southern Arabian sea, the CFCgenerally remains lower. Depth dependent CFC profiles in the Arabian sea and Bay of Bengalare also found in good agreement with the observations. It is observed that CFC decays rapidly with depth approximately after upper 100 m, whereas, it remains nearly constant up toa depth of 25-30 m.

Abstract ID – 369

CFSv2 model fidelity in capturing atmospheric internal processes during organization and intensification of Boreal Summer IntraseasonalOscillation (BSISO)

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Abstract

The study investigates the Climate Forecast System version 2 (CFSv2) model fidelity in capturing mean flow-eddy interaction, circulation-heating feedback and the energy conversion processes during organization and intensification of BSISO. Experiment is carried out to make 10 years free run to evaluate the model. The results reveal that model over estimates the BSISO intensity starting from the initial phase. But model underestimates the mean kinetic energy (MKE) related to upper level easterly wind both for strong and weak events and the underestimation is particularly more prominent for the strong events. However, the model is able to capture the lower level MKE with a slight under estimation for the strong events. At the upper level, eddy kinetic energy to MKE conversion (CK conversion) for model is significantly weak and contrary to observation, it shows a decrease in conversion in the subsequent lags. Model also shows decreasing mean available potential energy to MKE conversion (CA conversion) for the strong events at the upper level in complete contrast to reanalysis data which shows an increasing trend as BSISO approaches towards the organized and intense phase. For weak events as well, the CA conversion from reanalysis and model are completely opposite to each other. From observational analysis it is evident that vertical eddy momentum-vertical wind shear interaction (CK3) is the dominant contributor for CK conversion. Model shows that CK3 conversion for strong events is very weak at the upper level. At the lower level the model is able to capture the negative CK3 conversion but magnitude is under estimated. The process based analyses of CFSv2 simulation brings out that the model has serious deficiency in capturing the energy conversions, mean flow-eddy interaction and circulation-heating feedback processes. All these eventually led to lesser fidelity of model in capturing the organization and intensification of BSISO.

Abstract ID – 374

Verification of Thunderstorm events over North-East India using High resolution Unified model

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Theme: Weather forecasting Services at Different Time Scales.

Abstract

Thunderstorms in association with squalls and hailsarevery frequent to cause flash floods and lash large area over many parts of northeast India during pre-monsoon season i.e. March-May. The present study focuses the evaluation and verification of thunderstorms known as Nor'westers which affect the major parts of northeast IndiaduringApril and May 2018. The heavy rainfall due to these thunderstorms leads to loss of human lives, damages of properties etc. Therefore, the advance warning of the thunderstorms over this region is very much essential. Here an attempt has been made to evaluate the skill of **N**ational **C**entre for Medium Range Weather Forecasting (NCMRWF) **U**nified **M**odeling system (NCUM) in predicting these events over northeast Indian region (21N-30N,84E-90E) using traditional and Contiguous Rain Area (CRA) technique. In CRA method, the observed and forecasted events are objectively matched to evaluate the systematic errors in the forecast. The total is decomposed in three components viz.,displacement, pattern and volume errors. Traditional verification metrics like FAR, ETS, POD and BS etc., has also been carried out to verify rainfall during the April and May 2018. To select the thunderstorm event, rainfall threshold with more than or equal of 20mm/day has been considered in the present study. The verification has been carried out against the observations from IMD gridded data sets. The performance of the model in predicting the thermodynamic variables is also studied as a part of the study. The time series of rainfall averaged over the above selected north east domain is verified against the observations to avoid the spatial errors. The results are suggesting that the model skill is very good in predicting the pre-monsoon thunderstorm events over northeast India. The CRA technique suggests that the error contribution is large from pattern error followed by displacement and volume errors. It implies that model is able to predict the volume of pre-monsoon thunderstorm rainfall accurately while the skill of NCUM is poor in predicting the shape and structure of the rainfall events. However, in few cases, the contribution of displacement error is also noticed rather than pattern and volume errors. The higher values of POD is suggesting that model is able to predict the observed rainfall event accurately.

Keywords -Thunderstorms, NCUM, CRA, Traditional Verification.

Abstract ID – 375

Numerical Simulation of the Intensity Prediction of Tropical Cyclone Megh using WRF-3DVARModeling System

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Abstract

Governing equationswhich describe the flow of fluids in the atmosphere and is translated into algorithm to predict the variety of weather phenomenausing different types of NWP models.Short-term weather forecasts or longer-term climate predictions is simulated based on mathematical models using physical principles. In recent decades, the improvements made to regional models have allowed for significant improvements in high impact weather events like thunderstorm, monsoonal heavy rainfall, tropical cyclone (TC), monsoon depression etc. The primary and important task is toimprove the forecast skill of these weather systems, thereforeassimilation studies have been carried out withWeather Research and Forecasting (WRF)modelingsystem by utilizing the variousobservations.The main purpose of this study is to demonstrate andevaluate the ability of the WRF-Three dimensional variational (3DVAR) with assimilationof observations for simulation of the Extremely SevereTC'Megh' (5-10 November 2015) over the Arabian Sea. In this purpose, two numerical experiments are carried out such as CNTL (without data assimilation) and 3DV (with data assimilation).The simulated meteorological parametersand tracks of the TC are reasonably improved after assimilation ofobservations as compared to the CNTL experiments. The mean Vector DisplacementErrors (VDEs) are significantly decreased due to the assimilation ofobservations as compared to the CNTLexperiments. The study clearly suggests that the performance of themodel for simulation of track and intensity of the TC is significantly improved afterassimilation of the data.

Key words - Tropical Cyclone, NWP Model, Governing Equations, Data Assimilation, Vector Displacement Errors.

Abstract ID – 377

Simulation of extreme climatic features over India using nested Non-hydrostatic Regional Climate Model

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Abstract

The climate prediction over the north Indian region is a challenging task due to its complex orography and the nonlinear interaction of tropical and extra-tropical climate, which is influenced by the large-scale flows. Recent years, the North Indian region experienced severe heat wave conditions during pre-monsoon season and heavy rainfall during the monsoon season that led to the flood. Therefore, an high-resolution climate information required for effective disaster preparedness and response arrangements in order to reduce the loss in terms of lives and livelihood.

In this study, nested simulations are performed using an ICTP's non-hydrostatic Regional Climate Model (RegCM) over South Asia CORDEX region. A series of sensitivity experiments on cumulus convection and land surface schemes with a resolution of 30 km over CORDEX region and a nested domain of 10 km resolution covering North Indian region is carried out to customize the model. The initial and boundary conditions are derived from ERA-Interim analysis. The Optimal interpolation weekly Sea Surface Temperature data from National Oceanic and Atmospheric Administration (NOAA) are used throughout the simulations. The topography and land-use data are acquired from the United States Geological Survey (USGS) and Global Land Cover Characterization (GLCC).

The results revealed that the non-hydrostatic version of the RegCM model is realistically simulated seasonal monsoon feature over the Indian subcontinent in all cumulus convection schemes, nevertheless, there is variation in terms of intensity. The simulated extreme temperature and heavy precipitation events over north India in the nested simulations are discussed in detail.

Abstract ID – 381

Verification of Medium Range Probabilistic Rainfall Forecasts over India

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Abstract

Forecasting rainfall using Numerical Weather Prediction (NWP) models is a challenging task for modelers, especially in tropical regions. Initial conditions and model parameterization are the main reasons for these uncertainties. Ensemble prediction systems (EPS) provide an efficient way of handling the inherent uncertainty of these models. Verification of forecasts obtained from an EPS is a necessity, to build confidence in using these forecasts. This study deals with the verification of the probabilistic rainfall forecast received from the National Centre for Medium Range Weather Forecasting (NCMRWF) Ensemble prediction system (NEPS) for monsoon season, i.e., JJAS, 2016. Verification is done based on the Brier Score (BS) and its components (reliability, resolution, and uncertainty), Brier Skill Score (BSS), Reliability plot, Relative Operating Characteristic (ROC) curve and Area under the ROC (AROC) curve. Verification is carried out for Day 1 to Day 10 lead times for 2, 5 and 10mm/day rainfall thresholds. All the verification is done against the NCMRWF Merged Satellite gauge (NMSG) observed rainfall data for the same period. BS values for verification of NEPS forecast with NMSG observational rainfall datasets are lowest for 10mm/day rainfall threshold that is followed by 5mm/day and 2mm/day rainfall thresholds. This is further strengthened by low reliability, uncertainties and resolution, and high BSS for 10mm/day threshold as compared to the other two thresholds for verification against this data set. The ROC curve shows that for lower rainfall threshold (2mm/day) most of the events have higher hit rates as compared to higher rainfall threshold (5mm/day and 10mm/day), which implies that model has better skill in predicting these rainfall amounts. The reliability plots show that the events with lower probabilities are over forecasted, and those with higher probabilities are under forecasted. AROC is always seen to be greater than 0.7 for all thresholds, and lead-time, this is indicative of the skillfulness of the model. In all the verification values there is a peak at Day 6 forecast implying a deterioration of forecast at this lead-time.

Key words -Probabilistic Forecast, NEPS, Brier score, ROC curve, Reliability plots.

Abstract ID – 389

Numerical Simulation of the Indian Summer Monsoon Seasons for Two Contrasting Years using Regional Climate Models

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Abstract

Numerical Simulations of the Indian Summer Monsoon have been performed using two regional climate models the ICTP's RegCM and the WRF climate model. The present paper investigates the efficiencies of the above two models for two contrasting years, a normal and a deficient year. NCEP data is used for the initial and lateral boundary conditions. The ICTP regional climate model has 18 levels in the vertical and has 25 km resolution in the horizontal resolution, while the WRF has 38 levels in the vertical with the same horizontal resolution. The impact of cumulus convection in simulating the monsoon climate is studied. Results show that both the numerical models were able to simulate the gross features of the interannual variability of the Indian summer monsoon over the Indian sub-continent. The spatial variation of the rainfall is especially studied and presented along with the wind fields.

Abstract ID – 411

The 10-20 day intraseasonal variation of the South Asian summer monsoon simulated by GFDL models in the AMIP experiment of CMIP5

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Theme: Weather/Climate modelling at regional and global scales.

Abstract

The present study investigates intraseasonal variability with focus on 10-20 day period of Intraseasonal Oscillation associated with south Asian summer monsoon. Atmosphere-only simulations of three Geophysical Fluid Dynamics Laboratory (GFDL) General Circulation Models (GCMs) from Atmospheric Model Intercomparison Project (AMIP) of Coupled Model Intercomparison Project phase 5 (CMIP5) are used.Two of the GCMs are GFDL global High Resolution Atmospheric Model at different horizontal resolution and third "GFDL-CM3" model is of moderate resolution with updated atmospheric model component.

There are substantial deficiencies in simulation of intraseasonal variability of south Asian summer monsoon, in particular no model is able to capture the pronounced spectral peak corresponding to 30-60 day period of intraseasonal oscillation and the periodicity of simulated oscillation tended to be too short (< 30 days). Intraseasonal oscillation with 10-20 day period is associated with westward propagation from the western tropical Pacific to the Arabian sea along the monsoon trough. Only "GFDL-CM3" model simulated westward propagation of 10-20 day mode in low-level zonal wind. In conclusion, it remains challenging for atmosphere-only simulations of three GFDL GCMs from AMIP/CMIP5 to faithfully represent the amplitude and periodicities of two intraseasonal oscillation modes namely 30-60 day and 10-20 day, along with propagation characteristics of 10-20 day mode, despite higher horizontal resolution.

Abstract ID – 450

High Resolution Climate ModelingProductsfor the U.S.-India Partnership for Climate Resilience Workshops

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Abstract

As part of the Department of State U.S.-India Partnership for Climate Resilience (PCR), scientists from the NOAA National Centers for Climate Information, North Carolina State University (NCSU), and Texas Tech University (TTU) held a series of workshops across northern and southern India in 2017 and 2018 on high resolution climate modeling activities. Expert scientists from TTU, NCSU, and Indian Institute for Tropical Meteorology (IITM-Pune) presented state-of-the-art climate downscaling techniques. The United State contributions included climate products using the Asynchronous Regional Regression Model (ARRM) method and the NASA Earth Exchange (NEX) climate projections. PCR collaborators in attendance included India State Action Planners, researchers, solution providers and NGOs including the WRI Partnership for Resilience and Preparedness (PREP), and The Energy and Resources Institute (TERI). The scientific techniques were provided to workshop participants in a software package written in R by TTU scientists and several sessions were devoted to hands-on experience with the software package.

The ARRM and NEX products have different strengths with regard to future planning. The ARRM downscaling of global climate model data is focused on accurate station-level simulation of temperature and precipitation extremes. The NEX projection data is a global product and is well-suited for a national assessment of changes in key climate variables. The paper will illustrate the characteristics of these data, examining national projections of changes in extreme heat and showing future changes in temperature and precipitation extremes for selected cities throughout India.

Abstract ID – 480

Salient features before and after onset of Monsoon: NCMRWF model diagnostics study

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Abstract

The Indian summer monsoon is characterized with rainfall regimes, onset, advancement, active and break phases etc. The basic forcing of the summer monsoon is provided by the annual cycle of solar radiation interacting with different heat capacities of the tropical oceans and land areas. During May 2017 with the formation of a cyclonic circulation over Andaman Sea, south-westerly's crossing the equator strengthened and deepened leading to persistent cloudiness and rainfall over the region. This resulted into advance of Southwest monsoon into some parts of southeast Bay of Bengal, Nicobar Islands, entire south Andaman Sea and parts of north Andaman Sea on 14 May. It further advanced into some parts of southwest Bay of Bengal, some more parts of southeast Bay of Bengal and north Andaman Sea and remaining parts of Andaman & Nicobar Islands on 16 May and further into parts of southeast and east central Bay of Bengal and remaining parts of north Andaman Sea on 18 May. Southwest monsoon reached parts of southeast Bay of Bengal, south Andaman Sea and Nicobar Islands on 14 May (6 days ahead of its normal date). It advanced over Kerala on 30th May (2 days ahead of the normal schedule) and covered the entire country by 19 July (4 days later than the normal date).Daily operational forecasts from the global models run at the National Centre for Medium Range Weather Forecasting (NCMRWF), India were assessed for this diagnostics study during the southwest monsoon 2017. Week - by - Week Progress of the all India weekly and cumulative weekly monsoon rainfall anomalies during the 2017 southwest monsoon season have been attempted with NCMRWF model numerical models.The results were presented in this paper here it is highlighted that the predicted values of weekly percentage departure of rainfall from normal are found in good agreement with observed kind of departures (less than normal) on more than about 80% of the cases at sub divisional spatial scales. Model forecasts for monsoon season were consistently found reasonably well.

Abstract ID – 487

Validation of WAVEWATCH III Model Results in Northern Arabian Sea

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Abstract

The information of sea state is very critical in various marine activities such as sea state forecasting, sailing notifications, disaster warnings, port operations, coastal developmental activities etc. The lack of measured wave data with sufficient spatio-temporal coverage leads to the utilization of other data sets such as numerical model or satellite estimated wave data for various applications. However the reliability of these data sets needs to be assessed, which necessitates the validation using measured wave data. The National Institute of Ocean Technology (NIOT) maintains a moored buoy network in northern Indian Ocean since 1997 and measures wave parameters over two decades. The University of Hawaii has implemented a global-scale WaveWatch III (WW3) model forced with NOAA/NCEP's Global Forecast System (GFS) winds, which provides hourly forecast at 0.5-deg resolution. The present study reports the validation of the WW3 model results using moored buoy observations in Northern Arabian Sea during the year 2014.

The analysis of one year wave measurements in the northern Arabian Sea exhibited significant seasonal variation with substantial contribution from swell waves. The sea state exhibits rough sea conditions during southwest monsoon season (June to September) with significant wave height of ~5m which remains ~1.5m for the remaining period. The analysis of peak wave direction and peak wave period exhibited distinct bands of swell and sea waves during non-monsoon period, whereas that of monsoon appears to be merged together. The WW3 model results are analyzed in detail to identify how best the seasonality and presence of swell waves are captured in model results.

The statistical analysis of WW3 model at the selected location shows a good correlation with the moored buoy data, of about 0.97 for significant wave height and 0.93 and 0.79 for the vector components of peak wave direction. But a substantial difference is found in the case of peak wave period which shows less correlation of 0.34 as overall and on further segregation based on various seasons also shows a weak correlation of 0.30 for pre-monsoon, 0.05 for monsoon, and 0.53 for post-monsoon seasons.In addition when the peak period data sets are categorized as swell (above 8 s)and sea waves (0 to 8 s) reveals that swell contribution is over estimated in model data sets, particularly during pre-monsoon season.The correlation of swell waves exhibits 0.44 and 0.47 during pre-monsoon and post monsoon respectively whereas that of sea waves is very less. The over estimation of swell wave could be the reason for less correlation in peak wave period.The study reveals that the WW3 model data sets are reliable in northern Arabian Sea and it can be used for various marine applications. The study also proposes a detailed analysis of long term data of sea and swell waves and extending to other locations to estimate a clear picture of the spatio-temporal variability in Arabian Sea.

Abstract ID – 497

Estimating the Role of Mixed Layer Eddies in the Tropical Indian Ocean using High Resolution Ocean Model

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Abstract

A high-resolution ocean circulation model run is carried out for the period 2000-2009 using Turbulent Kinetic Energy (TKE) vertical parameterization scheme, with and without Fox-Kemper eddy parameterization. The regional version of the Nucleus for European Modeling of the Ocean (NEMO) model domain covers the tropical Indian ocean (TIO) [30E-120E; 20S-30N]. The horizontal resolution of the model is $1/12^0$. A total of 75 vertical levels are used with maximum resolution of 1 m near the ocean surface. The initial conditions of temperature and salinity are taken from the Levitus climatological data. The mixed layer depth (MLD) simulated with both the parameterization schemes is compared with observation. Even though the MLD from both the schemes are found to be consistent with observations, however, the MLD obtained using the 'TKE with Fox-Kemper scheme' gives relatively better results. The effect of Fox-Kemper parameterization on ocean vertical stability is studied using the buoyancy frequency (N^2), vertical shear of horizontal currents (S^2) and energy required for mixing (ERM) as quantifiers.

Keywords- NEMO, Vertical Pameterization Schemes, TKE, TIO.

Theme 3

Impact of Climate Variability/Change on Agriculture, Water, Energy and Health sectors

Abstract ID – 6

Assessing the role of meteorological factors on human health in India and its Extended Range Prediction

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Theme: Impact of Climate Variability/Change on Agriculture, Water, Energy and Health sectors.

Abstract

There are various complex ways in which the changes inclimatic factors (e.g. temperature, precipitation, humidity, extreme weather events etc.) can have direct or indirectimpacts on human healththrough changes in ecological conditions which can affect vector ecology and the appearance of various infectious diseases, namely malaria and diarrhoea. So,better monitoring and long-term planning for health systems are required with the help of an early warning system. For this purpose, the extended-range climatic forecasts will be very helpful to reduce health impacts through the development of early disease warning systems in 2-3 weeks in advance. In the present study we have tried to build up suitable relationships between the diseases, malaria (MAL) and acute diarrheal diseases (ADD), for two districts (Pune and Nagpur) in the state of Maharashtra, India and the meteorological parameters from the weather monitoring stations present in the region. A suite of weather metrics have been constructed using the standard meteorological factors (e.g. maximum/minimum temperatures and rainfall) based on available weather monitoring data based on Self-Organizing Map (SOM) technique. SOM is basically a pattern recognition technique based on unsupervised learning neural networks. Two separate SOM classifications (each for ADD and MAL) have been done in 3x3 lattice(total 9 classes) for each district using 10 variables (standardized) as input to SOM.The weekly total ADD and MAL data is available from 2012 to 2016 with some missing data. The Multi-Model Ensemble (MME) Extended Range Prediction (ERP) system (based on Climate Forecast System version 2) of Indian Institute of Tropical Meteorology is skilful up to 3 weeks lead in predicting rainfall/temperatures during the relevant seasons and hence can be used for operational purposes. So, after developing the suitable relationship between weather and climatic factors and their impacts on human health, an attempt is made for the real time monitoring and prediction of such conditions with a lead time of 2-3 weeks. A deterministic as well as probabilistic forecast approach for the prediction of different categories (% probability of Below Normal, Near Normal, Above Normal and Extreme occurrences) of infectious diseases (like malaria and diarrheal diseases) in sufficient lead time is taken up. The SOM clustering technique and the design of the prediction system and strategy adopted for ERP of such infectious disease outbreakswill be discussed in details. Skill of the prediction system will be shSome of the important events of occurrence of Malaria and ADD for these two different districts will also be highlighted.

Abstract ID – 25

A pilot study on Assessing effect of climate on the incidence of vector borne diseases at Pune

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Abstract

In recent years Pune has witnessed an enhanced number of Dengue cases, although Malaria cases have been reduced (Based on information on dengue and malaria cases provided by health department of Pune Municipal Corporation). Also India Meteorological Department, following GFCS requirement, has initiated Climate service for health sector. Following WMO/WHO, one of the aspects for holistic approach towards Climate service to health is research and development.

Accordingly an attempt has been made to understand the role of climate on some Vector borne disease (VBD), like Dengue and malaria at Pune. For that monthly number of cases of occurrence of these VBDs during 2010-2015, only available, from Heath Department of Pune Municipal Corporation and Monthly Climate data of these years, available from the office of Climate Research and Services, India Meteorological department, Pune has been used.

From this pilot study, following preliminary results have been found:

- In general, there is a decrease in the malaria cases for all months from 2012 onwards.
- In any year maximum incidences occur during June-Sept.
- Hotspot for Malaria observed to be associated with RH between 70-82% and Mean temp 25°-30° C and is also associated with monthly total rainfall 200-220 mm & Tmax 28°-30°C.
- In general, there is an increase in the dengue cases for all months from 2012 onwards.
- In any year maximum incidences occur during Sept-Nov, followed by August & December.
- four hotspots for Dengue has been observed, viz., RH: 80-85% & DTR: less than 5°C, RH: 75-80% & DTR: 5-10°C, RH: 65-70% & DTR: 12-13°C, RH: 55-60% & DTR: 17-18°C and Tmean: 22-26°C, RH: 60-80%.
- When mean temp is below 24^0C, then maximum Dengue cases occur at higher DTR (16°-18°C). When mean temp is above 24°C , then influence of DTR doesn't appear to be very specific. Above 24°C, as mean temp increases, dengue occurrence decreases.

Abstract ID – 65

Investigation of new convective atmospheric surface layer scaling parameters over complex terrain of Himalaya

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Abstract

Exchange properties of energy within the convective boundary layer have been traditionally addressed with the statistical fluid mechanical (SFM) approach of Reynold's averaged Navier Stokes Equation. Following this framework, the dimensional analyses of Monin-Obukhov (MO) and Deardroff similarity theory have provided the conceptual and practical foundations for almost all modeling of the convective boundary layer (CBL) during the last few decades. However, with extensive and thorough experiments of CBL energy exchange processes, it has been realized that neither MO theory nor the Deardroff similarity theory is conclusive and dynamically efficient in explaining the CBL energy exchanges. As an alternative to this framework, a chaotic dynamical system (CDS) approach has been put forward by McNaughton et al. (2004, 2006, 2007) where the fundamental energy exchange processes in a CBL are assumed to be due to interaction of different types of eddies. This new CDS approach, unlike the SFM approach, describes the turbulence processes with few nonlocal parameters (such as convective boundary layer height, dissipation velocity, surface friction layer height, etc). These newly developed nonlocal scaling parameters of the CDS approach are found to be satisfactorily collapse the energy, momentum and tracer spectra in a wavenumber axis when CBL turbulence is measured over a flat terrain. However, the model is yet to be tested over a complex terrain before its ubiquitous acceptance. This study attempts to investigate this new CDS approach for CBL turbulence using winter period (1-Dec-2016 to 22-Dec-2016) 10Hz, 3-D sonic observations of u, v, w wind and sonic temperature from two mountain sites (one ridge-top and an on-slope site) near Almora, Uttarakhand of Central Himalaya. Results of this study indicate that the CDS approach derived non-local scaling parameters (dissipation velocity and surface friction layer height) are a good proxy of SFM based MO model local parameters (friction velocity and Obukhov length), and as predicted by the CDS approach, a satisfactory smooth collapse of u, v and w wind velocity is noted in the wave number axis using the non-local scaling parameters for observations from both sites. The CDS approach, as tested for the first time over complex terrains of Himalaya, is found to perform better than the standard SFM approach of explaining convective boundary layer turbulence, and is a promising parameterization that could be used in weather prediction models.

Abstract ID – 75

A case study of respiratory diseases and absorbing aerosol loadings over three densely populated countries of the world

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Abstract

Aerosols are an assembly of liquid or solid particles suspended in the atmosphere. Absorbing aerosols like Black carbon (BC), organic carbon (OC) and dust, can strongly absorb solar radiation and might have a profound impact on the global and regional climate along with human health. Most of the absorbing aerosols are smaller in size and hence can easily enter the human system; and may become one of the causes of respiratory and cardiovascular diseases.In this paper, we have studied the variability of Absorbing Aerosol Optical Depth (AAOD) and the number of cases of respiratory diseases for the 3 densely populated countries of the world i.e. Brazil, Mexico and Japan.The choice of the countries was subject to the availability of the diseases data; the major ones including pneumonia, influenza and chronic lower respiratory diseases. The Level 3 AAOD daily data at 0.25° x 0.25° spatial resolution was obtained from Ozone Monitoring Instrument (OMI) aboard the AURA satellite. First, the inter-annual variability in AAOD and the number of cases of respiratory diseases was studied followed by the correlation analysis. The 10-yeartrends in the two parameters are discussed separately for the three countries during the period 2005-2015.

Keywords - Respiratory diseases, AAOD, China, Brazil, Mexico and Japan.

Abstract ID – 109

Climatic variability and trend for strategic crop planning in Raipur district of Chhattisgarh

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Abstract

The present investigation was carried out using the long term (1901-2002) meteorological data collected from the India water portal and remaining (2003-2017) meteorological data used from the Agrometeorological observatory situated at department of Agrometeorology, College of agriculture Raipur (C.G.). The long term mean annual rainfall of Raipur is 1268.2 mm with CV of 15.7% only indicating that it is highly stable and dependable. During the study period the annual rainfall varied between 775.5 mm (2017) to 1801.6 mm (1929) over 117 years. The decreasing trend in annual rainfall was observed @ 0.90 mm /year and for the monsoon rain (June –September), decreasing rate @ 0.83 mm per year was observed during the study period. On the basis of decadal analysis we found decreasing trend of rainfall @ 8.26 mm every decade. The result revealed that monthly maximum temperature varied between 31.0 to 33.9°C over 117 years with annual maximum temperature showing increasing trend of 0.008°C per year, while the minimum temperature was found to also increasing at the rate of 0.007°C per year and fluctuated between 19.1 to 25.5°C. During the decade 1911-1920, the mean maximum temperature was highest (32.9°C) and in the second decade 1911-1920, the mean maximum temperature was lowest (31.8°C). The CV percent of decadal maximum temperature was between 0.5 to 1.9%. This outcome is very useful to prepare the strategic crop planning in changing climatic scenario with special reference to growing demand of food for growing population. Rainfall and temperature are the key elements of weather due to their temporal and spatial variability at different scales and their impact in agriculture. Hence, analysis of their trend is vital for understanding of climate variability. Rainfall is the most important climate parameter which has direct effect on crop growth and yield under rainfed condition and the study will have far reaching implications in policy making for Raipur region representing Chhattisgarh Plains.

Key words -Rainfall, Temperature, Trend, Variability, Rate, Decade.

Abstract ID – 135

Impacts of Climate Variability on Sugarcane productivity using DSSAT CANEGRO V-4.6.1 model over Lakhimpur-Kheri District of Uttar Pradesh

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Abstract

Lakhimpur-Kheri district is a part of tarai area of Uttar Pradesh, India and situated at an elevation of 147 meters above the mean sea level. During planting of sugarcane in spring season. On an average air temperature during spring season ranged from 20-26.7°C at Lakhimpur-Kheri. The annual precipitation and annual PET values at Lakhimpur-Kheri are 1008 and 1503 mm, respectively. Sugarcane is long duration crop of 10 to 12 months. It is highly influenced by climate variability such as high temperature in summer and low temperature in winter, which highly influenced the crop yield. The main cause for low productivity of sugarcane are due to late planting and poor crop management . Decision Support System for Agro Technology Transfer (DSSAT) version 4.6.1 is a software application program contains carbon simulation, crop development, and energy and water simulation. Sensitivity analysis of DSSAT model has revealed that departure in maximum temperature during monsoon season has large influence on fresh stalk yield (t/ha) of different cultivars of sugarcane grown in Lakhimpur-Kheri district. Increase in maximum temperature up to 5°C over its normal during monsoon season increases the stalk yield considerably @ of about 0.3 t/ha/° C with the increase in maximum temperature. Among two dominating cultivars cv. CoS767 (midlate) has high potential (72 t/ha) & cv. CoSe95422 has low potential yield (67 t/ha) in the region during different sugarcane growing season of study period (1980-2013).

The length of growing season is very much restricted to south-west monsoon (June-September) period. A very low temperature restricts sugar accumulation and climatic components that control cane growth, yield and quality of sugar content. Therefore, the proposed study will help in determining strategies for increasing/sustainable production in the region through better agronomic management & adjustment of planting time.

Keywords -Climate Variability, Sugarcane and DSSAT.

Abstract ID – 154

Is India under the threat of food insecurity? How much is climate change/variability responsible for it?

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Abstract

India has an agrarian economy and it is one of the leading producers of rice, wheat, sugarcane, spices, tea etc still there is a shortage of food in India which is evident from the fact, India has a very high global hunger index (100) and surprisingly in the last 15 years the index has shown no improvement at all. India is home to over one-third of stunted children of the world.So now the question is India really standing under the threat of food security? Is the rising population only responsible for such fate of India? According to the World Food Program me, India has a very high vulnerability to food insecurity which will intensify in the coming years and the major reason behind this climate change. The constant climate change has huge negative consequences on agriculture in India. The constant loss of arable land, suicide of farmers and loss of interest of Indian rural population in taking up agriculture as occupation(because of monsoon crop failure and other reasons), weird change of rainfall patterns, excessive rainfall, drying groundwater, sea-water intrusion, long spells and unpredictable floods and droughts etc. has brought India under the threat of food insecurity.So in this paper I had tried to bring up the fact that in spite of having agricultural base a country like India is under the threat of food insecurity and the main reason behind this is climate change. In spite of implementing modern technologies like organic farming, green manure, sustainable management, various policies favoring the farmers, policies for eradicating the shortage of food in India etc, still it is found that India has not been able to beat the negative impacts of climate change and it continues to have a very huge proportion of undernourished population. I have brought out the devastating effects of climate change on India in the past recent years. At the end I have thought of few remedial measures that can be adopted to make India self-sufficient in case of food and secure food security for its population.

Abstract ID – 190

ENSO impact on crop production over Indo-Gangetic Plain

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Abstract

Estimates of fluctuation in climatic condition have a large potential to effect production of crops such as Rice (*Oryza sativa*),Wheat (*Triticum aestivum*),Maize *(Zea mays)*, Pulse and Sugarcane (*Saccharumofficinarum*)which is the most prominent crops in Indo-Gangetic Plains (IGP). To understand the influence of El Nino/La Nina on rainfall and sea surface temperature which directly or indirectly affect the Indian crop over Agro-Climatic Zones of Indo-Gangetic Plains. IGP comprises of five states viz., West Bengal, Bihar, Uttar Pradesh, Punjab, Haryana and Rajasthan. The crop data of 44 years from 1966-2009 is used in the detailed analysis to show the impact of El Nino/La Nina and its negative/positive association with crop production over sub regions of IGP. Rice production is severely affected by El Nino years over Middle and Upper IGP regions. The production of wheat crop is decrease during La Nina events in Middle regions of IGP and other crops such as Maize production are severely affected by El Nino past years,sugarcane has been affected during the years of La Nina whereas pulse crops production is severely affected by both events over sub regions of IGP except only Lower IGP. In this result we did not find a significant change in production of crop in Lower IGP region but other remaining sub region of IGP is large impact in production of crop during both events El Nino and La Nina. Correlation between crop production and sea surface temperature (SST) of NINO 3.4 regions are very insignificant during El Nino events but on other hand La Nina shows much significant correlation in IGP. Many years shows deficit rainfall over India during summer monsoon rainfall (June to September) hasbeen responsible for decrease in production but central and western part of U.P. of Upper IGP region and Punjab, Haryana, Rajasthan states considered in Trans IGP shows good correlation during La Ninaevents. Hence, alteration in Indian summer monsoon rainfall (ISMR) and sea surface temperature (SST) might cause increase/decrease in the crops production. Any improved predictability wouldbe extremely valuable in forecasting effects of individual El Nino events on agricultural systems.

Abstract ID – 239

Comparative Study of UHI over Metro and Non-metro Cities of India

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Abstract

The Urban Heat Island (UHI) is a phenomenon whereby urban regions experience warmer temperature than their rural, undeveloped surroundings. Several factors affect and intensify the severity of UHI. These factors are thermal properties of surface fabric, surface geometry, surface water content, urban deserts, anthropogenic heating and also air pollutants. Though UHI is a local phenomenon but it is related with climate and can modify it over long term. Thus it is useful and essential to estimate UHI for climatic studies. In present work we have compared two cities over Indian continent with different orography, vegetation distribution, urban sprawl and urban canopy distribution to evaluate the UHI. We have selected Delhi for metro-city and Ranchi as non-metro city but getting urbanized rapidly. We have selected metro and non-metro cities for this study in order to quantify the intensity of UHI more precisely. Urban canopy structure of metro cities is different from non-metro cities. Other factors which also cause UHI are different in both cities. Thus it is interesting to compare UHI effect for these two cities. To measure UHI effect we used satellite data for land surface temperature, vegetation index. Results show that urban heat island effect is significant and could be visually characterized by the spatial pattern, extent and heterogeneity. The intensity of retrieved thermal properties and the maximum urban/suburban temperature shows significant differences. Lack of vegetation over suburban areas also could lead to higher temperature as urban areas. Remarkable changes are notices in UHI effect over metro and non-metro cities.

Abstract ID – 268

Spatiotemporal Analysis of a Self-calibrating Palmer Drought Severity Index (Sc-PDSI) for Evaluating Agricultural Drought in Semi Arid region of India

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Abstract

The current study highlights a comparative spatio temporal analysis evaluating the agricultural drought in seven districts of the Bundelkhand region, considered as one of the most severely affected drought prone region of Uttar Pradesh, India. We have analyzed monthly Self-calibrating Palmer Drought Severity Index (Sc-PDSI) at 0.5º spatial resolution during the period of 1998-2014 (17 years), obtained from the Climate Research Unit (CRU) database. The Sc-PDSI index uses a dynamic calculation approach and automatically calibrates the original PDSI replacing the empirical constant. Sc-PDSI over perform than PDSI during extreme meteorological conditions, especially in severe drought condition and enhances the region-wise comparison.In this study we presented and compared the trend of Sc-PDSI for seven district located in the study area in terms of spatial and temporal variability. The result clearly expounds increasing drought condition in the central and north districts as Jhansi, Jalaun and Hamirpur facing repetitive drought condition.

Keywords –Drought, Sc-PDSI, Climate Research Unit, Trend, Extreme event.

Abstract ID – 307

Estimating reference evapotranspiration with the FAO Penman-Monteith equation using NASA-POWER modelled data over agricultural area in Varanasi, India

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Abstract

Evapotranspiration is considered as one of the most important component of the hydrological cycle. On the Earth surface, evapotranspiration plays important role in context of water-energy balance and irrigation as well as agriculture practices. The watershed hydrology is influenced due to the global climate change as a result of varying evapotranspiration (ET) processes at different scales. FAO (Food and agriculture organisation) Penman-Monteith equation used as a standard equation for estimation of ET_0 on daily basis. This study involves maximum and minimum temperature, wind speed, relative humidity and solar radiation data. Reference Evapotranspiration (ET_0) have been estimated in this study using the NASA-POWER data products derived from MERRA-2 and GOES satellites. The performance of NASA-POWER data for ET_0 was examined over the agricultural regions in Varanasi and compared with the ground based measurements at regular interval at aforementioned duration. The performance indices such as Bias, Root Mean Square Error (RMSE) and correlation(r) indicate the values of 0.826, 1.914 and 0.969 for NASA/POWER data.

Abstract ID – 324

Riseinatmospheric CO2 levelanditsprobableimpactsonphotosynthesis, hydrologyandlocalclimate

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Theme: Impacts of climate variability/change on agriculture, water, energy and health sectors.

Abstract

Increased carbon-dioxide (CO_2) in the atmosphere is a serious concern of present time for its harmful effect on environment. In this study probable impacts of increased CO_2 in the atmosphere on photosynthesis, hydrology and local climate have been discussed based on a hypothetical model. In this hypothetical model we consider the earth to be composed of only soil, water body, plants and atmosphere. Basic photosynthesis equation is the only assumed equation. Due to increase in CO_2 level in the atmosphere plants adapt themselves to intake more CO_2 by increased photosynthesis and store it as glucose and grows.Increased photosynthesis requires more water and to save water the plants reduce stomatal conductance. This leads less transpiration. As a result ground moisture will increase where the vegetation is present and this will affect the runoff. Increased CO_2 raise the temperature of the earth and this leads to more evaporation from the water bodies and the area where there is no vegetation.This may lead to aridity in the land without vegetation cover and increase in salt content in the water bodies like ocean affecting marine animals. Increased vegetation will change the wind direction and reduce wind speed.

Abstract ID – 352

Effects of climate change on wind power prospects over India

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Theme: Impact of Climate Variability/Change on Agriculture, Water, Energy and Health sectors.

Abstract

Climate change and its impact have been discussed in literature for a long time.Global warming and increased frequency of extreme events like heat waves, drought and flood,attributed to climate change, have become common phenomenain last few years. Large scale wind power generation in India has a long history since its inception in the year 1986. Currently, India has an installed capacity of more than 34 GW and ranksfourth in the world.This capacity shall be enhanced to 60 GW by the year 2022. In the last three decades spatial and temporal distribution of mean wind speed at turbine hub-height, which is the key parameter to estimate the wind power potential, has changed.

In the current study climate change impacts on wind and onshore wind power have been analyzed over Indian wind rich states.The Modern-Era Retrospective analysis for Research and Applications (MERRA) 50m winds from 1979 to 2015 have been statistically assessed. Trend analysis of mean wind speed shows a decreasing tendency over western India at rate of 0.1-0.15 ms^{-1}/year. On the other hand, southern peninsular India shows an increase in wind speed at a relatively lower rate ranging from 0.05 to 0.1 ms^{-1}/year. Analysis of the diurnal variations in wind speed in the first and last decadesof the study period shows a decrease in the mean wind profile during high wind hours of a day, irrespective of the trend.

This study shows that a reassessment of impacts of climate change on potential areas selected for the future wind farms installation is a necessity. This study can be made more robust by including other reanalysis products available from the various global Met centres.

Keywords - Wind Power, Climate Change, MERRA, Trend Analysis.

Abstract ID – 356

Characteristic changes in heat stress over India in response to global warming

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Abstract

A critical aspect of human-induced climate change is how it will affect climatological mean and extremes around the world. Summer season surface climate of the Indian sub continent is characterized by hot and humid conditions. The global warming can have profound impact on the mean climate as well as extreme weather events over India that may affect both natural and human systems significantly. In this study we examine direct measure of the impact of climate change in terms of heat stress. The Heat stress Index is the measure of combined effects of temperature and atmospheric moisture on the ability of the human body to dissipate heat with rising temperatures. It is important to assess the future changes in the heat stress index, also it is desirable to know how the future holds in terms of temperature extremes for a country like India where so much of outdoor activities happen both in the onshore/offshore energy sectors, extensive construction activities etc. This study assesses the performance of the Coupled Model Inter comparison Project Phase 5 (CMIP5) simulations of heat stress index in the present century and changes under various future scenarios. In view of this, we provide the expected future changes in the heat stress indices over India and also the frequency of heat stress exceeding a certain threshold. Besides, we provide spatial variation of expected future changes in the heat stress index derived as a function of daily mean temperature and relative humidity and representative of human comfort having a direct bearing on the human activities. The observations show an increase in heat stress over many parts of the Indian landmass and those are generally well simulated by the models. The results indicate a substantial change in frequency and intensity of heat stress over East & west coast regions which may have serious implications on agriculture, human health, management of urban infrastructure and water resources.

Abstract ID – 370

Impact of climate change on the agricultural production over the Allahabad region of Indo-Gangetic plain

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Abstract

The growth, development, and yield of a particular crop are largely determined by weather conditions during the crop growth season. Even with minor deviations from the normal weather, due to corresponding changes in the efficiency of applied inputs (such as seed quality, soil conditions), the crop production seriously gets affected. A robust multidisciplinary approach is required for assessing the effect of changing climate on crop yield. The crop model, namely, Decision Support System for Agro Technology Transfer version 4.7 (DSSAT4.7) has been applied to assess the effect of warming environment on the crop growth and production. The DSSAT has dynamic crop growth simulation model for over 40 crops. The RICER047 model from DSSAT has been used to simulate rice production in the Allahabad region [25N, 81E] of Indo-Gangetic plains during 1st January 1998 to 31st December 2015. The significant seasonal variability of the rice yield during the period of simulation has been investigated vis-à-vis changing temperature and rainfall of the region.

Abstract ID – 391

Multi-pathway assessment of human health risk posed by gas and particulate phase Polycyclic Aromatic Hydrocarbons (PAHs) and Nitro-PAHs at a traffic dominated site in Agra, India

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Abstract

Polycyclic Aromatic Hydrocarbons (PAHs) and Nitro-PAHs are a group of environmental contaminants with carcinogenic and mutagenic potentials. These are ubiquitous and highly persistent in nature and mainly emitted from anthropogenic emissions. In the present study, concentrations of 16 priority PAHs and 2 Nitro-PAHs were determined in the atmospheric gas and particulate phase samples collected from a traffic dominated site in Agra, India. Gas and particulate phase PAHs samples were collected simultaneously on PUF plugs and Quartz micro fiber filters respectively using high volume sampler (TE-1000x). Extraction of PAHs was done in the mixture of DCM and n-hexane. PAHs in the organic extract were analyzed by Gas Chromatograph Mass Spectrophotometer (GC-MS) in selected ion monitoring mode. The mean concentration of total PAHs in particulate phase and gas phase was 3121 ± 308.9 and 1732.5 ± 175.1ng m-3 respectively whereas the mean concentration of 2 Nitro PAHs in particulate phase and gas phase are 65.3 ± 16.3 and 24.6 ± 6.5 ng m-3 respectively. Low molecular weight PAHs were higher in the gas phase whereas high molecular weight PAHs were higher in the particulate phase. Incremental lifetime risk of cancer posed by exposure of 16 USEPA priority PAHs from inhalation, dermal and ingestion pathways was also determined for both the gas and particulate phase PAHs. The Incremental lifetime cancer risk (ILCR) from PAHs exposure in Agra was higher than 10−6, which clearly implies a potential risk and it is dominated by gas phase concentration of PAHs. Threats to the cancer risk for adults and children is dominated by the dermal exposure of PAHs where in case of infants it is mainly via inhalation. Four to five ring PAHs contributes maximum to ILCR whereas two to three ring PAHs contributes least.

Keywords -Polycyclic Aromatic Hydrocarbons (PAHs), Nitro-PAHs, Incremental lifetime cancer risk (ILCR), Multi-pathway, Environmental exposure.

Abstract ID – 430

The ENSO and Indian monsoon climate variability during warm climates in CMIP5/PMIP3 simulations

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Abstract

In this study, we analyse the El Niño-Southern Oscillation (ENSO) and mean monsoon climate and its variability in India during the three different warm periods in past climate known as the Mid-Holocene (MH; 6ka), the Medieval Warm Period (MWP; 1ka) and Historical period (HS; 0ka or Present day) by using available CMIP5/PMIP3 model simulations.

We find that Indian summer monsoon rainfall (ISMR) was higher during MH than MWP and HS. We also found that majority of the models simulate weak correlation coefficients between ENSO and Indian summer monsoon rainfall and temperatures during MH than MWP and HS suggesting a possibility of slow background changes resulting in an apparent modulation of the interannual ISM-ENSO association. From the El Niño and La Niña composites, we see shrinking of tropical pacific warm and cold tongues and the amplitude of La Niña is weaker than the El Niño from MH to HS through MWP. We also see zonal shift in La Niñas during HS when compared to MH and MWP. A westward shift in the Walker circulation is also observed in the central tropical pacific during MWP compared to the other two periods. Also in majority of models, we have observed the meridional shift in Intertropical Convergence Zone (ITCZ) from MH to HS. The results are qualitative, given the inter-model spread.

Abstract ID – 498

Effect of Local Wind Forcing on the Bay of Bengal Coastal Kelvin Wave and Indian Summer monsoon deficit in June 2009 and 2012

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Abstract

Southwest monsoon is very much important for food, water and economic of the Indian sub-continent. Bay of Bengal is a major supplier of moisture to the Southwest monsoon. Coastal Kelvin waves at the eastern rim of the BoB radiates their energy toward the interior bay through eddy shedding and affect the thermal structure of the bay. Furthermore, it is known to strengthen the East India Coastal Current. An investigation on the effect of local winds on the Bay of Bengal (BoB) coastal Kelvin wave (KW) is studied by doing four sensitivity analyses using the Regional Ocean Modelling System (ROMS). The meridional wind stress component is found to have more influence on coastal KW than its zonal counterpart. The winds of December – April affect the 1st upwelling Kelvin wave most. During this time the meridional wind component at the BoB is northerly. The 50% weakening of this northerly wind component at the BoB causes over all 4.7% reduction of upwelling along the eastern rim of BoB. On the other hand the same 50% strengthening causes 4.6% increased upwelling on an average. The 50% weakening of meridional wind hinder the northward propagation of the 1st upwelling KW producing anomalous downwelling along its pathway. On the other hand the strengthening the same meridional wind strengthens the 1st upwelling Kelvin wave propagation. The local winds affect the other KWs also in similar manner. Further, our study found that during Indian Summer Monsoon deficit in June 2009 and 2012 first upwelling Kelvin Wave activities are reduced due to the southerly wind anomaly.

Abstract ID – 502

Heavy Precipitation over Himachal Pradesh during August 2018

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Abstract

August being one of the rainiest months in Himachal Pradesh having long period average of rainfall for the month of August in Himachal Pradesh is 261mm, which contribute to about 34% of total seasonal rainfall in Himachal Pradesh. It is very crucial for Hydropower Sector.On 13th August 2018 heavy to very heavy precipitation and exceptional heavy rainfall was recorded at 0300UTC, over east-central part of the state. Most of the stations reported more than 100mm of rainfall during the last 24hrs on 13th Aug 2018. Rainfall was started from the mid night of 12th Aug and lasts till 1130hrs of 13th Aug 2018. On 13th Aug 2018, state as whole received 72mm which is 486% more than its normal rainfall. Highest rainfall 172mm was recorded in the district of Hamirpur, which is 932% more than its normal value. District Solan received 154mm (950%), Shimla 67.9mm (857%), and district Mandi 117.8mm (735%). Except district Lahaul & Spiti, all other districts received excess rainfall from its normal values. Due to this heavy spell rainfall over the state, about Rs604 crores and 16 loss of human life was reported by Govt of Himachal Pradesh. Therefore, study is undertaken to find out the characteristic features of very heavy rainfall (24 Hours Rainfall $\geq$125mm) over Himachal Pradesh on dated 13th August 2018 by analysing the daily rainfall data of different stations in Himachal Pradesh. For this study surface charts, upper air charts, Satellite imagery, Radar images and NWP model charts were used to identify the synoptic features present and their effect of weather was studied.

Keywords -Heavy Rainfall, Western Disturbances, Trough, Low pressure, Himachal Pradesh.

Abstract ID – 510

Modelling Vector Borne Disease over India

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Theme: Impact of Climate variability on Health Sector.

Abstract

Climate change is a concern over India in recent decades resulting health hazards primarily because of the vector borne diseases (VBD) like Malaria, Dengue, Chikungunya etc. The weather and climate parameters play important role in the VBD dynamics which includes the interaction between host, vector and virus. The advanced prediction of the VBD is very much needed for the pro-active health care like climate prediction, but it is very challenging task as these predictions will include the complexity of theweather/climate modeling and the VBD disease modeling. In this work the burden of VBDs like Malaria, Dengue and Chikungunya over India is being measured and quantified at regional scale by data analytics and using the available long term disease data. Also a modeling platform is being developed by integrating a variable resolution general circulation model (VR-GCM) and Liverpool Malaria Model (LMM) for the advance prediction of Malaria incidences over India. The results suggest that the modeling frame work predicts the VBD dynamics well in advance both in space and time.

Abstract ID – 513

Effects of diurnal temperature variability and extreme temperature on mortality- a time series study from Varanasi, India

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Abstract

The impact of extreme temperature on morbidity and mortality has been well established in many developed countries and some developing countries. With the increasing night time temperature, the gap between maximum and minimum temperature has led to decline in diurnal temperature variability that can have serious consequences on health particularly in sub-tropical humid climate cities that enjoy a substantial difference between maximum and minimum temperature. Acknowledging the research gap from the developing countries we aimed to steadilystudy the effects of extreme temperature and diurnal temperature variations (DTV) on non-accidental mortality in Varanasi, India (2009-2016).The meteorological variables were collected from India Meteorological Department (IMD), New Delhi andthe daily all causenon-accidental mortality was collected from Municipal Corporation of Varanasi.The time series study was done using semiparametric Quasi-Poisson regression model that was adjusted for nonlinear confounding variables: time trends, relative humidity, ambient air quality (SO_2, NO_2, O_3 and PM_{10}) and days of the week (DOW) using penalized cubic smoothening spline. The additional vulnerability was further assessed based on age and sex. We found that the daily mean mortality was increased by 30% duringheat wave and cold spell. The results were expressed in terms of Relative risks (RR) that showed the all-cause mortality were more pronounced during heat waves (1.13), particularly for females (1.22) and for infants (< 4 years, 1.38), compared to the cold spells (1.06). Importantly, the effect of extremes increased when the model was controlled for airborne particulates, especially for infants (11%) during heat wave and age group 45-64 years during cold waves (54%). Decrease inDTV had anoverall negative impact on all-cause mortality (0.6%) specifically for age group 5-44 years (1.2%). The study is a first time analysis with decrease in DTV with a decreasing trend for the study period. We found that age and gender play an important role in increasing the susceptibility. We further, hypothesized that the detrimental impacts of increase in daily minimum temperature coupled with declining maximum temperature may induce physiological abnormalities disturbing the circadian rhythm causing excess mortality. The output from the study well be useful in framing relevant governmental policies and mitigation strategies and strengthening better early warning system.

Key words -Temperature extreme, Diurnal temperature, Non-accidental mortality, Air quality.

Theme 4

Weather and Climatic Extreme Events

Abstract ID – 1

Frequencies of heat waves over India in the global warming era

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Abstract

Recent studies indicate an increase in heat wave occurrences, attributable to global warming. Heat waves leads to severe illness sometimes death. Also persisting heat wave conditions (i.e.) higher temperature may affect livestock. In this study, an attempt is made to analyse the characteristics of heat waves over Indian region during the summer season using IMD gridded daily maximum temperature data for the months of (March-April-May) for the period from 1951 to 2014. In this study, we used the IMD criteria for identifying the occurrence of heat waves, (i.e.) when the maximum temperature anomaly is more than 4-5 ^{o}C (5-6 ^{o}C) where the normal maximum temperature is ≥ 40 ^{o}C (< 40 ^{o}C) and as a severe heat wave when the maximum temperature anomalies are ≥ 6 ^{o}C (≥ 7 ^{o}C) in regions where the normal maximum temperature is ≥ 40 ^{o}C (< 40 ^{o}C) and declaration of a heat wave if the temperature exceeds 45 ^{o}C irrespective of the temperature anomaly (Bedekar et al. 1974). The frequencies of HW events have been computed for the individual months of March, April and May and the season as a whole (MAM). The results indicate that the frequency of heat wave events are increasing in most parts of northwest and coastal regions of India. Heat wave is a natural calamity which kills most of the people and the major impacts are human illness, agricultural crop failures and power outages.

In addition, the occurrence, duration and intensity of heat waves during El Nino and La Nina years are examined. The results show that the occurrence of heat waves is more during El Nino years than La Nina years. This complements the well known negative relationship between Indian southwest monsoon rainfall and El Nino causing delay in the Indian summer Monsoon onset date. The descending branch of air over India due to El Nino- SO teleconnections cause higher temperatures over the Indian subcontinent than other years. During La Nina years, most of the Indian region generally receives above normal rainfall and temperatures are lower and therefore heat waves are less in many areas.

Key words - Heat waves, La Nina, El Nino, Summer season and characteristics.

Abstract Id – 4

Hot days, heatwaves, and severe heatwaves, over India in the 1.5°C and 2°C warmer worlds

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Theme : Weather and Climatic Extreme Events.

Abstract

In the summer of 2015 a heat wave claimed more than 2500 lives of southeastern India. Wehner et al., (2016) showed that the risk of this heat wave was increased due to anthropogenic forcings. The extreme temperatures that have occurred in the recent past and further increases projected under future scenarios have implications for human health and productivity. In light of the Paris accords, future stabilization of global mean temperature at the 1.5°C above pre-industrial aspirational target and the “not to be exceeded” 2°C target (still higher than current temperatures), the possibility of increases in extreme temperatures under these scenarios is very real. In this study we seek to understand the nature of extreme temperatures over India in the 1.5°C and 2°C worlds in comparison to the current climate. We make use of model output contributed under the Half a degree Additional warming, Prognosis and Projected Impacts project (HAPPI; Mitchell et al., 2017).
The HAPPI database contains output from many atmospheric GCMs with multiple simulations (~100 each) of historical (2005-2015), 1.5°C warmer decade, and 2°C warmer decade. The large number of ensemble members provides an opportunity to study the extremes in temperature that occur over India and how they may change. In order to provide insights into the future comparable against current operational practices, we make use of definitions of “*hot days*”, “*heat waves*”, and “*severe heat waves*” used by the India Meteorological Department (IMD). We compare bias corrected model output against observed daily temperatures from the IMD gridded (1°x1°) temperature dataset.
We investigate the frequency, timing and duration of such heat events in the future scenarios. Our Preliminary findings indicate that heat waves, and severe heat waves are expected to become more frequent and of longer duration in the 1.5°C and 2.0°C warmer worlds. Many new areas are seen to become heatwave prone in the future.

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Abstract ID – 14

Tendencies of tropical cloud clusters transformation into tropical cyclones

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Abstract

Tropical cloud cluster (TCC) plays a vital role in earth's climate and releases a large amount of latent heat into the atmosphere. Further, clumping of these tropical clouds forms the basis for genesis of tropical cyclones (TC) and influences its lifetime also. However, TC genesis occurs only when there is organized tropical convection. It is now known that not all the TCCs are developed into cyclones over the globe and only few TCCs grow into tropical cyclones selectively. So, it is essential to understand why only certain TCC develop into a TC and others don't? In the past it is shown that the ensemble characteristics of TCCs are an important factor to understand the complete climatology of tropical convective cloud systems and their development into TC. In this regard, the present study employs the global TCC observations generated by GridSat and IBTrACS data set from 1980 to 2009 to investigate the TCC distributions over the various Oceanic basins such as North Atlantic, South Atlantic, East-West and South Pacific and North and South Indian basins. The central objective of the present study is to delineate the processes responsible for transformation of TCC into TC. The TCCs are identified based on different IR temperature thresholds in each basin. Present results suggest that overall ~ 5.5 % of TCCs were developed into TCs per year over the globe. It is also found that the numbers of TCCs which are grown into TCs are increasing with years. The noteworthy result from the present study is that the tendency of TCCs developed into TCs is increasing with cloud cluster size up to 300 km^2 in North Atlantic, West and South Pacific oceanic regions as shown in figure 1. However, a decreasing trend in TCC developing into TC is observed in East Pacific basin with all TCC sizes. Interestingly in North Indian basin, TCCs developing into TCs are efficient for TCC having size above 100 km^2. Overall, it is found that there is an increasing trend is observed TCCs developing into TCs especially, at 100-200 km^2 TCC sizes. However, the results also indicate the role of large-scale environment conditions in development of TCC into TC.

Keywords -Tropical Cloud Cluster, Tropical Cyclones, Global TCC data.

Abstract ID – 21

Energetics aspects of the cyclonic storms during 2013 and anomalous cyclogenesis over Indian seas

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Abstract

Over the Indian Seas, major tropical cyclone periods are pre and post monsoon seasons. During the year 2013, 10 cyclonic disturbances developed over Northern Indian Ocean, out of which 5 intensified into Cyclonic Storm and all of these were in Bay of Bengal.As it is the higher number in the last decade, 2013 can be classified as a year with anomalous cyclonic activity. Objective of the present study is to understand the dynamics of these five intense cyclonic vortices during 2013 from an energetic perspective.An attempt has been made to understand the dynamics of the atmosphere for the intense cyclonic vortices, of strength Cyclonic storms and above, formed over Indian seas during 2013, from the perspective of atmospheric energetic. Attempt has also been made to understand the dynamical cause for anomalous cyclogenetic activities over Indian seas during 2013 cyclone seasons, from the perspective of atmospheric energetic. Salient features of the results of this study are given below:

- Maximum intensification of all the intense cyclonic vortices was associated with an enhancement in both barotropic and baroclinic eddy kinetic energy conversion.
- All these systems intensified at the expense of A_E and A_Z.
- For all of these systems baroclinic eddy kinetic energy conversions dominates over barotropic eddy kinetic energy conversions.
- Anomalous cyclogenesis in 2013 may, at least partly, be attributed to an above normal MSE in the atmosphere, above normal baroclinic and barotropic eddy kinetic energy conversion during cyclone months over the region under study.
- Release of convective instability is not likely to be attributed for anomalous cyclogenesis in 2013.
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Abstract ID – 30

Case Study of Severe Thunderstorm Activity Over Chhattisgarh on 21ST May 2016

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Abstract

Thunderstorm, resulting from vigorous convective activity, is one of the most disastrous weather phenomena in the earth's atmosphere. The severe thunderstorms associated with thunder squall, hail storm, flash flood and lightning cause extensive damage and losses to life and property. A common feature of the weather during the pre-monsoon season over the Indian region is the outburst of severe local convective storms.

Preparedness against Thunderstorm, squally wind, tornado etc. is most essential for human being. The main objective of this study is to identify the synoptic features and state of instability over Chhattisgarh on the day of consideration i.e. 21st May 2016. This paper may help the forecasters to assess the possibility of thunderstorm activities and serve the information for the development of the thunderstorm risk assessment model for the Chhattisgarh region.

This paper presents on the aspects of the realized significant weather phenomena of thunderstorm, which is supported through the analysis of thermodynamic Instability condition of atmosphere instability indices based on the Radio-Sonde and Radio wind (RS/RW) ascent products from observatories at Raipur and Jagdalpur in Chhattisgarh. Satellite imagery, surface and upper air charts have also been analyzed which support the thunderstorm activities in different locations of Chhattisgarh. The Showalter Index, K-Index, Total-totals Index and convective available potential energy (CAPE) show the favorable conditions for the severe thunderstorm to occur in above mentioned stations; however, due to physiographic uniqueness of the state, the values of CAPE, and other thermodynamic parameters show different values in different stations. The reason for dry thunder storm with sever squall has been discussed.

Severe thunderstorm with squall was experienced on 21st May 2016 over several parts of Chhattisgarh during evening; for study of which T-ϕ grams of Raipur and Jagdalpur from Radio-Sonde data of 00 Z of 21st May 2016 have been obtained and used for analysis. The upper air charts were obtained from IMD website and satellite imagery showing signature of line squall of thunderstorm have also been included. Rainfall, thunderstorm and squall reports were also obtained from Meteorological Centre Raipur for this study.

The indices of Raipur and Jagdalpur as computed at M.C.Raipur are as follows :

Station	S I	K I	TT	CAPE
Raipur	-4.7	43.6	51.8	1109.74
Jagdalpur	-9.4	35.9	44.6	1271.40

The Showalter indices are negative for both at Raipur -4.7 and Jagdalpur -9.4 which are less than -3. Hence conditions are favorable for convective activity at both the places. Similarly K indices are Raipur 43.6 and Jagdalpur 35.9 which are more than 20 and total indices 51.8 and 44.6 which are comparable with 50. CAPE value is more than 1000 in both places. All the index and parameters were very favorable for heavy thunderstorm over Chhattisgarh and there was thermodynamical instability in atmosphere. So severe thunderstorm occurred over the region but it was dry thunderstorm over most places. Strong wind of more than 50Km/h was recorded over the region. Trees were uprooted at many places, electric poles and kachcha houses were damaged.

At Raipur there was no rainfall i.e. dry TS was recorded. Dust storm was also recorded in Raipur. The reason for no rainfall or very less rainfall was less moisture incursion due to strong dry westerly winds in lower atmosphere coming from very hot region of Maharashtra and MP as seen in synoptic chart. The maximum temperature over the region was more than 40° C, so moisture available was not sufficient for rainfall. The cyclonic storm 'Roanu' over NW Bay moved away so moisture incursion from Bay was also very less. These were the reason for less rain and strong thunder squall reported over C.G.

Abstract ID – 41

Why the tropical cyclone "Ockhi" was a difficult case to predict

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Abstract

The performance of forecasting tropical cyclone Ockhi could not fulfill the expectations, resulting in loss of many lives. It is admitted that the genesis location of the system near coast was rare and also it underwent an unusual rapid intensification. In combination of these facts one more important aspect that affected the confidence of the forecasters was the performance of the Numerical Weather Prediction (NWP) models over the Bay of Bengal during the month of November, 2017. In this study the forecast skill of three Global NWP models viz. ECMWF, NCEP-GFSand IMD-GFS, are scrutinized for the same period. Forecasts of several dynamical and thermo-dynamical parameters simulated by each of the models are compared with the analyses of the same models. It is found that there were several inconsistencies in the models' forecasts. During November, 2017 a number of false alarms have been detected in this study. The 850 hPa level vorticity, middle tropospheric moisture, instability, wind shear are the four parameters used in Genesis Potential analysis and forecasts. Prediction skill of all these four parameters are investigated along with location and magnitude of minimum mean sea level pressure, 10m wind etc. over the Bay of Bengal. The results show that the models often overestimated genesis of cyclonic vortices during the period and that in turn may have adversely affected the forecasting.

Abstract ID – 47

Climate Variability and Extreme Events in India: The Socio-economic Consequences

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Abstract

Climate is the composite prevailing weather conditions of a particular region as temperature, air pressure, humidity, precipitation, sunshine, wind speed etc. over several decades and any changes in climate is very difficult to identify without a very long spell record. Climate change and climate variability therefore operates on different time scales (Science, 2017). Climate change is nothing new and it took place several times naturally since the birth of the Earth. However present variabilities in climate poses a real threat to the world specially to the high populous countries like India. The resilience of ecosystem of the earth is being disrupted by the abruptive variations in climate which could further lead to natural hazards like floods, droughts, wildfires, heatwaves etc. It is believed that climate change caused several occurrence of extreme events and India is not the exception. This paper tries to establish a relation between the variation in climatic condition and the occurrence of extreme events in India and the socio-economic consequences of such extreme events on the environment and the society including loss of life, property and livelihoods.

Key words -Climate variability, Extreme events, Socio-economic consequences.

Abstract ID – 49

Influence of Atmospheric Rivers in the Occurrence of Devastating FloodAssociated with Extreme Precipitation Events over Chennai using differentReanalysis Data Sets

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Abstract

The main focus of the present study is to examine the presence of Atmospheric Rivers (ARs) in the occurrence of Chennai (13.5° N, 80.5° E) flood event over Tamil Nadu which is south-eastern part of Indian peninsular region of India during November to December 2015. The vertically integrated horizontal water vapour transport (IVT) algorithm was used for the detection of ARs using three different reanalysis products, namely, the NCEP-NCAR (National Center for Atmospheric Research), NASA's Modern-Era Retrospective Analysis for Research and Applications (MERRA) and ECMWF Interim Re-Analysis (ERA-Interim). It is noticed that the occurrence of heavy precipitation events (HPEs) prior to the flood in the Chennai city, has been in good agreement with the presence of ARs during that time. The distribution from TRMM-3B42RT, TRMM-3B42 are validated with the with in situ rain gauge observations over the Chennai city. We have conducted quantitative analysis of IVT and their impact on heavy precipitation events and flood occurred over Chennai city. It is seen that MERRA reanalysis could be able to provide better presence of ARs. The study mainly reveals that persistent ARs of more than 18 hours resulted in extremely heavy precipitation and lead to associated flood over Chennai. Over the given reference period 1979-2015, correlation between IVT and HPEs is statistically significant at 99.5% confidence level. But the correlation between IVT during persistent ARs and corresponding HPEs is statistically significant at 90% confidence level. A large fraction of HPEs occur after ARs, with a small portion of ARs would lead to HPEs. This study advocates that the detection of ARs can be used as important proxy in identifying the likelihood of occurrence of heavy precipitation/flash flood events for a given location using reanalysis data sets.

Abstract ID – 50

Salient features of Thunderstorms over Bay of Bengaland Adjoining North East India during active phaseof Indian Summer Monsoon: A Case study

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Abstract

Predictions of Thunderstorms developing over the Bay of Bengal (BoB) and North East India (NEI) is highly challenging because scientific knowledge regarding Thunderstorms is far from complete, and data is sparse. In this paper we have examined Satellite observed thunderstorms over (BoB) and adjoining NEI during 27 July to 01 August 2015to understand the thermodynamics characteristics of thunderstorms. Examination of reanalysis, Satellite and Radiosonde data products such as Relative humidity (RH), wind shear (850-200 hPa) and Tropical Rainfall Measuring Mission (TRMM) rainfall data in the domain 0-30°N and 50°-100°E. RH varied between 80-100 %, over 15°-30°N, 70°-100°E, which suggest active towering cumulonimbus thunderstorm clouds formed during vigorously active southwest monsoon conditions producing severe thunderstorms over the head Bay of Bengal. Thermodynamic indices derived from Wyoming radiosonde products such asconvective available potential energy (CAPE), convective inhibition energy (CINE) , Lifted Index, Showalter Index, Sweat Index, Precitipitable water content (PWC) is examined. The analysis reveal that the CAPE values were high (1740.54 J/kg) on severe thunderstorm days nearly constant during intermediate thunderstorm active days (993.66 J/Kg) and during weak thunderstorm it reduces sharply to 401.5 J/Kg. The rainfall was very heavy in the range of 200-260 mm causing flash floods in the North Eastern parts of India. Understanding thunderstorms dynamics and thermodynamics will enable better prediction of Thunderstorm and floods, leading to enormous societal benefits.

Abstract ID – 56

Teleconnection of large scale processes on heavy rainfall over Odisha during summer monsoon season

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Abstract

In recent years, wet climatic zones are becoming wetter, and dry climatic zones are becoming drier. Heavy rainfall is an event which is causing flash flood over a region and damage to both life and economy. The present study investigates the characteristics of large scale features associated with monsoonal heavy rainfall events (rainfall > 64.5 mm/day) over Odisha for a period of 34 years (1980 – 2013). The analysis reveals that the heavy-to-extreme rainfall days and dry days are increasing, while the light-to-moderate rainfall days and wet days are decreasing over Odisha. Climatological heavy-to-extreme rainfall frequency and intensity are more in urban (Khordha) and high elevated (Eastern Ghat; height ~1.6 km) areas and having an increasing trend during the study period.

Analysis of large scale meteorological parameters with extreme rainfall events over Odisha suggests that there is a strong sea surface temperature gradient between south Bay of Bengal and Andhra Pradesh coast one day prior to the occurrence of extreme rainfall, which is causing stronger south westerly wind at 850 hPa along east coast of India. Presence of a low pressure system (i.e. less geopotential height), strong rising motion (negative omega at 500 hPa pressure level) and warm middle atmosphere over Odisha promoting to have more moisture in the air. More vertically integrated specific humidity is also present on the occurrence of extreme rainfall over odisha during summer monsoon season.

Key words - Heavy rainfall, Summer monsoon, Climatological, Odisha.

Abstract ID – 63

Impact of DWR precipitation estimates on simulation of heavy rainfall events

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Abstract

The Indian sub-continent often receives widespread heavy rainfall under the influence of organized mesoscale convective systems (MCSs) embedded in large scale synoptic systems. Rainfall amounts of 100–300 mm in a day, in and around the weather systems, are not uncommon.

Accurate quantitative forecasting of precipitation, especially during severe weather episodes, is one of the most challenging tasks of meteorological modeling. The frequent assimilation of variables directly related to precipitation may contribute to a better definition of model moisture, vertical velocity, and latent heating, and could therefore lead to an improvement in short-range precipitation forecasts. The surface precipitation-rate estimates derived from the Doppler Weather Radar (DWR) data are potentially of considerable value to high resolution Numerical Weather Prediction (NWP) models. An attempt is made to evaluate the impact of the assimilation of rain rates derived from the Indian DWR data through latent heat nudging (LHN) scheme for simulation of heavy rainfall events using high resolution (4 km) NCUM regional model.Model produced profiles of Latent Heating is scaled by the ratio of model and observed precipitation rate from DWR.

In this study, two numerical experiments are carried, namely CNTL (without LHN scheme) and LHN-R (with LHN scheme) for simulation of two heavy rainfall events along east coast of India. The initial conditions are provided to both the experiments from the regional 4DVAR analysis system. The data assimilation is performed with a 3-hourly data assimilation cycle,starting 24 hrs before the start of model integration in each case. The 3 hr forecast obtainedfrom the previous cycle is used as the first guess in the next cycle. Thehigh resolution regional model is integrated upto 72 hours from 00 UTC initial conditions. The LHN is performed in the short forecast step of every data assimilation cycle in the LHN-R experiment. The statistical skill scores at different threshold of rainfall in the forecast are reasonably improved in the LHN-R simulation compared to CNTL. Study provided apositive proof of the concept that the assimilation of the Indian DWR precipitation rate data within the NCUM-R modeling frame work can improve the simulation of heavy rainfall events.

Key words -NCUM regional model, heavy rainfall events, Precipitation rates, Latent Heat Nudging.

Abstract ID – 82

Effect of convectively coupled equatorial waves on daytime temperature distribution over India

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Theme: Weather and Climatic Extreme Events.

Abstract

Parts of Indian subcontinent experience severe heat waves every year during the pre-monsoon months of April to June. This increase in daily maximum temperature cause severe damage to human beings leading to sunstroke and even the death. Distribution of temperature is influenced by various local and large-scale atmospheric processes. Large scale atmospheric variations with time scales less than a season (also called the tropics Intraseasonal oscillations) are known to impact tropical weather significantly. Continuous propagation of wet and dry phases of large scale oscillations can have significant impact on temperature variations. In this study we look at the role of convectively coupled equatorial waves and Madden Julian oscillations on the distribution of pre-monsoon temperature over India for a period of 35 years from 1979 till 2013. IMD daily maximum temperature data is used for this purpose. Phases of equatorial waves are quantified by frequency-wavenumber filtering of the NOAA OLR interpolated daily data for the same period. The results show highly significant modulation in the temperature distribution for certain waves. On average over the country, there is an increased of probability of higher temperature up to 45% during the presence of dry phase of Rossby wave while wet phases of waves can decrease the occurrence by 30%. Over all, it is seen that the large scale tropical waves have significant propensity to modulate the temperature distributions over the country.

Abstract Id – 84

A case study on Dust Storms occurred over Uttar Pradesh in May'2018

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Abstract

Thunderstorms are the manifestation of the convective activity in atmosphere. It's destructive off springs are the hailstorms, lightening, high winds, heavy rains and most violent of all are the tornadoes. Dry thunderstorms produce Dust storms are normally considered to be natural hazards. During such events, dust aerosol is loaded into the atmosphere, directly reducing visibility and effectively reflecting solar radiation back to space. Essential conditions for the formation of a severe thunderstorm are (i) Conditional instability (ii) Availability of moist air at lower levels (iii) Insolation and orography for initial lifting of moist air at higher levels (iv) Presence of high lapse rate of temperature, due to dry westerly at upper levels and moist southerly/southwesterly air at lower levels (v) Presence of trough or cyclonic circulation in lower levels over the region. In addition, strong vertical wind shear is found to be one of the important factors for the occurrence of severe thunderstorm as the release of latent energy in an environment of strong vertical wind shear often leads to the development of severe convective storms (Stephen et al. 2000). Though each one of the conditions is considered favourable for convective development, their relative importance and the weightage to be given to each factor have not yet been clearly established. Thus, any discussion on this will have to be only qualitative and in general terms. Thunderstorms occur in northwest India and west Uttar Pradesh in all the months of pre-monsoon season. The activity is more in western Himalayas than in the plains. In the plains the activity is more in the second half than in the first half of the season (IMD, 1973). Dust storm occurs only in the plains. Significant dust storm activity begins in April and reaches its maximum in June. These dust storms are locally known as Andhi (IMD, 1980).

In this study Dust storm phenomenon that occurred over Agra and Moradabad on 2nd May, over Etwah, Mathura, Aligarh and Agra on 9th May, over Bareilly, Barabanki, Bulandshahar and Lakhimpur Kheri on 13th May and over Unnao and Raibareli on 28th May'2018 have been studied. These deadly dust storms claimed 130 lives during the May'2018 in Uttar Pradesh. We have analyzed different features of thermodynamic indices and parameters, synoptic situations and various products of numerical weather prediction model and tried to find out probable dynamic and thermodynamic aspects of such weather phenomenon. For this study, description of the thunderstorm along with the synoptic conditions and current weather observations, Satellite imageries, various diagnostic products of GFS model and Doppler Weather Radar products have been collected from India Meteorological Department, New Delhi and Thermodynamic indices and parameters are collected from the web link.

Abstract ID – 86

Extremes in Southwest Monsoon Rainfall over Northeast Regions of India and its association with Largescale Circulation

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Abstract

Southwest monsoon rainfall is dominent during break phase of monsoon over the northeast region of the Indian subcontinent. Hydrological disasters are recurrent over this region due to heavy downpour with short duration. Therefore, we discuss the characteristics of rainfall extremes during the southwest monsoon over the region (88^0 E- 93^0 E; 23^0 N- 27.5^0 N) and also their evolution in addition to their dissipation features using recent rainfall data from TRMM 3B42 V7 and CPC South Asia for 17 years from 2000 to 2016. Circulation features during lead-lag of extreme events are also examined using NCEP/NCAR (National Center for Environmental Prediction / National Center for Atmospheric Research) reanalysis products. We identified 32 extreme events such that rainfall of the day exceed 90^{th} percentile (90P). During the extreme events, heavy rainfall is located mainly in the NER without much spread in the aerial domain. The highest number of extreme rain events is found in the month of July, followed by the months of June and August. Trend analysis indicates the significant decreasing of low rainfall events compensated by significant increase in very heavy (>95P) to extremely heavy (>99P) rainfall events. Life of the extreme rainfall events are found to be about 3 days during which NER receives higher than 100 mm/day. Strengthening of southerly component of lower level wind from the Bay of Bengal and updraft due to convergence at 850 hPa over the region favours rainfall peak. The sea level pressure anomaly gradient and vertical velocity show a sudden development of the conditions favourable for the heavy downpour over the northeast regions.

Abstract ID – 91

Analysis of Extreme Rainfall Event due to Cloud burst using Multiscale Observation and Non Hydrostatic Model

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Theme: Weather and Climate Extreme Events.

Abstract

Climate change is the most important global environmental challenge faced by human beings with implications for natural ecosystems, agriculture & health sector. One of the major concerns with a change in climate is the increase in the increase in extreme weather events. Climate Change projections indicate increase in the frequency and intensity of Extreme Rainfall Events (EREs). The Himalayas,India shows an increasing trend of the ERE due to Cloudburst events over the mountainous region evidenced by analysing the multi-source climate observed data.The disaster vulnerability is very high due to cloud burst events,which results the loss of life and properties. This present study on the Himalayan belt is being carried out using multi source observation data taken from TRMM(Tropical Rainfall Measuring Mission and CMORPH(CPC Morphing Technique) data sets and using the simulation from a non hydro static model (NHM) .

The NHM is configured for the simulation of rainfall occurred because of cloud burst events over India. As convection plays an important role so different convective parameterization schemes (CPS) were used for the simulation and analysis of the rainfall due to cloud burst events. Model resolution is also analyzed in terms of quantitative precipitation forecasting.The model is designed for a broad range of spatial and temporal scales for the simulation of cloud burst events with different large-scale conditions using different lateral boundary conditions and model domains.The model is well capable of simulating the extreme events before 48-72 hours. Some sensitivity studies also carried out with the model for the optimized configuration of the model for the meso-scale forecasting of the EREs due to Cloudburst.This model configuration and the observational study can be used for the investigation of the Cloudburst mechanisms in particular over Himalayan region and the medium range forecasts can be useful for disaster management for Himalayan belt.

Abstract ID – 165

An observation based approach for fog forecasting over the Indo-Gangetic plains

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Abstract

Fog in the Indo-Gangetic plains (IGP) in India covers a large area, yet its localized nature poses challenges towards accurate predictions. In order to overcome these challenges and to enhance our existing understanding of this phenomenon, an attempt is made to derive a relation between visibility and associated meteorological factors over the region using multiple linear regression. An increasing trend in fog frequency has been observed over ten stations in the IGP during the study period (DJF-1977/78 to 2013/14). Trends in associated meteorological variables including temperature (dry bulb, dew point, maximum and minimum), wind speed and visibility have been observed in the study period. Multiple linear regression with visibility as dependent variable and abovementioned meteorological factors as independent variables is used to quantify these changes. Based on model statistics, suitable threshold values for fog/non-fog occurrences are defined and an equation is derived for the entire IGP. The equation is applied to the ten stations and the model skill and accuracy are assessed. Thereafter, fog forecasting for DJF (2015/16-2016/17) is carried out and validated with observations for 15 stations.

Abstract ID – 167

Analysis of severe weather using RGB scheme of INSAT-3D satellite at IMD

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Abstract

In weather forecasting, it is extremely valuable to assess when and where the initialization of instability is going to occur. For the purpose of forecasting severe weather, it is useful to predict the initial stage when atmospheric instability produces significant convection. In this study, Real-time Analysis of Products & Information Dissemination (RAPID), a web-based quick visualization and analysis tool for INSAT satellite data on a real-time basis has been introduced for identification of thunderstorm events.

The combination of channels using red-green-blue (RGB) composites of INSAT-3D satellite and its value contents have been used to prepare the threshold for Day Microphysics (DMP) and Night Microphysics (NMP). The threshold technique has been developed separately for both the RGB products of the year 2017-18 of March to June, prior to the event (1- to 3-hours) for the detection of the thunderstorms. The training data have been prepared and tested onto 2018 during pre-monsoon season. A validation analysis was conducted using Forecast Demonstration Project (FDP) of Storm Bulletins for pre-monsoon weather systems prepared by India Meteorological Department (IMD) and RADAR observations, demonstrating that this approach is extremely useful in recognizingthe area of convection prior to the occurrence of the events by the RGB thresholds. This threshold technique yields a very good probability of thunderstorm detection more than 83% and 82% with acceptable false alarm conditions less than 9% and 12% for DMP and NMP respectively.The thresholds techniques are found to be useful for nowcasting application and are being used operationallyusing RAPID tool.

Keyword -INSAT-3D, RAPID, DMP, NMP, RGB.

Abstract ID – 183

Role of land-atmosphere interactions in convection and precipitation
Theme: Weather and Climatic Extreme Events

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Abstract

Precipitation is a highly stochastic variable, which varies in spatial and temporal scales. Accurate prediction of precipitation associated with thunderstorms, squall lines, cloudburst or synoptic systems embedded in the monsoon circulation requires a better understanding of the land-atmosphere interaction processes that are involved in the triggering of moist convection leading to the formation of deep clouds. In this study, we investigate the role of land-atmosphere interactions over the Indian region in the initiation of convection during such extreme events during the pre-monsoon and monsoon seasons. Observations based on radiosonde data, precipitation, surface fluxes of radiation and atmospheric reanalyses are used to investigate feedback processes occurring at the land-atmospheric interface. Thermodynamic and dynamic indices such as the Convective Available Potential Energy (CAPE), Convective Inhibition Energy (CIN), Lifted index (LI), K-index, Total Total Index (TTI), Deep Convective index (DCI) and SWEAT index are also studied to quantify the convective instability of atmosphere. The relative roles of local and large-scale factors in the convective initiation processes over land are investigated.Better understanding of such processes will be beneficial in understanding systematic errors in the representation of convection in coupled models and propose a roadmap for further improvement.

Abstract ID – 185

Comparison and Analysis of Cold Wave and Severe Cold Wave Events over Indo-Gangetic Plain

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Abstract

The Indo-Gangetic Plain is an environmentally sensitive, socially significant and economically strategic domain of India; it incorporates seven meteorological sub-divisions of India. Future changes in exposure, vulnerability, and climate extremes resulting from natural climate variability, anthropogenic climate changes, and socioeconomic development can alter the impacts of climate extremes on natural and human systems and the potential for disasters (IPCC, 2014). Cold wave is defined as the occurrence of extremely low temperature in association with the incursion of dry cold winds from the North into Sub-continent. Based on daily minimum temperature data during 1984-2013, frequency of cold wave (CW) and severe cold wave (SCW) events have been examined forwinter season (DJF) over seven meteorological sub-divisions in Indo-Gangetic Plain (IGP).The highest number of cold wave days (40) is found in Amritsar for 1984-2013 and least (7) over Kolkata. The long term minimum temperature data over IGP has been categorised as seven subdivisions of three decades i.e. 1984-1993 as D1, 1994 to 2003 as D2 and 2004-2013 as D3, respectively The data is further analysed with descriptive statistics by standardizing and finding departure from mean minimum temperature for entire winter season data over all seven selected stations over the IGP region. The analysis results show that Amritsar minimum temperature ranges from 4.3 to 9.7 ^{o}C with a mean of 6.4^{oo}C while over Kolkata the spread of minimum temperature is rather on higher side of box plot with a minimum temperature of 12.62 ^{o}C, maximum of 19.15 ^{o}C and a mean of 15.06 ^{o}C for 1984-2013. The significant SCW days were found in Amritsar, Delhi, Agra and Varanasi during D1 and D3 decades.

Key words - Extreme temperature, Cold wave, Frequency, Decadal variation.

Abstract ID – 191

Study on extreme rainfall events over India during the recent decades

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Abstract

The Indian subcontinent receives more than 80% of the rainfall during the southwest monsoon season hence the quantity of monsoon rainfall plays crucial role in the socio-economic status of the different regions of India. The extreme rainfall events are increasing during the recent past and this leads to natural calamities. For example, very heavy rain events cause the catastrophic floods and landslides, which in turn affect agriculture and property. During the past decades, besides weakening of the monsoon, significant increase in the number of extreme rainfall events is observed. Here, we have made an attempt to identify the extreme rain events in the past decade from 2008 to 2017 using IMD gridded daily rainfall data. An arbitrary criterion is employed to identify the extreme rain event in such a way that when the rainfall exceeds a threshold value of 100 mm/day with three times standard deviation for a long period average of 30 year climatology for a particular region. It is observed that most of the extreme events during the period are occurred mainly beyond 16^{o}N. The contribution of such extreme rain events to the seasonal rainfall is substantially high. Also, there is a notable increase in the number of events in July occurring over the northwestern part of India. The observed increasing trend with statistically significant extreme events must be seriously taken into consideration while forming the policies for water resources and disaster management.

Abstract ID – 210

Heat waves over India during the 20thand 21stcentury

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Abstract

In the 21st century, climate change is considered to impose the greatest environmental threats to the world. Associated changes in climate extremes are hypothesized to have greater negative impacts on human society and the natural environment than the changes in mean climate. In this context, an assessment of temperature extremes is made for the Indian subcontinent to identify the changes since 1951 to 2015, and for the future climate periods till 2100.

The frequencies of the days having thresholds of 40C, 42C and 45C for the maximum temperature over India during the pre-monsoon are evaluated using the grid-point maximum temperature data of India Meteorological Department [IMD] for the period 1951–2015. Corresponding temperature predictions from CMIP model outputs and statistical downscaling model (SDSM) methodology were compared with the IMD gridded maximum temperature data for validation. Statistical metrics of BIAS, RMSE and MAE have indicated low BIAS, high correlation and high IOA (Index of Agreement) validating CMIP climate simulations.

Similarly the model projected maximum temperatures from the future climate projections using the same model for the climate periods of 2021-2050 and 2070-2099 are calculated. The data for the period from 1 March to 31 May, for the each of the two climate periods, are used to characterise the heat waves in future climates. Specifically the characteristics of heat waves in terms of intensity, duration and area extent are calculated and compared to heat waves of the current climate. An increase in the heat waves duration, mean maximum temperatures and frequencies of heat wave days in future climate periods have been identified.

Key wards -Maximum temperature, Heat waves, CMIP model, Frequencies.

Abstract ID- 214

Are recent increased fatalities due to lightning activity in India related to increase in lightning activity owing to climate change?

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Abstract

The IPCC report (2013) projects global warming of 1-5 °C by the end of 21^{st} Century. The global warming is closely related to increased concentration of green house gases. Previous studies have shown that on different temporal and spatial scales small increases in surface temperature leads to increase in thunderstorm and lightning activity. The lightning induced deaths are on the rise especially in the tropical south Asia and Africa but IPCC report does not explicitly deals with lightning activity and its future projection. Studies on this aspect become all the more important as the subgrid scale phenomena such as convective clouds and hence lightning are poorly resolved and taken in to account by climate models.

With Recent increase in deaths due to lightning activity in India we are posed with a question - are these fatalities related to increase in the lightning activity owing to climate change? In order to address this issue we have analyzed trends of lightning activity, surface temperature, upper tropospheric water vapour, cloud ice, Convective Available Potential Energy (CAPE) and aerosols. We also present correlation of these parameters with lightning activity using lightning flash rate data of Lightning Imaging Sensor aboard TRMM, TRMM Level -2 Precipitation Radar data, gridded temperature data of IMD, aerosol data acquired by MODIS. The result indicates that upper tropospheric temperature rise is more than surface temperature rise. This imply stable atmosphere with fewer thunderstorms. The increased convection transports additional water vapour into upper troposphere. The water vapour acts as green house has by absorbing infrared radiation emitted by the surface of the Earth. This results in more warming in the upper troposphere than at the surface and stabilizing of the atmosphere. However, results also show that within the thunderstorm the instability measured by CAPE is positively correlated with lightning activity.

This paradox of stabilization of global mean atmosphere with increase in lighting activity leads us to conclude that tough thunderstorm activity has subdued but those develop are much more explosive producing more lightning activity and perhaps lead to more fatalities.

Key word -Lightning, Thunderstorm, Climate Change.

Abstract ID – 243

Some dynamical and thermodynamical aspects and convective asymmetries associated with the development of Tropical Cyclone OCKHI (2017) over the North Indian Ocean

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Abstract

The Tropical Cyclone (TC) OCKHI (2017) is the one of the rapidly intensified system occurred over NIO recently. It formed over southwest Bay of Bengal (BOB) off southeast Sri Lanka coast as a depression (D) on 29.11.2017/0300 UTC, moved across Sri lanka, intensified into a cylonic storm (CS) over the Comorin area on 30.11.2017/0300 UTC. Moving westwards into the Lakshadweep area, it further into severe cyclonic storm (SCS) on 01-12-2017/0000 UTC and into very severe cyclonic storm(VSCS) on 01.12.2017/0900 UTC over the southeast Arabian Sea (AS). The system underwent rapid intensification (increase in maximum surface wind speed (MSW) by 30 knots in 24 hours) during the period 01.12.2017/0000 UTC to 02.12.2017/0000 UTC when the MSW increased from 50 kt to 80 kt. It attained its peak intensity of 85 kt on 02nd Dec /0600 UTCover the AS. It moved northwestwards over the AS till 03.12.2017/1800 UTC maintaining the intensity of VSCS. Subsequently it recurved northeastwards and gradually weakened into a well marked low pressure area before crossing south Gujarat coast on 06.12.2017/0000 UTC. The system caused extensive damages over the extreme south coastal Tamil Nadu, south Kerala and Lakshadweep due to gale winds and heavy to extremely heavy rainfall.The present study analyses some dynamical and thermo-dynamical features associated with the development of the TC OCKHI. It is well known that the upper/lower level outer eddy momentum flux and the eddy flux convergence (EFC) at the inner radii can serve as catalyst to organize diabatic sources through secondary radial circulations which excite internal instabilities in TCs. During the formative period of OCKHI over the southwest BOB, another low level circulation was also present over the Andaman sea and the adjoining southeast BOB. The likelihood of interaction between the two systems and the role of synoptic scale eddy forcing and diabatic heating associated with the development and intensification of the TC OKCHI are analysed in this study. The EFC at various pressure levels is computed using NCEP FNL 1°x1° resolution data at 6-hrly intervals for the life period of OCKHI in storm relative cylindrical co-ordinate system.Also the diabatic heating associated with the development of OCKHI is examined by determining the vertical profiles of heat and moisture based on the heat and moisture budget equations using 6-hrly,1°x1° resolution, NCEP FNL data The asymmetry in the convective structures associated with the development of OCKHI is also analysed through Fourier first order wave number -1 asymmetry using TRMM 0.25˚ x 0.25˚ rain rate data at 3-houly intervals (3B42V7).The results are presented and discussed.

Abstract ID – 248

Characteristics of extreme rainfall events over India during monsoon 2017

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Abstract

The frequency of occurrence of extreme rainfall events is increasing during the course of time, attributed mainly as a result of climate change. Here, an attempt is made to study extreme rainfall events over India during southwest monsoon season during 2017. The features of southwest monsoon season during 2017 are examined utilizing IMD daily gridded rainfall data for 30 years (available at a spatial resolution of 0.25ºX0.25º) and associated mechanism responsible for the heavy rainfall is analysed utilizing NCEP daily reanalysis data for 2017. The daily rainfall climatology and standard deviation is computed for 30 years at the entire grids (66.5°E-100°E & 6.5°N-38.5°N). Extreme rainfall event at each grid is identified using a threshold value when the daily rainfall value exceeds more than three times its standard deviation based on long period average climatology value and the rainfall value exceeds more than 100 mm. The composite of the number of extreme events and contribution of the extreme events to the seasonal rainfall are analyzed. The monthly variation of extreme events is also studied. Extreme rainfall events occurred over mainly three regions : westcentral India (71.5°E-73.5°E & 24°N-25.5°N), central India (79°E-81°E & 23°N-24.5°N) and northeast India (85.5°E-91.5°E & 25.75°N-26.75°N). It is found that the extreme events are occurred beyond 16ºN. Presence of a cyclone originated in the Bay of Bengal and its movement along a northwestward direction is the major reason responsible for the intense rain spell. Over westcentral India and central India, most of the extreme rainfall events clustered in the month of July. The distribution of extreme rainfall events in the northeast region is not confined during July rather spreads during the entire monsoon season. The contribution of rainfall from the extreme events to the seasonal rainfall varies between 20% and 60%. Low level convergence and cyclonic vorticity associated with the wind pattern during the period of extreme events give rise to ascending motion of humid air and subsequent intense convective clouds. Favourable circulation pattern during these days are mainly responsible for the occurrence of the extreme rainfall events.

Abstract ID – 256

Changes in patterns and trends of temperature extremes indices over Himachal Pradesh and Punjab (1951-2014)

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Abstract

Changes in extreme weather and climate events have profound impact on human societies. The time series analysis of temperature observations provides direct information about hydrological changes, water resources availability and potential hazards (heat waves and droughts).Understanding the mechanisms associated with extreme events at regional scale provide useful information to identify changes in amount, intensity, frequency of extreme events that impact on humans and mechanisms of the past change and future projections.Knowledge on the spatial variability and temporal trends of dailytemperature is essential for efficient management of water resource and agriculture. The spatial and temporal changes in the indices of temperature extremes, on basis of daily gridded data (1° * 1°) over Punjab and Himachal Pradesh for the period 1951-2014 were analysed. Nine indices of extreme temperature (TXx, TNx, TXn, TNn, DTR,SU25, TR20, CSDI and WSDI) were examined for the study. The analysis also includes a series of tests designed to determine whether monthly, seasonal and annual rainfall data is consistent, random and trend free.

Himachal Pradesh and Punjab forms a physically contiguous natural region with strong physiographic, climatic and hydrological links. The temporal analysis reveals noticeable variations in different climatic zones with increasing temperature in the temperate and cold arid zone of Himachal Pradesh while decreasing trend in sub-tropical, sub-humid and dry semi-arid zones of Punjab.The frequency of change magnitudes of hot days and warm nights have indicated anincreasing trend for the entire area with statistically significant at few locations.

Keywords -Gridded data, Temperature Extremes.

Abstract ID – 263

Spatial and seasonal variation of rainfall contribution by the echo top height spectrum of precipitation systems and associated cloud bulk properties over the South Asia

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Theme: Weather and Climatic Extreme Events.

Abstract

The present study is carried out over the South Asian region to investigate the climatological features of rainfall contribution by full spectrum of maximum echo top height 20 dBZ and 40 dBZ ($ETH_{20dBZ(max)}$ and $ETH_{40dBZ(max)}$) of precipitation systems with special reference to deep convective systems (DCSs) and intense convective systems (ICSs). For this purpose, 17-yrs (1998-2014) of the Precipitation Radar on the Tropical Rainfall Measuring Mission satellite observations are considered during the premonsoon (March-April-May) and monsoon (June-July-August-September) seasons. The rainfall characteristics are further analyzed in context with the cloud bulk properties of precipitating cloud systems from 4-yrs (2007-2010) of the Cloud Profiling Radar on CloudSat satellite observations. It is found that over the coastal and oceanic regions, during the premonsoon, unlike the continental region, maximum rainfall contribution is from deeper precipitation systems with high $ETH_{20dBZ(max)}$ compared to the monsoon. The precipitation systems with $ETH_{40dBZ(max)}$, contribute maximum percentage of rainfall is in the range of 5-7 Km over all continental, coastal, and oceanic regions during both seasons. Amongst all the three regions, the rainfall contribution by DCSs during the premonsoon (monsoon) varies in the range of 00.8-42.0%, with maximum contribution over the Bay-of-Bengal (03.2-32.7%, with maximum contribution over the Eastern-India-Coast). Contribution by ICSs varies in the range of 00.0-30.6% with maximum value over the Eastern-India-Coast (00.0-15.0%, with maximum value over the Western-Himalaya-Indentation). The vertical profiles of the Cloud Liquid Water Content (CLWC) and Cloud Ice Water Content (CIWC) of precipitating cloud systems over continental, coastal, and oceanic regions are distinctly different. The preferential regions of rainfall contribution by ICSs are associated with relatively higher value of CIWC in the mixed-phase regions of clouds (near 10 km). The regions of higher rainfall contribution from weak precipitation systems with $ETH_{40dBZ(max)}$ between 5 to 7 km are associated with higher value of CLWC in the warm-phase regions of clouds (near 5 km). This indicates that dominant stratiform precipitation by the bright band near 5 km over those regions.

Keywords -South Asia, Precipitation systems, Echo top height, Deep convective systems, Intense convective systems.

Abstract ID - 266

A comparative study for predicting tropical cyclone wave field using numerical wave models and non-linear autoregressive neural network model

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Theme:Weather and Climatic Extreme Events.

Abstract

Tropical cyclones (TC) are generally relatively small rapidly moving low pressure systems that are capable of generating severe wave conditions. The intense winds during tropical cyclones generate destructive ocean surfacewaves. The tropical cyclonewave field is generally analyzed using in situ buoy data, numerical model data, and satellite and aircraft-based remotesensing systems. For future predictions we depend on the numerical models. When these modelsare forced with TC winds, wave growth tends to be overestimateddue to spuriously large wind stress in the wavegrowth parameterization. Underestimated large-scale atmospheric model TC winds may compensate the error but it is reasonable to run a wave model with an accurate wind field. In this study we develop a non-linear autoregressive neural network model for predictions during extreme events. We train the network with a large data set and then use the network architecture for future predictions. The analysis regionscovering the Bay of Bengal (BOB) extends from 78º E to 98º E and 25º N to 5º N and the Arabian Sea (AS) extends from 55º E to 75º E and 25º N to 5º N. Significant wave height (SWH) data is extracted for the period 2006-2015,for the above region from the NOAA WAVEWATCH III (WW3) global wave model. The six hourly global wave data is generated by a multi-grid forecast model with two way nesting capability and with 0.5º global grid.Empirical orthogonal function (EOF) analysis is a powerful tool for data compression and dimensionality reduction. The EOF technique decomposes the space-time distributed data into spatial modes ranked by their temporal variances.EOF analysis has been carried out over the BOB and AS region for the above 10 years to extract the dominant mode representing maximum variability of the total variance. The first principal component is subjected to dynamic neural networks which are good at time-series prediction. The future values of a time series are predicted from past values of that series. This form of prediction is called nonlinear autoregressive. The time series is divided into training set, validation set and testing set. To construct a network architecture the number of hidden neurons and the number of delays are chosen by trial and error till the mean squared error is minimum. The network performance is tested during the Ockhi cyclone which formed near southern India and Sri Lanka on November 30, 2017, moved out over the Arabian Sea, intensified on December 2-3, but then weakened quickly as it moved north and closer to land. A comparative study is made between the numerical model generated SWH and the non-linear autoregressive neural network model estimated ones.

Abstract ID – 272

The vagaries and extremities in summer monsoon

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Theme:Weather and Climatic ExtremeEvents.

Abstract

In this article the variability of monsoon depending on teleconnections like El Nino and La Nina and Indian Ocean Dipole(IOD). It is observed that the monsoon rainfall on an average is decreasing and the extremities in deficit rainfall is associated with the synergistic effect of El Nino and IOD. In this article a special care is taken to observe the extremities of rainfall during Southwest monsoon. It is observed that cloud burstare more and the resulting in floods and flash flash. However, the number of rainy days is not increasing which results in the rainfall is not efficient for agriculture. Number of steps to contain these extremities within the human preview is also suggested.

Keywords -Summer monsoon, El Nino, La Nina, IOD.

Abstract ID – 273

Role of different ENSO phases on the regional rainfall extremes during Indian summer monsoon

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Abstract

The climate extremes like drought and frequent floods in response to changing hydrological cycle are complex phenomena directly affecting the entire eco-system. Intensity and frequency of extreme rainfall events over homogenous regions, such as Central India are significantly increasing, also at local scale they are spatially non-uniform with increasing spatial variability. Extreme events such as droughts, floods over the Indian region are increasing in the last few decades. Understanding the role of large scale tele-connection pattern associated with these frequent extremes is challenging especially due to the combinations of multiple factors involved along with natural climate variability. In this study, we are trying to understand more about floods and droughts associated with ENSO phases over homogeneous rainfall regions. We identified five different ENSO phase in relation to extremes associated with monsoon rainfall. In this study we made an attempt to study five ENSO phase over different homogenous are explored. It is found that, different ENSO phases modulate the rainfall through changes in walker and Hadley circulation. Spring El-Nino is mostly associated with floods and excess monsoon rainfall season similarly the La-Nina in phase. Spring La-Nina is widely is associated with droughts and deficit monsoon rainfall season similarly in phase El-Nino. Neutral phases have fewer appearances of extremes and in Central Indian region seasonal rainfall heavy than the rest of the country.

Abstract ID – 286

Persistent very heavy rainfall episode over Mumbai 7th-10th July 2018 - A diagnostic study

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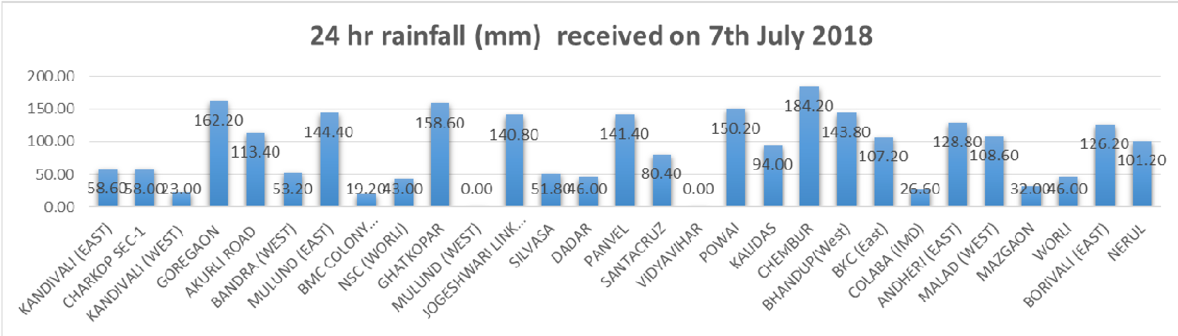
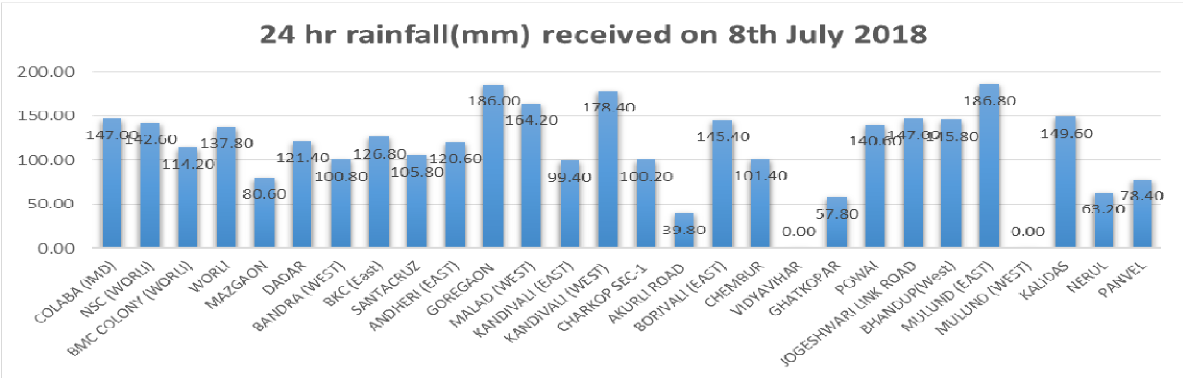
Abstract

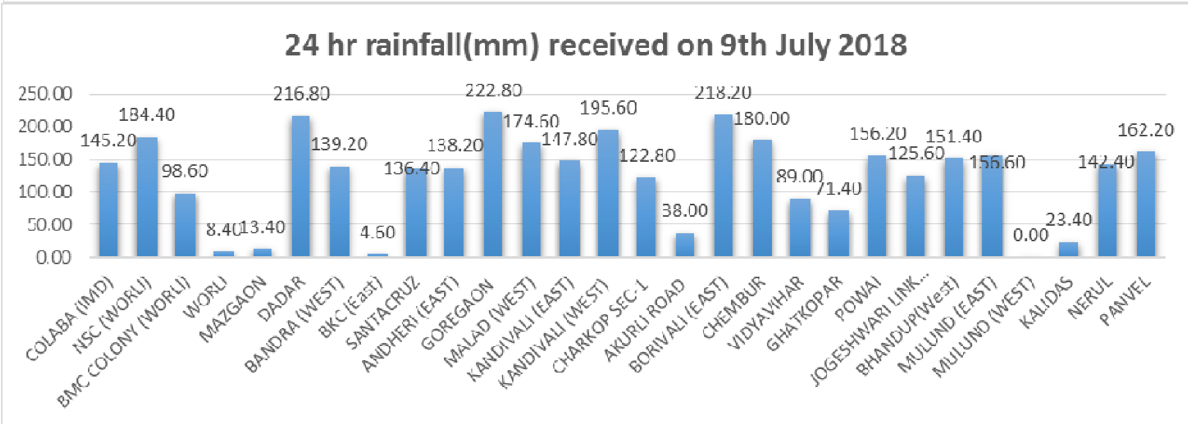
West coast of India is often prone to heavy to very rainfall during active monsoon conditions. Mumbai being a coastal metro city along the west coast is often prone to vagaries of monsoon. Though heavy rainfall events are common during monsoon, continuous days of heavy rainfall is a not a regular phenomenon. Mumbai recorded continuous heavy to very heavy rainfall with isolated extremely heavy falls for four days continuously during 7th - 10thJuly 2018, disrupting the routines of the city. In the present work an attempt has been made to analyse this continuous spell of heavy to very heavy rainfall over Mumbai. The extremely heavy downpour paralysed the entire city. The intense heavy rains were not only restricted to Mumbai but the entire North Konkan subdivision experienced very heavy downpour with 3 stations in Mumbai and 9 stations in the subdivision reporting extremely heavy rainfall during the spell. Highest rainfall amounts received within Mumbai were 184.2mm (Chembur), 186.8mm(Mulund), 222.8mm(Goregaon) and 129.8mm (Borivali) respectively on 7th, 8th,9th and 10th July 2018.

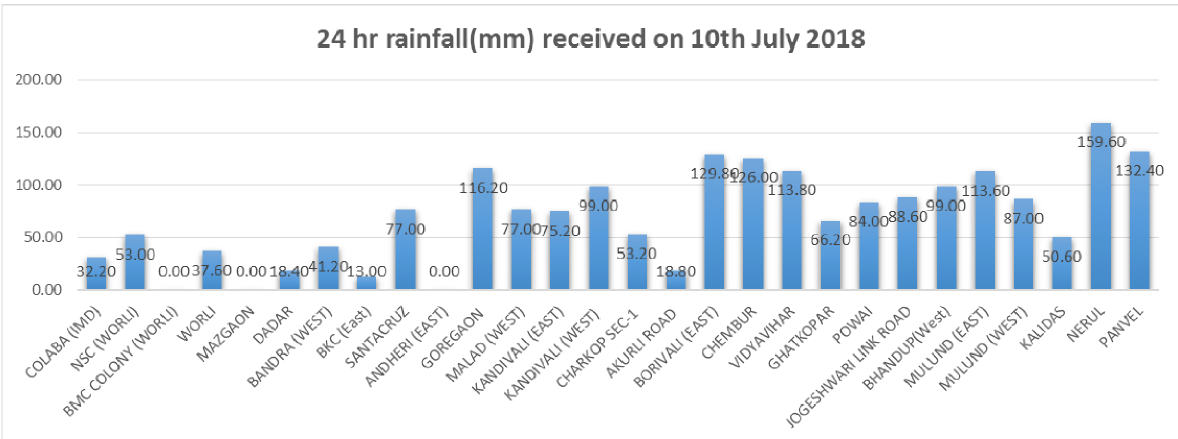
Inorder to understand the atmospheric dynamics that led to the event, stream line analysis of different atmospheric levels were carried out. It was found that this intense and persisting heavy rainfall episode was associated with the persistence and movement of large scale synoptic systems during the period. The major synoptic systems that contributed to the event was the persistence of an east west shear zone in the higher atmospheric levels roughly between 18 and 20 degree latitude, presence of a mid-tropospheric cyclonic circulation over Gujarat and the presence of a feeble off shore trough. Another significant system which contributed to this event was the presence of intense convection over North West Bay. Under the combined influence of these systems, wind confluence and moisture feed from Arabian Sea over the northern coastal belt of Konkan was seen to increase. Persistence and slow movement of these large scale systems resulted in this extremely heavy rainfall episode that lasted for continuous four days. Observations based on satellite and radar were analyzed to study the hourly intensity variation of the event. Both dynamic and thermodynamic parameters associated with the event were also studied. All the dynamic parameters like vorticity, divergence, vertical velocity, and different thermodynamic indiceswere found to be conducive for intense convection over the region.

Furthermore an attempt was also done to study similar events of very heavy to extremely heavy rainfall events over Mumbai during the last 3 years with the help of SAFAR AWS network. It was found that these typical synoptic situations when combinely existed were capable of evoking extremely heavy rainfall events over Mumbai and around, during active phase of south west monsoon season. This could be used as a potential indicator for predicting extremely heavy rainfall events over the region and thus result in an effective early warning mechanism.


24 hr rainfall (mm) received on 7th July 2018


24 hr rainfall(mm) received on 8th July 2018


24 hr rainfall(mm) received on 9th July 2018


24 hr rainfall(mm) received on 10th July 2018

Abstract ID – 294

Identification of some predictors for seasonal ACE of Bay of Bengal during post-monsoon season

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Abstract

A study is conducted to identify some of the predictors for seasonal Accumulated Cyclone Energy (ACE) of Bay of Bengal (BoB) during post monsoon season. The ACE is calculated by summing square of the estimated maximum sustained wind speed (v_{max}) over the life span of a tropical cyclone. Since this summation is a huge number, so the ACE is defined by dividing the summation of square of v_{max} by 10^4. ACE = $10^{-4} \Sigma \, v^2{}_{max} v_{max}$ data is taken from the RSMC, New Delhi website. There are v_{max} data of tropical cyclones in 3 and 6 hour interval. To calculate ACE, v_{max} data of 00, 06, 12 and 18 UTC are taken. In this study ACE values are calculated 1990 to 2017. Seasonal ACE of post-monsoon season of a year is calculated by summing ACE values of all the tracks during October, November and December of that particular year. The predictors are selected using linear correlation of post monsoon ACE values with the monthly gridded data (several months before the start of post-monsoon) of different environmental parameters like Sea Surface Temperature (SST), Sea Level Pressure (SLP), zonal and meridional wind at different levels etc. The gridded data is taken from National Centre for Environmental Prediction (NCEP)/National Centre for Atmospheric Research (NCAR) reanalysis data of National Oceanic & Atmospheric Administration (NOAA). Areas of the monthly gridded environmental data several months before the post-monsoon season with fairly large spatial extent and significant correlation with the post-monsoon ACE value have been demarcated for determining predictors. In order to be the predictor, some other criteria are checked: (i) predictors should be persistent i.e. the predictor parameters should have significant correlation till the end of post-monsoon season. (ii) Predictor parameters should have physical relation with the seasonal ACE. (iii) NCEP/NCAR reanalysis field should represent the climatology of the region.

Abstract ID – 298

The role of synoptic-scale atmospheric features on the formation of severe hailstorms over India

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Abstract

Hailstorm forecast is a challenging task. These storms are a major threat to agriculture and society and could cause appreciable damage to property. Hail climatology over India is a premonsoonphenomenon (March-April-May). The characteristics of hailstorms in terms of their occurrence are strongly depended on the topography of the region.The aim of the present study is to investigate the spatial variation of intensity (determined by hail size) of hailstorms over the India in the premonsoon season. The variation of these statistics can be examined in relation to topographic, synoptic and thermodynamical factors.This study will be carried out over Indian region during the premonsoon season (1981-2015).The hailstorms will be identified from the Daily Weather Report, India Meteorological Department (IMD) across the study region.After that, thestorms will be categorized into different intensity scalesin terms of hail size as hard (<1cm), potentially damaging (1-2 cm), and severe (>2 cm). To investigate the role of synoptic condition for days when hailstorms of any category (hard, potentially damaging, and severe) occur in prefer regions of India, geopotential height anomalies at 500 mb and surface pressure anomalies will be calculated by subtracting the premonsoon mean from daily composites of the National Centers for Environmental Prediction-National Center for Atmospheric Research (NCEP-NCAR) reanalysis data at a 2.5^{o} x 2.5^{o} grid. In addition to synoptic condition, to understand atmospheric thermodynamical structure, Freezing Level (FL, km), Convective Available Potential Energy (CAPE, J kg^{-1}), and Convective Inhibition (CIN, J kg^{-1}) will be taken from upper air radiosonde profiles from India Meteorological Department.

Keywords - Pre-monsoon, Severe hailstorms, Synoptic sale, Freezing level.

Abstract ID – 308

Tropical Cyclone Intensification Analysis Using satellite generated Infrared and Water Vapour Imageries

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Abstract

Present study discusses the identification of intense convections in tropical cyclones using bispectral imageries which are generatedevery half an hour from thegeostationary satellites. The analysis is based on the spectral response differences between geostationary infrared (IR) and water vapor (WV) channel data.WV spectral response peak is about 350 mb while IR peak is near the surface. Thus, WV BT are typically colder than the IR during tropospheric clear-sky conditions. In opaque cloud conditions associated with intense, active convection penetrating the tropopause, the sign of the measured difference between the two channels can reverse due to the reemitted absorbed radiation from upper-tropospheric–lower-stratospheric water vapour. The differenced BT values of WV and IR channel in regions of intense TC convection is thus analysed in the present study to identify the information about TC intensity changes which can be further utilised for cyclones intensity predictions.

IR and WV imageries of tropical cyclones formed in the North Indian Ocean(NIO) generated by Meteosat-7 and INSAT-3D satellites have been analysed in the present work.The differenced BT (IR-WV) values of two channels during the cyclone entire life was computed and the correlations between the total number of negative pixels in inner core region of TC and its current and future intensity was investigated.Strong correlations were found between TC intensity and IR-WV BT values at varying 6-hrs forecast intervalperiods, peaking between the 12- and 24-h time periods. Thusthe results show the indication of cyclone intensification at least 12-hour prior of its occurrence using satellite generated TIR and WV imageries.

Keywords - Tropical cyclone, INSAT-3D, Meteosat, TIR, Water Vapor, Geostationary satellite, Intensity.

Abstract ID – 311

Efficiency of regional climate model REMO in simulating heatwave over India: A comparison with observations

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Abstract

Heatwave is an unusual high daytime temperature condition for prolonged periods. It has significant impact on human-health in terms of morbidity and mortality. It also includes the effect on agriculture and energy sector which are major controller of Indian economy. In the recent decade, Intergovernmental Panel on Climate Change (IPCC) has reported a significant increase in number of hot days, frequency and intensity throughout the globe, especially over Asia. Various studies have documented the impact of heatwave on human health all around the globe. India is among the most vulnerable country to health impacts of heatwave due to poor quality of life. Therefore understanding the dynamics and variability of heatwave is key concern for human health in India. In the present study we have addressed the dynamics of heatwave using high-resolution regional climate model forced with Era-Interim reanalysis data for historical simulation. Compared to Global Climate Models (GCMs), RCMs are of much higher resolution, hence they capture better regional information. Very few studies have used RCMs for the study of heatwave over India. We have uesd WMO Expert Team on Climate Change Detection and Indices (ETCCDI) for identifying heatwave condition. Observational and Era-Interim reanalysis dataset are compared to interpret the capability of model in simulating the extreme heat events. It has been observed that model is able to capture the spatial and temporal variability of heatwave event reasonably well, both in terms of signal and magnitude. The highest trend has been seen in minimum monthly temperature (TNn) over north west regions of India. Model and observation show an increasing trend (95% confidence level) for all calculated indices. The model has negative cold biases for some regions and trend for some indices is statistically insignificant. This analysis suggests that this model may be used to study the future heatwave dynamics and impacts over the region.

Abstract ID – 318

Eddy Detection Technique for Tropical Cyclogenesis in the Bay of Bengal basin

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Abstract

Tropical cyclogenesis and its detection is a subject of immense interest to the meteorological and oceanographic community. Detection of tropical cyclogenesis is possible using remote sensing techniques after its initiation over the warm ocean surface as a depression. Prior to tropical cyclogenesis initiation process over the oceans, initial instability mechanism and vortex development are triggered at higher atmospheric levels and that eventually subside over warm ocean surface before being detected by satellites. Several studies using observational data and numerical models were carried out on tropical cyclones over oceans spanning entire life history covering stages of initial depression to intensified systems and finally the dissipation stage after landfall. Most of the studies focussed on understanding the intensification process, forward motion and track forecast using state-of-art atmospheric and ocean models, as well ensemble prediction. Though these studies are important to understand tropical cyclone characteristics, a proper understanding and knowledge on cyclogenesis initiation and its development at various atmospheric strata is still lacking. Therefore, it is warranted for concentrated efforts and a detailed study in order to understand the physical mechanisms and supporting atmospheric dynamical conditions that can initiate as well sustain tropical cyclogenesis, as well subsidence characteristics of the well-developed vortex into warm ocean surface. Detection of the early stages of vortex initiation in higher atmosphere requires continuous atmospheric monitoring through sophisticated instruments and soundings. On the other hand, a detailed evaluation and critical analysis of high-resolution atmospheric model products can also help to better understand the dynamical system that results in spatio-temporal instability at different atmospheric levels. Prior studies have pioneered in the development of different theories for tropical cyclone formation, hypothesis and observational techniques to track and detect instability mechanism well in advance. Pioneering recent studies by Dunkerton et al. (2009), Montgomery et al. (2012) and Wang et al. (2012) have led to different theories such as: Bottom-Up Vortex Merger theory, Top-Down Vortex Merger theory, Top-Down Shower Head theory, and quite recently the Marsupial Pouch theory. Considerable effort was made on the application of these theories for the Atlantic and Pacific Ocean basins. For example, the application of recent Marsupial Pouch theory could successfully detect 55 cases out of 61 tropical storms and hurricanes that formed over Atlantic and east Pacific Ocean basins. Though the statistics looks quite impressive for these two Ocean basins, detailed studies pertaining to application of this theory for tropical cyclogenesis detection over the North Indian Ocean basin is very limited. It was in a very recent study by Rajasree et al. (2016) that advocates on thesuccessful implementation of Marsupial Pouch theory and Bottom-Up Vortex Merger theory for Madi cyclone (2013) about three weeks prior the satellite detected this system as a depression in the central Bay of Bengal. Unlike the other global ocean basins, there are unforeseen challenges in atmospheric detection of tropical cyclogenesis over the North Indian Ocean region due to dominant monsoon wind system and its reversal. Motivation for this study is to analyse and investigate the feasibility and performance of various theories for the North Indian Ocean basin. The study implemented Eddy Detection Technique on recent 2013 severe cyclonic storms Phailin and Madi with an objective to understand the spatio-temporal distribution of eddies at various atmospheric levels. The Okubo-Weiss (OW) parameter computed from horizontal wind components at different eta levels (from surface to 10 hPa level) was used as a tool for eddy detection. WRF simulated high-resolution winds along with ERA-Interim 0.25° wind data was used for estimation of OW parameter. The study objective mainly focussed on the lead-time period of tracking the disturbance at various levels in the atmosphere. The study signifies clear detection of instability mechanism at different eta levels between 500 hPa to 800 hPa of at least 150-200 h prior to the satellite detection of Madi and Phailin cases as depressions in the ocean surface. The threshold value for OW parameter in the subsequent eta levels has been established. The authors believe that the findings from this study can be extended for different cyclonic systems as well develop a framework for extended prediction of tropical cyclogenesis for the North Indian Ocean basin.

Keywords -Tropical Cyclogenesis, North Indian Ocean, Eddy Detection Technique.

Abstract ID – 340

High resolution Simulation study of Heat wave and Cold Wave over Odisha

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Theme: Weather and Climatic Extreme Events.

Abstract

Temperature extremes are the consequence of regional climate change and have direct impact on the mortality and morbidity. Being a coastal state "Odisha" often faces both heat wave and cold wave resulting health risks in various part of the state. 2015-16 year witnessed the extreme temperature both in summer (heat wave) and winter (cold wave). In this study the real time station level daily temperature (maximum, minimum and mean) data from India Meteorological Department are being used to analyze the intensity of the extremes during May, December 2015 and January 2016. The atmospheric dynamics and synoptic features associated with heat wave and cold wave events are being quantified. The state of art WRF meso-scale modeling system is evaluated for the short-range prediction of the extreme temperature causing heat and cold wave. It is observed that the model configuration system could able to predict the extreme temperature episodes well in advance, so it can be well integrated with the pro-active disaster management.

Abstract ID – 359

Beneath a hole in the monsoon: A tale of the Southern Bay of Bengal Cold Pool

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Theme:Weather and Climatic Extreme Events.

Abstract

The minimum in Indian Summer monsoon rainfall is located around Sri Lanka and the ocean below is characterized by a cold pool - having cooler water in comparison to the surrounding region. The meridional gridient in SST between this cold pool and the northern Bay of Bengal has been suggested to be critical for triggering deep atmospheric convection furhter north. Owing to itsWeather and Climatic Extreme Events.possible impact on monsoon variability, some studies have been carried out to understand the evolution of cold pool SST during this period. These studies suggest, coastal upwelling along southern coast of Sri Lanka and eastward advection of cooler water contributes to the decrease in SST during summer monsoon. However, the processes leading to the formation of cold pool, still, remain unknown. In this study, we have investigated the mechanism responsible for the formation and maintenance of southern Bay of Bengal (BOB) cold pool using high resolution satellite data, model simulations and in-situ observations for the year 2009. Our study reveals formation of cold pool is dominated by atmospheric processes, whereas oceanic processes dominate its maintenance. Cooling of SSTs during premonsoon and onset phase acts as a prerequisites for the formation of cold pool, which are linked to the reduction in Net Heat flux (NHFX) during theses periods. Cooling of SSTs during premonsoon and onset phase acts as a prerequisites for the formation of cold pool, which are linked to the reduction in Net Heat flux (NHFX) during theses periods. The changes in NHFX during premonsoon and onset phase are dominated by reduction in Short-wave (SW) radiation associated with strong convective activity over cold pool. Convective activity over the cold pool are associated with the northward movement of Maximum Cloud Zone (MCZ) that forms over Equatorial Indian Ocean (EIO) during these periods. SST within the cold pool after the steady increase during February-April months, cools first during premonsoon rain event and then during monsoon onset. Analysis of high resolution satellite data for the period 2003-2009 suggest that, these sequence of events occurs with minor amount of inter-annual variability. SST within the cold pool shows several intraseasonal cooling events during the summer mon-soon. Considering that rainfall above the cold pool is very low during the summer monsoon, these cooling events occurring within the summer should be necessary for maintaining the cold pool. The seasonal evolution of SST shows that it continues to decrease till the end of the summer monsoon. In-situ data collected during CTCZ field program in 2009, at two time series locations (TSL) and model simulations were used to determine the processes responsible for such cooling events. To estimate the contribution from advection to the observed SST tendency at fixed location, a measurement stratergy called 'opertaion advection' was used in this study.

Abstract ID – 361

Cloud Resolving Model simulation of Cloud Burst Events over Uttarakhand during southwest monsoon season of 2018: Sensitive of cloud microphysics

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Theme:Weather and Climatic Extreme Events.

Abstract

Cloud burst (CB) events over Uttrakhandregion areone of the hazardous meteorological phenomena during southwest monsoon season. Recently, a series of CB events are occurred over Uttrakhand during 16-20 July 2018 causing flash flood and associated damages. Generally CBs provides intense rainfall over limited area within short-periods due to dense convective clouds/thunderstorms. The ARW-WRF Model, version 3.6.1 (WRF.v3.6.1) is used to simulate series of CB events over India using three nested domains. The outer most domains have resolution of 27 km include south Asia monsoon region. The inner most domain has resolution of 3 km, centering over Uttrakhand region. The intermediate region has resolution of 9 km covered Indian region. The NCEP FNL (Final) operational global analysis data available at a resolution of 1° × 1° for every 6 h considered as initial and boundary forcing for the simulations. The experiments using three cloud-microphysics schemes such as WDM6, Thomson, and Milbrandt-Yau (MY) along with YSU PBL and Grell–Devenyi Ensemble (GDE) convective schemesare used for the model simulation. Each simulation up to 126 h has performed and outputs are generated every 3 h intervals. The synoptic and dynamical features of the CB are studied. The precipitation and cloud features shown very sensitive and compared with observations. The synoptic characteristics associated with CB events are studied through MSLP, wind, geopotential height and precipitation. However, the characteristic of hydrometeor concentrations at 12 h intervals are analysed and discussed in this paper.

Keyword -Cloud Burst, Cloud Microphysics, WRF model, Uttarakhand.

Abstract ID – 380

Numerical modeling of combined wave-current-tide-surge-mangrove interaction during AILA cyclone

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Theme: Weather and Climatic Extreme Events

Abstract

The wave attenuation characteristic during the passage of AILA cyclone in the head Bay of Bengal region is reported. More specifically the role of wave-tide-current-surge-mangrove interaction on wave attenuation characteristics is analyzed in detail during this extreme weather event. Numerical experiments were performed using the coupled wave-hydrodynamic model (ADCIRC+SWAN) for the AILA event during 23-26 May, 2009. During this event it was reported that the Sundarbans mangrove forests has absorbed the fury of the AILAcyclone and acted as a natural barrier to the coast. A more complex scenario is observed while considering the case of nonlinear interaction in the presence of time varying water level elevations and currents. Tidal variation on wave dissipation in a mangrove ecosystem has a profound effect on the wave attenuation characteristic due to varying water levels and submergence level of the mangrove root systems. The effect of nonlinear interaction between waves, current, tide, surge and mangroves on the wave attenuation characteristics and the spectral transformation reported in the presence of mangroves during an extreme event. This comparative study has analyzed the efficacy of *Avicenna Marina* (seen along Sundarbans coast) in attenuating extreme waves during AILAcyclone. The study also intends to improve the reliability of wave forecasts for the Head Bay of Bengal region, as the existing operational wave models do not incorporate wave-mangrove interaction for reliable nearshore wave predictions.

Keywords - ADCIRC-SWAN,Mangroves,Wave attenuation, AILAcyclone.

Abstract ID – 384

Prediction Techniques satisfying initial conditions for Thunder cloud development over Eastern India during Pre-monsoon period

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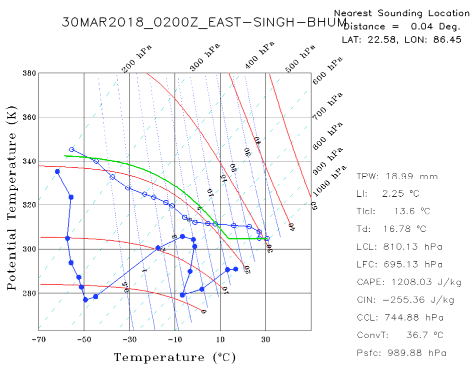
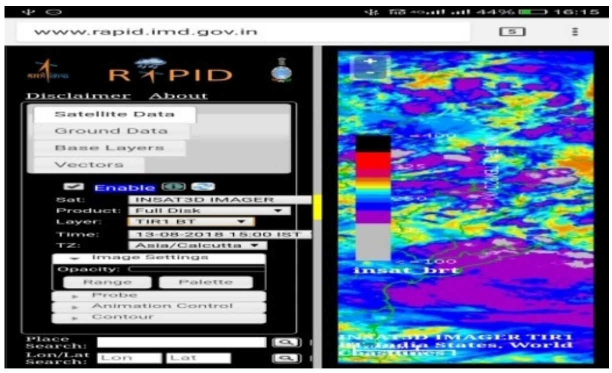
Abstract

Severe weather hazards are dangerous weather phenomena that threaten life and property. There are several dangerous and destructive weather hazards. The most common types of storm hazards – tornadoes, floods, droughts , heat waves , etc.Tornadoes develop from thunder clouds and most frequently from super cell thunder clouds. They also occur within squall lines and hurricanes. Tornadoes are formed when cool air overrides a layer of warm air, this way forcing the warm air to rise. Thunderstorm, lightning and sometimes hail are associated with thunder clouds or called Cumulonimbus cloud (CB). "Cumulo-" is a prefix that denotes that the clouds were formed by convective (vertical) motions and "-nimbus" describes a cloud with precipitation.Each year, all around the world approximately 2,000 people die from lightning strikes which is associated with thunder cloud.. So, prior prediction of development of CB cloud is necessary to save lifes and properties.Finding prediction techniques satisfying initial conditions for Thunder cloud development considering Satellite sounding data over Eastern India during Pre-monsoon period.Using various parameters value like CAPE, TPW, LCL, LFC, etc from TPhigram of Satellite data which satisfies initial conditions for development of thunder clouds and verified by RAPID data on daily basis.





Abstract ID – 387

Heat wave scenarios and verification over Andhra Pradesh State

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Abstract

Increased occurrences of summer heat wave conditions in recent years are fettle to the human life. Prior information about the possible heat wave conditions will help in reducing the risk to human life and also helps in taking precautionary action and also the government agencies to be vigilant and allow them to plan outreach activities to save the lives of the public. The governments of Andhra Pradesh have a dense network of weather observations network to continuously monitor temperatures across the state, these data provide the spatial distribution of temperatures in real-time monitoring. Numerical model temperatures are useful in forecasting of heat wave conditions to disseminate the information to all stakeholders. Since 2016, Government of AP have adopted heat wave action plan for monitoring heat wave conditions based on observed temperature data and weather forecast information is a part. Heat wave action plan of AP adopted two criteria to identify the heat wave affected areas; one based on the criteria suggested by IMD using observed maximum daily temperature and its deviation from normal and second one using a Thermal index computed in combination of temperature and humidity taking the threshold values for heat index based on bio-climatic charts suitable to areas in Andhra Pradesh region. In this present study, authors are attempted to use Numerical Weather Prediction temperatures for identifying areas prone to heat wave conditions in next 24hours and 48 hours using the criteria suggested by IMD as well as Heat Index. Mandal level advisories about possible heat wave conditions in the next 48 hours have been generated and compared with the actual areas affected by heat wave conditions. NWP models data (9 km x 9 km resolution) has been used to prepare the advisories at Mandal (sub-district) level. Here, the heat wave scenarios are studied for the Andhra Pradesh region and validated the heat wave conditions with the available observed data.

Abstract ID – 388

Identification and classification of Mesoscale Convective Systems based on Image processing and Data Mining Techniques: A Survey

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Abstract

Mesoscale convective systems (MCS) are systems of clouds formed by convective process and responsible for most of the precipitation percentage over an area. Study of MCS is important as these systems are responsible for extreme weather conditions such as thunderstorms, heavy rain and floods. Occurrences of extreme weather conditions have large societal impact as it leads to financial as well as human life loss. Because of the importance of MCS identification and advancements in remote sensing technology significant research is going on for MCS identification, characterization and tracking so that it will be useful for prediction of precipitation and extreme weather conditions. Many researchers in past 20 years worked on RADAR as well as Satellite data. Due to large areal extent recent work is done based on the satellite data. Most of the initial work was based on identification and classification of MCS based on size, duration and its shape. MCS tracking is a challenging task as it exhibits dynamic structure due to splitting and merging nature of clouds. Models are developed in the past based on brightness temperature, area overlapping techniques and graph based techniques applied on remotely sensed satellite images. Most of the research is based on thermal infrared images as pixel intensity values in an image are directly proportional to the temperature of the clouds. Work is done based on image processing techniques for MCS tracking such as point pattern matching, neighbourhood search criteria to select contiguous pixels, temperature induced mean based cloud motion prediction model Though work is done in the field MCS across the globe very few people worked over an Indian region. Some of the work is based on identification and tracking of MCS over Indian region. Still in the scenario of climate change it is important to do Identification and classification of MCS over an Indian region. In this paper we propose a system for identification and classification of MCS over Indian sub continent based on Size, duration and shape using image processing techniques based on thresholding techniques for cloud temperature and data mining techniques for classification of MCS such as decision tree. Decision tree is a supervised machine learning algorithm which split the data according to the certain features. It can be further be used to understand the relationship between occurrences of MCS and severe weather conditions based on atmospheric features such as vorticity.

Abstract ID – 392

Influence of Boreal Sudden Stratospheric Warming On Northern Hemispheric Tropical Troposphere

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Theme:Weather and Climatic Extreme Events.

Abstract

This study demonstrates the variability over northern hemispheric tropical troposphere during boreal sudden stratospheric warming (SSW). The convective activity over this region during major SSW period indicates that strong interactions between stratosphere and troposphere. Convective activity was enhanced in the latitude zone 0–10° N. The tropical surface temperature was negatively correlated with that in the tropical stratosphere temperature although the upward motion of air create convective cell over the study region. Prior the peak day of warming two convective cells developed either sides of the equator then gradually decayed and propagate northward. During the major SSW, the surface temperature over tropics increases suddenly. The occurrence of convective activity is during SSW is further verified using ST radar data at Cochin (10°2'31"N, 76°19'54"E).

Abstract ID – 393

Simulation and validation of heavy rainfall event

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Abstract

Two intense rainfall episodes occurred over the coastal districts of Odisha during passage of monsoon depressions in current monsoon season (2018). The two intense rainfall episodes are 12-14 July and 19-23 July 2018. Rainfall amount to 300 mm are recorded in 23 blocks and 200mm in 46 blocks and total 14 districts and 62 blocks are get affected due to severe rainfall and flooding situations. Efforts will be made to simulate these intense rainfall episodes using a high resolution non-hydrostatic model i.e.. WRF-ARW. The work is mainly comprises of two components a) validation of model forecast parameters up to 96 hours b) the impact of model microphysical parameterization and associated processes with reference to the evolution, location, magnitude and intensity of rainfall over the region. The surface and upper level data from observation instruments such as micro rain radar, ceilometer and automatic weather station will be utilized to validate the model results. The results related to cloud parameters and processes will be discussed. The cloud related parameters such as (i.e. reflectivity, fall speed, drop size distribution, height of clouds) will be critically examined to quantify its impact on precipitation characteristics. Further, fundamental parameters such as surface temperature, relative humidity,wind from model forecast will be validated againstavaliable observation to understand the model biases (deficiencies) in predicting these high impact weather systems. Efforts will be made to examine at half hourly, hourly to daily temporal scale to understandthe rainfall characteristic including its evolution, structure and rainfall amount. We will also examine some of the stability indicies and their implication on the intense convective scenarios over the study region.

Abstract ID – 398

Synoptic Analysis of Very Heavy to Extremely Heavy Rainfall Events Over Sikkim and Sub-Himalayan West-Bengal During South-West Monsoon 2017– A Case Study

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Abstract

In order to find out a potential indicator for predictingVery Heavy toextremely heavy rainfall over Sikkim and Sub-Himalayan West Bengal (SHWB) a study has been undertaken. In this study an attempt has been made to find out the main synoptic situations which are responsible forVery Heavy toextremely heavy rainfall events over Teesta, Jaldhaka, Torsha and Raidak river catchment, which are flowing though this region.During South-West Monsoon 2017 total 3 spells have been identified where heavy to extremely heavy rainfall was observed in several stations for consecutive days. Average areal precipitation has been found to be around 100-300 mm in those river basins. From this study it has been found that the main rain giving systems in this region are (i) passing of the axis of monsoon trough close to the foot hills of Himalayas, (ii) upper air cyclonic circulation (cycir) developed over Bangladesh moved in northward and reached over SHWB, (iii) north-south trough from Bihar to Bay of Bengal, (iv) east-west trough running across SHWB or northern parts of Gangetic West Bengal (GWB) and (iv)cycir over Bihar. The possibility of occurrence such type of Very Heavy to extremely heavy rainfall evens would be higher if two or more conditions prevail simultaneously.

Abstract ID – 401

Assessment of 3DVAR Data Assimilation in Simulation of a Heavy Rainfall Event Associated with Monsoon Depression

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Abstract

Monsoon depressions (MDs) are a dominant weather feature during the Southwest-monsoon season (June–September) over Bay of Bengal (BoB) and provide heavy rainfall over the eastern and central parts of India. To avoid damage associated with such type of events a successful and reliable forecast is in forefront of research.The non-hydrostatic mesoscale models are capablefor simulation/prediction of high impact weathersystems which lead to heavy rainfall episodes overIndia. However, the forecast skill of these models is very limited, particularly for importantvariables like rainfall. Hence, there is a necessity forefforts to improve performance of the mesoscale models in short-range predictions on a real-time basisfor the Indian monsoon region particularly for predictionof the extreme weather events, which lead to heavy rainfall events. Therefore, assimilation approaches that ingestlocal observations are important to develop improvedanalyses which served as initial condition to themesoscale model. Particularly, over thelast decade, high-resolution mesoscale models withthree/four dimensional techniques (3DVAR/4DVAR)are being increasingly applied for studying meteorologicalphenomena.

In this study, effect of three dimensional variational (3DVAR) assimilation is used in the simulation of monsoon depression (MD) that formed during 9-12 August 2016 using the Weather Research and Forecast (WRF) modelling system. The National Center for Environmental Prediction FiNal Analyses (NCEP FNL) areprovided to the model as initial and lateral boundary conditions. Two numerical experiments were carried out in this study; first a control (CTRL) or a base run without any data assimilation and another a 3DVAR run in which upper air and surface weather observations are assimilated in a time window of ±3 hours through WRF 3D-Var scheme. After the successful inclusion of additional observationaldata using the 3DVAR data assimilation technique,the resulting reanalysis was able to successfullyreproduce the structure, location as wellas prominent synoptic features associated with the MD. The movement and intensity of the MD is reasonably well capture by the 3DVAR run as compared to the CNTL. The statisticalskill scores also revealed that the precipitation forecast duringthe period has appreciably improved due to assimilation of observations.The results of this study indicate a positive impact of the3DVAR assimilation on the simulation of heavy rainfall events associated with the MD.

Key words -Mesoscale model, Data assimilation, 3DVAR, Monsoon depression, Statistical skill scores.

Abstract ID – 407

Impact of cloud microphysics parameterization scheme on the prediction of heavy rainfall event

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Abstract

In the past three decade, both intensity and frequency of heavy rainfall events over the Indian subcontinent have been increasing, causing huge damage to life and economy. Recently, an extreme heavy rainfall of 773 mm/day has been recorded on 24thJuly 2017 over Mount Abu, Sirohi District, Rajasthan,which was the maximum precipitation in a day in the last 100 years. In this study, initially the real time prediction of this event was done by Indian Institute of Tropical Meteorology (IITM) Global Forecast System (GFS T1534).The GFS T1534 could able to capture the event but rainfall intensity is underestimated with shift in the location.To correctly predict the event in terms of intensity and location, some experiments are conducted using a non hydrostatic mesoscale Weather Research and Forecasting (WRF) model.

The main objective of the present study is to see the impact of microphysics on prediction of intensity and location of the heavy rainfall events.A three-way nested domain with horizontal resolution of 12 km, 4 km and 1.3 km for lead time up to 78 hours starting from 00 UTC on 22nd July 2017 has been used. Initial and Boundary Condition were used fromGFS T1534 (0.125°×0.125°) data and updated every 3 hourly.Sensitivity experiment were carried out using four different microphysics schemes (WRF single moment 6 class, Morrison Double Moment, Milbrandt-Yau Double Moment and WRF Double Moment 6 class). The Yonsei University (YSU) as PBL scheme and Kain-Fristch as cumulus scheme are kept fixed for all experiments.

The results are validated using European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis data (ERA5, 0.125°×0.125°) and high resolution merged rainfall data. The analysis (ERA5) revealed strong upper-level divergence and high moisture content at lower level were favorable for the occurrence of heavy rainfall event. The model with all microphysics scheme were able to capture this rainfall event driven by large scale phenomenon andalso able to nicely depict the frozen and liquid hydro-meteors except WDM6 scheme.

Abstract ID – 414

Analysis and forecasting of high impact weather (Flood) in eastern India during monsoon season

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Abstract

Heavy rainfall and flood is very common feature during southwest monsoon season (June-September) in Eastern India. Every year flood and flash flood brings a lot of misery to the people of this region. West Bengal, Odisha and Bihar are very prone to the heavy rainfall and associated flood in eastern India. Major river basins in eastern India are Ganga river basin in Bihar and West Bengal area. Odisha has three river basins namely Mahanadi, Subarnarekha, Brahmani and Baitarani. In this paper an attempt has been made to analyse the meteorological feature associated with heavy rainfall leading to flood/flash flood in 2014-2017.Four incidences of flood in 2014-2017 namely (i) flood in Odisha occurred in Baitarani, Brahmani and tributaries of Mahanadi in the 1st week of August 2014 (ii) flood in Gangetic West Bengal during July-Aug 2015 (iii) flood in Bihar during July-Aug 2016 and (iv) flood in Gangetic West Bengal(GWB) during July 2017 has been analyzed. From the analysis it has been observed that Odisha flood during 1st week of August 2014 was associated with the formation of a low pressure area (LOW) over North West Bay of Bengal and its intensification into a deep Depression during 3-6 August 2014. This system spurred the vigorous monsoon conditions over the Indo -Gangetic plains. Odisha received very heavy rainfall to extremely heavy rainfall in the rivers catchments area leading to flood in this region. The 2015 massive flood in GWB flood during 25July-2Aug 2015 was associated with unusual Tropical Cyclone (CS) KOMEN over North Bay of Bengal and its movement towards GWB leading to heavy to very heavy rainfall during 25 July to 2Aug 2015 over the district of GWB.The deadly flood in Bihar during July –Aug 2016 was associated with running of Monsoon Trough (MT) along the foothills of the Himalayas with embedded Cyclonic Circulation (CYCIR) over Bihar and adjoining area in lower level. It leads to heavy to very heavy rainfall along with extremely heavy rainfall over Bihar and adjoining Nepal area leading to rise of Koshi river basin above danger level and massive flood occurred in northern district of Bihar. The recent flood in GWB during July 2017 was associated with heavy to very heavy rainfall along with extremely heavy rainfall over GWB and adjoining Jharkhand area. The meteorological system are monitor round the clock with the help of Satellite picture, conventional chart, Radar from DWR (Kolkata,Patna,Paradeep), regional and national NWP model along with guidance/bulletin of NWFC/CWD, New Delhi. Forecast of quantitative precipitation estimate (QPE) has been shared/discussed with CWC/DVC/Irrigation and Waterways Department (I&WD, Govt of West Bengal) during severe weather system to regulate dam suitably. The significance finding divulged that passing of depression over GWB and Odisha may bring flood to the respective state whereas continuous passing of monsoon trough along the foot hills of the Himalayas may bring flood to the state of Bihar. Proper monitoring of Monsoon system and proper co-ordination among IMD, CWC, DVC and I& WD for dam management may reduce the loss of life and property.

Abstract ID – 418

Validation of Geostationary Satellite derived rainfall estimation products with the station rain-gauge data

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Abstract

Accurate estimation of rainfall over temporal and spatial domain is vital for various hydro-meteorological, agro-meteorological applications and weather monitoring- forecasting activities. In-situ measurements of rainfall using rain gauges are available over the country with its own limitations of geographic coverage and near-real time data availability.With advances in Satellite technology, Satellite derived rainfall estimations are improving rapidly. More and more products based on satellite estimates are being operationally used by the meteorological and disaster management community.

However the accurate rainfall estimates through satellites is limited by spectral resolution of the satellite sensor, types of wavelengths used, type of satellite orbit, scanning speeds and spatio-temporal resolution and hence they need to be continuously monitored and validated against the authentic observation sources such as rain gauges.

In this study we have used two satellite derived products viz., INSAT Multispectral Rainfall (IMR) and hydro Estimator (HE). Both the products are based on the measurements by INSAT 3D and are available in half-hourly and daily format. However they differ in the methods employed to estimates the rainfall. To validate these products we have used the rain gauge data obtained from IMD at 3525 ground stations. This data comprises of the rain gauge stations maintained by IMD, hydro-met stations, agro-met stations and the state government run stations. We have put the data through statistical analysis and scrutinized various skill scores to judge the usability of the data. The results are discussed in details in the study.

Abstract ID – 445

Diagnostic study of Western Disturbances that caused extreme precipitation over Indian Himalayas: 1985-2016

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Abstract

Extreme winter precipitation events over Indian Himalayas have caused huge loss in property and human lives over Himalayan region in past few decades due to extreme precipitation sometimes along with snow avalanche, flash flood and landslides over the region. These extreme precipitation events over the Himalayan region occur under the influence of active Western Disturbances (WDs) mainly in winter months. Thus, detailed understandings of diagnostic features associated with these systems are very much essential for its accurate prediction. In general, it is seen that the most of these systems pass across the Himalayan region without causing any heavy precipitation. However, some systems cause a very large amount of precipitation with heavy to very heavy snowfall/rainfall over the region. During the period winter months (December to March) of 1985-2016, there were 14 cases of intense WDs that have caused extreme precipitation (≥ 12 cm, very heavy precipitation as per India Meteorological Department Criteria) over Indian Himalayas.

In the present work, a detailed diagnostic study is carried out to understand the various synoptic features associated with the 14 intense WDs that caused extreme precipitation over Indian Himalayas. The some of the broad finding of the study are:

- The analysis suggests that these intense systems are seen from lower to upper tropospheric levels in the form of cyclonic circulations (CCs) at lower tropospheric levels (upto 850 mb) and as a deep north-south westerly trough (sometimes with embedded CCs) with its southern tip in deep in Arabian Sea between Longitude 63° to 67°E upper tropospheric level (upto 300 hPa) .
- Generally, the positions of these systems at lower tropospheric levels are 700-800 km away in southeastwards over central Pakistan & adjoining west Rajasthan area.
- In the rare cases, when a fresh WD merge with the pre-existing disturbance over the region. Then it may cause extreme precipitation (>200 mm in 24 hours) along with/or long wet heavy spell over the Indian Himalayas.
- The average life of these intense systems over the study area is 5 days with its average movement Longitude 5° per day.

Key words -Extreme precipitation, Indian Himalayas, Western Disturbances**.**

Abstract ID – 482

Investigation of Human Influences on Heat waves over India

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Abstract

Efforts to understand the influence of climate change on heat waves have increased in the past all over the globe. However, despite substantial progress, a clear understanding of human influence on heat waves in India has not yet knows or has not yet been developed. The Heat Wave Magnitude Index (HWMI) represents the drastic increase of HW over India from observational datasets during the last decade. The increasing trend in heat waves is attributed to the anthropogenic (Anthropogenic Aerosols (AA), Green House Gases (GHG), and Land Use (LU)) influence over India. Under Representative Concentrations Pathway (RCP) 4.5 emission scenario, the risk of occurrence of heat waves over India will increase by ten folds during the 21st century. More than ~70% of land area will be affected by intense heat waves over India (as opposed to moderate and normal heat waves). The risk in the occurrence of heat waves in the southern part of India is projected to increase significantly during the 21st century. Further, a strong relationship is found between heat waves and precipitation deficits, which indicate that intense heat waves tend to occur under drier conditions. The concurrent occurrence of heat waves and droughts are projected to increase in most places in India during the 21st century.

Abstract ID – 485

Dynamical downscaling of extended range forecasts for Extreme weather event predictions

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Abstract

IMD/IITM Extended Range Prediction (ERP) system for forecasting meteorological variables with lead time of 2-3 weeks is in operational mode. ERP forecast is the combination of global models running at 100 km and 38 km resolutions along with multi-physics and has some spatio-temporal error when it comes to prediction of extreme events beyond one week. Coarse resolution models are unable to resolve sub-grid scale features and high resolution global models are computationally expensive to run at S2S scale. Downscaling gives a better way to get fine scale details from low resolution global forecasts. Dynamical downscaling with the advantage of explicit representation of physical processes in regional models is efficient to reveal feasible regional information in global model output signals. IITM/IMD, ERP global model outputs going as boundary conditions to regional model have shown improvement in predicting the extremes with a lead time of 10 days. This improvement with downscaling is of the fact that atmosphere-ocean coupled models has the signal of large-scale forcing that has given an improvement in the ERP.

Theme 5

Weather forecasting Services at Different Time Scales

Abstract ID – 5

Skill evaluation of extended range forecast of rainfall and temperature over meteorological subdivisions of India

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Theme: Weather forecasting Services at Different Time Scales.

Abstract

Under the National Monsoon Mission Project initiated by the Ministry of Earth Sciences, Govt. of India, an indigenous dynamical ensemble prediction system (EPS) has been developed at the Indian Institute of Tropical Meteorology based on the state-of-the-art coupled model - Climate Forecast System Model Version 2 (CFSv2), for the extended range (~15-20 days in advance) prediction. The forecasts are being generated for the entire year covering southwest monsoon, northeast monsoon, summer and winter seasons. As the forecast of rainfall is important during southwest and northeast monsoon seasons, and that of temperature during summer and winter seasons, the present study documents the deterministic as well as probabilistic skill of the EPS in predicting them in the respective seasons, over various meteorological subdivisions over India, on pentad lead time scale. The EPS is found to be skillful in predicting the rainfall during southwest and northeast monsoon seasons, and temperature during summer and winter seasons, over different subdivisions of India. In addition, the EPS is noted to be skillful in predicting selected extremes in rainfall and temperature. This affirms the reliability and usefulness of the present EPS in operational perspective.

Abstract ID – 42

Prediction of Indian Summer-Monsoon Onset Variability: A Season in Advance

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Theme: Weather forecasting Services at Different Time Scales.

Abstract

Monsoon onset is an inherent transient phenomenon of Indian Summer Monsoon and it was neverenvisaged that this transience can be predicted at long lead times. Though onset is precipitous, itsvariability exhibits strong teleconnections with large scale forcing such as ENSO and IOD and hencemay be predictable. Despite of the tremendous skill achieved by the state-of-the-art models inpredicting such large scale processes, the prediction of monsoon onset variability by the models isstill limited to just 2–3 weeks in advance. Using an objective definition of onset in a global coupledocean-atmosphere model, it is shown that the skillful prediction of onset variability is feasible underseasonal prediction framework. The better representations/simulations of not only the large scaleprocesses but also the synoptic and intraseasonal features during the evolution of monsoon onset arethe comprehensions behind skillful simulation of monsoon onset variability. The changes observed inconvection, tropospheric circulation and moisture availability prior to and after the onset are evidencedin model simulations, which resulted in high hit rate of early/delay in monsoon onset in the highresolution model.

Abstract ID – 60

Seasonal Prediction of Indian Summer Monsoon : A dynamical downscaling perspective

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Abstract

The importance of rainfall associated with Indian summer monsoon and its large scale dependencies are quite well known to the scientific and economic community. Hence the prediction of Indian summer monsoon rainfall at a lead time of 2-3 months is of great importance. HoweverIndian monsoon is a complex system with its complexities in the form of land surface heterogeneities, intra seasonal variability and mesoscale convective activities. GCMs have improved a lot over time in simulating the seasonal rainfall, onset dates etc., but still lack in a skillful prediction. Downscaling of GCM outputs using a Regional Climate Model can help in representing the land surface and sub-grid scale processes better than the parent model and hence help in improving the predictive skill of the summer monsoon. In this study, we have used a dynamical downscaling method by two different regional climate models, RegCM and WRF, forced by CFSv2 initial and boundary conditions to evaluate the predictive skill of the two regional models. The evaluation have been carried out by comparing the downscaled products with observation/reanalysis data sets as well as the parent model used for driving the model. Both the models capture the seasonal rainfall amount and pattern better than the host GCM but still lack in a skillful prediction when compared to the observed data set. Improvements are observed in simulation of VIMT, CAPE and upper air circulations.

Abstract ID – 131

Verification of temperature forecast by an Ensemble Forecasting System

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Abstract

Verification is an essential component of model development. It helps to enable comprehensive, fast and reliable assessments of forecast performance of a forecasting system. The ensemble prediction system at NCMRWF (NEPS) is a recent version of Met office Global and Regional Ensemble Prediction System (MOGREPS) with 45 members (44 + 1 control) and horizontal resolution of 33 km and 70 vertical levels is implemented. Ensemble Transform Kalman Filter (ETKF) method is used for generating the initial condition perturbations. A 10 day forecast is generated everyday based on 00 UTC initial conditions.
The present study deals aims at verifying the temperature forecast byNEPS over northern India extending from 18.15^{o}N to 32.55^{o}N in the north-south direction and from 68.175^{o}N to 86.175^{o}E in the east-west direction. The model forecast of maximum temperature during the period 19th June, 2018 - 3rd July 2018 has been used for verification.The purpose of the study was to investigate the ability of NESP to predict heat wave over the region under consideration so the threshold temperature of 308^{o}K was considered. This is the average climatological maximum temperature within the study area during this period of time. The day1 to day5 forecast is verified against the analysis data. Verification is done based on the Reliability, Rank-histogram, Root Mean Square Error (RMSE), Spread, Brier Score (BS) and Relative Operating Characteristics (ROC).

The reliability plots show that the day1 forecast is more reliable than the day3 and day5 forecasts as the model shows more overconfidence in day3 and day 5 forecasts.For the day1 forecast the rank histogram is almost flat which suggests that the ensemble spread correctly represents uncertainty and truth (here analysis) is nearly indistinguishable from the ensemble members. The spread in day3 and day5 forecasts is small and underestimates the true uncertainty in the forecast. A comparison between rootmean square error (RMSE) and ensemble spread shows that initially, for day1 forecast the ensemble spread is larger than RMSE. The growth of ensemble spread with forecast lead time is less than that of RMSE. A Brier Score value close to zero indicates that the accuracy of the forecast is good. For all these forecast lead times(day1 to day5) the area under ROC curve value is greater than 0.9. It suggests that the ensemble forecasting system has good discrimination property i.e., very good ability to distinguish between the situations leading to occurrence and non-occurrence of events.

Abstract ID – 168

New technology of RAPID and RGB of INSAT-3D/3DR satellite for extreme weather forecast/nowcast improvement at IMD during 2015 to 2018: Lightning data with INSAT-3D satellite, A New Initiative for Nowcast services

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Theme:Weather forecasting Services at Different Time Scales.

Abstract

High Impact Severe Weather like thunderstorms, dust, lightning, heavy rainfall and hail are associated with strong winds, synoptic conditions of the atmosphere. The severe thunderstorm activity during the pre-monsoon season is particularly very high and intense and led to a lot of devastation in the form of loss of life, damage to property, aviation and crops. This also creates significant societal and economic problems especially as a major havoc to day to day routine life as well as entire communication as well as transportation system especially over the Indian subcontinent. In view of the increased public awareness of the high impact of severe weather events and its influence on social, cultural, commercial, health, defence, transport etc., it is felt that there is a requirement of a well laid out system/methodology/technology for monitoring and nowcasting of these weather events by India Meteorological Department (IMD).Hence there is a need to develop a standard tool to provide uniform monitoring for forecasting/nowcasting services of above mentioned weather events.In past 2-3 years, two major implementations have been incorporated in the Satellite Division of IMD for weather forecasters and user community i.e., an on-line INSAT-3D visualization tool, RAPID (www.rapid.imd.gov.in) and utilization of the combination of channels using red-green-blue (RGB) composites of INSAT-3D. The RAPID provides features of interest to the scientific community with no specific operating system/software/library/compiler required on the desktop. On the other hand, the cloud types and surface features are very well identified by the different color shades in the RGB scheme. In the current study, an approach describing a significant part of nowcasting services and some of the extreme events including fog, low clouds, duststorms, thunderstorm and monsoon feature of 2016-2017-2018 will be presented in the conference. Apart from this RAPID analysis tool for INSAT satellite data on a real- time basis will also be demonstrated for identification of severe weather events.At the end, the merged lightening & satellite cloud top temperature operational product which is a joint collaboration of IMD, IITM & IAF will be demonstrated for nowcast services over the Indian region.

Abstract ID – 293

Prediction of Cyclogenesis over Bay of Bengal with Artificial Neural Network Model

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Theme: Weather forecasting Services at Different Time Scales.

Abstract

Prediction of the intensity of cyclones with high precision has always been a challenge for the meteorological community. An attempt is made in the present study to predict the pressure drop (PD) and maximum sustained wind speed (WS) associated with the tropical cyclones of Bay of Bengal (BOB) using statistical methods and artificial intelligence. Multiple linear regression (MLR) and polynomial regression (PR) has been analyzed to evaluate the best forecasting hour. The result of MLR and PR provided 60 and 84 hour lead time as the best forecasting hours. Square of low level vorticity (LLV), difference in equivalent potential temperature (EPTD) and Mid-tropospheric relative humidity (MRH) are observed to be the most suitable parameters for prediction with 60 hr lead time and square of LLV and EPTD for 84 hour lead time as obtained through principal component analysis. Multilayer feed forward network with different architectures are developed to obtain the best model for prediction of PD and WS at 60 and 84 hr lead time over Bay of Bengal (BOB). The square of LLV, EPTD and MRH are used as input parameters of the Artificial Neural Network (ANN) model for forecast with 60 hr lead time and square of LLV and EPTD are taken as inputs of the ANN model with 84 hour lead time. The prediction skill of the models is evaluated by different accuracy measures such as Root Mean Square Error (RMSE), Prediction Error (PE) and Mean Absolute Error (MAE). The result shows that the multilayer Perceptron (MLP) model with three input layers, three hidden layers with three nodes at each hidden layer and two output layers (M5) is the best suitable model for prediction with 60 hr lead time and for 84 hr lead time forecast, the MLP model with two input layers, two hidden layer with two nodes at each hidden layer and two output layers is the most suitable with some limitations.

Key words -Cyclone, MLP, MLR, PR, LLV, EPTD, MRH.

Abstract ID – 358

Evaluation of skill of global model rainfall forecasts over River Basins of India for hydro-meteorological applications

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Abstract

Quantitative precipitation forecast (QPF) from global models is highly desirable for various hydro-meteorological applications, including flood forecasting. QPF of Numerical Weather Predictions (NWP) modeling systems is one of the input parameter for the hydrological models. In recent years, the high resolution global models have resulted in improved rainfall forecasts in medium range. In this study, two state-of-art deterministic NWP models have been investigated over different river basins of India to assess their ability during the monsoon season 2017. The Unified Model operational at National Centre for Medium Range Weather Forecasting (NCUM) and Global Forecast System (GFS) which is also operational at India Meteorological Department (IMD) are used in the present work. The forecast has been verified over 9 river basins of India during the monsoon season 2017. Various skill score like Mean, Root Mean Square Error (RMSE), correlation co-efficient (CC) from Day-1 to Day-5 have been examined for nine river basins within India for 2017. Also, standard verification metrics like Bias, Equitable Threat Score (ETS), Probability of Detection (POD) and HK-scores etc have been examined during the monsoon season 2017 from Day-1 to Day-5 forecasts. It was found that both models have useful skill at different river basins. The mean rainfall is very well produced while the total accumulated rainfall for the season is over-predicted by both models in all 9 river basins. Forecast skill looks good upto Day-3 forecasts in five river basins viz. Cauvery, Godavari, Krishna, Mahanadi, and Mahi from both the models. For the Mahi and Mahanadi basins, even the Day 5 forecasts were seen to be skilful.

Keywords -NCUM, GFS, NWP, Hydro-meteorological applications, Flood forecast.

Abstract ID – 363

Bias-correction and verification of summer temperature forecasts over India

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Abstract

There are various methods of bias corrections (BC), out of them the decaying average bias correction technique we have chosen to serve the purpose. It has been recognized as an essentially useful technique for the medium range weather forecasting and is now finding its place in forecasting the extreme events. In the present study we have investigated temperature forecast skill for a high-resolution NWP model in the summer season over India when many parts of the country are in the grip of heat waves. Classical statistical scores are computed to serve the verification purposes. Raw forecast of NCUM fails to capture temperature over hilly regions and large negative biases during the season are evident. Applying the decaying average bias correction technique the traditional verification scores and associated methods on the deterministic forecasts, we have attempted to examine performance of the bias corrected forecasts against the traditional deterministic raw forecasts. The results are indicating an appreciable (POD upto 60%) improvement in forecasting skill and detecting extreme temperatures have become possible well in upto 3 days before. Underestimation over hilly regions has been corrected upto 7 days before and locations of the extreme temperatures are also better captured by the bias corrected forecast. Further, it is found that the bias corrected forecasts smoothes down the unexpectedly soaring signals, which thereby reduce the false alarms and thus prove to be more realistic than the deterministic raw forecast.

Keywords -Extreme Events, Bias correction decaying average, POD, Temperature forecasts.

Abstract ID – 390

Monthly long range forecast of Indian summer monsoon rainfall

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Abstract

Effective Strength Index (ESI) is the combined effect of North Atlantic Oscillation (NAO) and Southern Oscillation (SO). It has been observed that the influence of various meteorological parameters (sea level pressure, temperature, geopotential height, zonal wind etc.) on monsoon circulation is drastically changed during positive and negative phases of ESI tendency from January to April. Hence separate forecast models, for positive and negative phase of ESI-tendency, have been developed for predicting Indian summer monsoon rainfall on monthly scale. In order to obtain the prediction parameters, cluster regions for different meteorological parameters at lower, middle and upper troposphere in pre-monsoon months (January through May) and seasons (winter, spring) have been identified by applying the shared nearest neighbor algorithm. The time series, for the period 1951-2017 (67 years) have been constructed by averaging the met-parameters over the respective clusters. The prediction equations are obtained using 62 years data (1951-2012) and results are verified for remaining 5 years. The significant linear and nonlinear relationship between these time series and monthly summer monsoon rainfall over India gives cluster parameters. For each month (June to September), two separate sets of independent cluster parameters have been selected by cross-validation procedure. It is seen that for each month, root mean square error (RMSE) in predicting summer monsoon rainfall departure is much less than the standard deviation (SD) of rainfall departure. The correlation coefficient (CC) between observed and estimated rainfall departure is around 0.85 in all four monsoon months (June to September).

Theme 6

Aerosols, Atmospheric Chemistry and Weather/Climate

Abstract ID – 10

Distribution of oxide of nitrogen over the Indian subcontinent: investigation of sources using chemistry transport model

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Abstract

Weather Research and Forecasting Model Coupled with Chemistry (WRF_Chem V-3.8.1) was used to simulate the distribution of NO_2 and quantify the contribution from various emission source regions/source types over the Indian subcontinent. The model simulations were made for the year 2015 using MACCity emissions. The relative NO_2 contribution of five regional sectors namely Northern India, Eastern India, Southern India, Western India and North-East & Burma was analysed by enabling anthropogenic emissions of NOx only over the chosen regional sector. The analysis revealed that local anthropogenic emissions mainly controls the spatial distribution of nitrogen dioxide over the simulation domain. Surface NO_2 distribution showed that eastern India experiences local influence (produced from easternemission sources) of 10.81±6.96ppbv which was found to be highest among all five regional sectors. The outflow of this region contributes 2.36±1.58 ppbv over southern India. The northern and western Indian region experiences a NO_2 concentration of 6.02±6.57ppbv and 6.58±3.98ppbv respectively due to local regional emissions.The contribution of locally produced NO_2 is found comparatively much lower (3.29±3.62ppbv) over southern Indian region. North-eastern & Burma regional sectorwas found to experience the least local contribution of 1.65±1.18ppbv among the five regional sectors.

To quantify the contribution from different anthropogenic emission sources like Energy sector, transport sector, industry sector and agriculture sector; model simulations were made using each type of emissions separately. Over eastern, western and north eastern regions, maximum NO_2 contributed from energy sector whereas, over northern and southern regions, transport sector played the most important role. Over eastern India, the contribution of energy source was found to be maximum (5.85±4.44 ppbv) to the surface NO_2 concentration. A similar scenario was found in Western and North east regional sector where the surface concentration of NO_2 from energy source was found to be 3.70±2.82 ppbv and 1.64±1.33 ppbv respectively. However, over Northern and Southern regional sectors, transport sources exceeded that of energy by 0.6 ppbv and 0.25 ppbv respectively. Model simulations are made to investigate the influence of crop residue burning event "Parali" over Punjab on the air quality of this state and its downwind locations during kharif season. The surface level of nitrogen dioxide increased by ~6 -12 ppbv over Punjab due to Parali. The outflow of Punjab during this period enhanced the surface NO_2 concentration over Delhi by 1.25 ppbv. Model simulations are also made with reduced anthropogenic emissions to understand its impact on other criteria pollutant ozone. Reduction of NOx anthropogenic emissions by 30% over the simulation domain resulted in a decrease of surface ozone by 40-50 ppbv. A nonlinear behaviour of ozone with respect to NOx is also evident over some parts of northern India during winter and autumn. Under the reduced NOx emission scenario, free tropospheric (800 hPa to 300 hPa) ozone also decreased by 20-30 ppbv. These results highlight the importance of reduction of NOx anthropogenic emissions over India.

Abstract ID – 16

Improving the accuracy of PM2.5 mass by using chilled Teflon filter Sampler

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Abstract

Filter media is widely used in PM2.5 manual sampling and real-time monitoring devices to determine the compliance with air quality standards. However, PM2.5 mass concentrations underestimated due to the evaporation loss of semi-volatile materials (SVM). To reduce the evaporation-induced PM2.5 losses, the temperature of incoming aerosol was reduced to 4 0C at the sampling filter after the aerosol was dried to the average relative humidity of 22.2±12.6%. Field test results showed that the total ion concentrations of a normal sampling filter were lower than the those measured by a reference porous metal denuder sampler with the average bias of -15.19%, while the bias of the chilled filter was significantly reduced to only -2.44%, indicative of the effective suppression of SVM evaporation loss. The gravimetric weights of chilled filter samples were slightly increased in the chilled filter samples due to the capillary condensation of water vapor which was quantified using surrogate TiO2 nanoparticles. After correcting for the remained water concentration, the accuracy of PM2.5 mass was significantly improved with the average bias of only about +2.9%.

Keywords -Aerosol sampling, Evaporation loss, PM2.5 sampling inlet, Chilled filter, Water vapor condensation.

Abstract ID – 18

Investigation of the role of microphysical parameterizations on precipitation and black carbon prediction in regional climate model

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Theme :Aerosols, Atmospheric Chemistry and Weather/Climate

Abstract

Aerosols have crucial impact on the regional and global climate system. The aerosol burden is largely controlled by model-specific transport, removal, chemistry, and parameterizations of aerosol microphysics and to a lesser extent by the spatio-temporal distributions of the emissions. The parameterizations of microphysical physical processes, contribute significantly to the model uncertainties. Transport of aerosols is controlled by winds. The cloud coverage, rain localization, and intensity can be influenced by humidity. Humidity is also crucial for hygroscopic particle growth, which is important for the particle settling and wet deposition processes. Microphysical processes control formation of cloud droplets and ice crystals, their growth and fallout as precipitation. Microphysics plays a crucial role in regional climate models. The main microphysical processes are latent heat cooling, condensate loading, precipitation, coupling with surface processes, radiative transfer, and cloud-aerosol-precipitation interactions. There are significant uncertainties associated to the microphysical and dynamical interactions with chemistry in regional climate models.
The simulations of Weather Research and Forecasting model coupled with Chemistry (WRF-CHEM) version 3.6.1 are investigated over western, north, and central Indian regions during winter (December-January-February) and monsoon (June-July-August-September) seasons of 2008. The simulation experiments are performed at horizontal grid resolution of 30 km × 30 km. Fifty vertical levels are considered in which 20 vertical divisions are taken within 10 km as aerosols are mainly confined in lower troposphere. The role of microphysical parameterizations on meteorology and black carbon (BC) mass in WRF-CHEM is investigated. The five model simulation experiments are designed considering Yonsei University (YSU) boundary layer schemes Grell-Freitas (GF) cumulus parameterization scheme and five microphysics schemes (Morrison double-moment, New Thompson et al., WRF double-moment 5-class scheme, WRF double-moment 6-class scheme, and Thompson aerosol-aware. The rainfall in monsoon season can be simulated over the region using Morrison double-moment physical parameterization scheme and YSU boundary layerscheme with GF cumulus parameterization schemes. The same shemes are able to simulate BC mass over the region. BC mass is found to underestimate in almost all the experiments during winter over Pune, Delhi, andKanpur, while BC mass is overestimated in monsoon over Ahmedabad, Delhi, and Kanpur. This suggests that the wet scavenging is not efficient to reduce the BC mass in model simulations during monsoon season, while lower emission rate may cause differences in winter. This study will be useful in improving the future climate predictions.

Abstract ID – 34

Long-term observations of black carbon aerosol over a rural location in southern peninsular India: Role of dynamics and meteorology

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Theme:Aerosols, Atmospheric Chemistry and Weather/Climate.

Abstract

Ten years (2008–2017) of Black Carbon (BC) observations obtained using Aethalometer (AE-37) are analyzed to investigate the seasonal trends and temporal variability over a tropical site Gadanki (13.5oN, 79.2oE) located in south-east India. Diurnal variations of BC have two peak structures one in the morning (~08 IST) in all seasons and second in the evening (~20 IST) only during the pre-monsoon (March–May). Intra-annual variation in BC indicated February and March months as the bio-mass burning with highest BC mass concentration (3000–5000 ng/m^3). About 46% of air parcel back trajectories found passing across the in-land regions of southern peninsular India brining transported aerosol to the source location during pre-monsoon. The lowest BC (~1500 ng/m^3) is noticed during the monsoon months (June–September). The average BC (2200 ng/m^3) represents observational site as a typical rural site. The inter-annual variability of BC did not show any significant trend. However, trends in the maximum (March) and minimum (July) BC values show statistically significant decreasing trend suggesting reduction in bio-mass burning sources during March supported by the decrease in the fire counts. Diurnal variation in the absorption angstrom exponent indicates that the morning and evening peaks are contributed by the bio-mass combustion with values above threshold of 1. However, angstrom exponent values are found below 1 during noon time of monsoon season suggesting fossil fuel contribution. Strong coupling is found between aerosol concentration and tropospheric dynamics, meteorology in addition to the sources. The present study is expected to provide valuable input to the modelers and observational physicists as BC is climate sensitive variable.

Abstract ID – 44

Studying the impact of dust aerosols in formation of theAphelion Cloud Belt over Martian tropics[Subject area: Aerosols, Atmospheric Chemistry and Weather/Climate]

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Abstract

The present study used six Martian years of observations from Mars Climate Sounder instrument on-board Mars ReconnaissanceOrbiter for investigating the water ice cloud appearance over Martian tropics during the aphelion season, when Mars is farthest from the Sun.Analysis of zonal average water ice column opacity suggests that the spatial extension is mainly confined over northern tropics (0 – 30°N), and is seenprimarily during nighttime. The aphelion cloud mainly appeared over northern tropics within the solar longitude (L_S) between 45° and 135°. Profile observations (during MY 31)suggests its presence at an altitude of 10 – 30 km.In addition, a high value of dust opacity at this height range is observed too. The cloud belt starts to form during L_S = 45 – 75° (phase 1), reaches its maxima during L_S = 76 – 105° (phase 2) and starting to dissipate afterwards, i.e. L_S = 106 – 135° (phase 3). However, the latitudinal belt of thick clouds (column opacity > 0.25) remained same with high optical depth during all 3 phases, when nighttime observations are considered. Profile observations near Isidis (12 – 22°N, 90 – 110°E; hereafter called L1) and Lunae Planum (12 – 22°N, 50 – 70°W; hereafter called L2) also demonstrate the maximum intensity of thick clouds during phase 2, with water ice extinction values greater than 0.003 km^{-1}within 20 – 30 km altitude. The appearance of this thick clouds, however, is not dependent upon the dust aerosol present in the atmosphere, as realized from the dust extinction profiles for both L1 and L2. However, the dependency of cloud formation upon the dust aerosols (as ice nuclei)could be understood from the distribution of the dust density-scaled opacity, which depends upon the high altitude (at ~25 km) dustiness. Variation of the dust density-scaled opacity at L2 clearly shows its peak above 30 km during the phase 2, which also happened to be the peak phase of aphelion cloud belt. The correlation coefficient profiles confirm this aspect, where the value exceeds 0.75 mainly during phase 1, when the cloud formation starts and also during phase 2, at an altitude near 30 km. The work is still being refined to get final set of results before it is presented in TROPMET-2018.

Abstract ID –76

Statistical characteristics of the cloud cells in the contrasting monsoon seasons over the rain-shadow region of peninsular India

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Abstract

The convection over the study region in the contrasting summer monsoon seasons of 2013 and 2014 and their evolution have been studied with reflectivity spectra. The cloud cells are categorized into six categories based on the radar reflectivity data obtained from Hyderabad S-band radar for the excess (2013) and deficient (2014) summer monsoon seasons. These categories are: (1) very light (VL: 7-18.5 dBZ), (2) light (19-27.5 dBZ), (3) moderate (28-36.5 dBZ), (4) strong (37-45.5 dBZ), (5) very strong (46-54.5 dBZ) and (6) extreme (≥ 55.0 dBZ). The cloud cells (here after referred as "cells") with higher reflectivities are in the higher states of their evolution process. Higher reflectivity indicates higher rainfall rates as the rainfalls are related to reflectivity by Marshall-Palmer relationship. Among these, three categories (pre-convective, PC: 19-27.5dBZ, convective-initiation, CI: 28-36.5dBZ, and convective-enhancement, CE: 37-45.5dBZ) constitute about 59-64% of the total cloud population and play a vital role in the total rainfall. The monsoons are classified into excess/deficient if the seasonal rainfall is more/less by 10% from the climatological mean.The study showed that on the daily scale, occurrence of these cells is an ubiquitous feature of this rain-shadow region. Persistent formation of these cells is due to large scale monsoon circulation and solar heating. On the intraseasonal scale monsoon conditions are classified into active and break conditions based on rainfall activity. Prevalence of high moisture (>80%) and upward vertical velocity (up to 300 hPa) are responsible for high occurrence of these cells in the active conditions. The solar heating of the land surface is conducive for formation of these cells in the break monsoon conditions and in the afternoon hours. Mean rate of evolution of convection from lower category to higher category is -0.6 to -0.7. The clouds in the states of PC, CI and CE show maximum/minimum values in the local afternoon/morning hours. It is brought out that the driving mechanism for initiation and development of clouds is the combined effect of large scale circulation and solar heating. The convection is equal in the four quadrants indicating no preferred area for development of the convection. The spatio-temporal variability of these cells will be useful for understanding the evolution of convection and modeling studies.

Abstract ID – 79

Modeling aerosol loading due to forest fires over Indian landmass

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Theme: Aerosols, Atmospheric Chemistry and weather/Climate

Abstract

A major forest fire incidence occurred over the Indian landmass specifically covering northern India and Nepal that started in the region since February and reached its maximum intensity by the end of April, 2016. Aerosols (particulate matters) loading due to this wildfire is characterized using simulations from Weather Research and Forecast model (WRF-Chem) which accounts for meteorology-chemistry-aerosol processes simultaneously. The paper compares the particulate matter loading from the experiments with and without inclusion of biomass burning emissions into WRF-Chem model. Brazilian Biomass Burning Emissions Model (3BEM) has been utilized to estimate the emissions due to biomass burning. Fine particulate matter averaged over the region of intense fire activity shows significant increase of up to 700% due to biomass burning emissions. Strong diurnal variability is produced by the model for the distribution of particulate matter with maximum during nighttime and minimum during daytime. Very high values of aerosol optical depth (AOD) ranging from 0.5 to 1 are observed by Moderate Resolution Imaging Spectroradiometer (MODIS) over the region of intense fire. WRF-Chem simulations show considerable improvement in AOD values after inclusion of biomass burning emissions with more than two fold increases over the experiment without biomass. But both the experiments have underestimated AOD in comparison to MODIS. Inclusion of biomass burning emissions produces reduction in downward shortwave flux ranging from -3 to -8 W/m^2.

Abstract ID – 98

A multivariate analysis of surface ozone and its precursors over a polluted zone of Kolkata, India and quantification of the intrinsic uncertainty through Shannon entropy

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Abstract

In the present work, we have considered ozone and its three precursors namely NOx, SO2, and PM10 over Kolkata, a polluted urban region of India. To explore the interdependence of these parameters through identification of multicollinearity, we have applied Bartlett's Sphericity test with the null hypothesis of the nonexistence of non zero Pearson Correlation between the variables. It has been Chi-square value that this null hypothesis would be rejected with $\alpha=0.95$ and hence the existence of multi-colinearity is established. This outcome of the sphericity test has created that the necessity for Principal Component Analysis (PCA).Four principal component have been computed for the factor loading, and notably high factor loading has been observed for the first principal component for ozone. Factor loading for other principal component corresponding to ozone precursors have also been thoroughly explored, and finally, NOx and PM10 have been identified as the best explanatory variable for ozone as considered in the current framework.To recognize the uncertainties associated with these pollutants we have implemented Shannon Entropy that is a measure of uncertainty and information formulated concerning probability theory. Given the above, Binomial, Poisson, Normal and Log normal distribution have been fit to the data as obtained through PCA. The maximization of Shannon Entropy has been chosen as the criteria to identify the probability distribution fitted to the concerned data. It has been observed that normal and log normal distribution generate probabilities leading to maximum entropy for three of the parameters. It may be noted that normal and log normal being continuous distributions, we have created grouped data and finally with the corresponding probability measured entropies have been computed through discrete approach. Finally, the normal distribution is identified as the best distribution to recognize the uncertainty associated with all the parameters obtained through PCA. As a future work, we propose to incorporate more precursors of surface ozone and to generate predictive models through identification of affinity and self-similarity as an extension of Shannon entropy in the framework of probabilistic information theory. Also, to investigate the interdependence of the various meteorological parameters prominent for the summer monsoon and the surface ozone over Gangetic West Bengal, India, is being proposed as future work.

Abstract ID – 125

Absorbing aerosol distribution across the Eastern Himalayan region

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Abstract

Melting of the snow and glaciers over the Himalayan region is a serious environmental issue and it has a major impact in the global snow cover index. Studies have shown that aerosol burden over this region might impact the snow properties. Hence, a comprehensive study on the aerosol loadings, especially focussing on the absorbing particlesdemands attention. This study aims to provide a statistical view ofAerosol Absorption Optical Depth (AAOD) levels derived from Ozone Monitoring Instrument (OMI) at 388 nm wavelength during the time period 2005-2017 over the Himalayan region (25-40°N and 88-105°E). The NOAA Digital Elevation Model have been utilized to extract the aerosol data for the Himalayan region, followed by geo-processing of the daily AAOD datasets. The intra-annual and inter-annual variability along with the changing levels of absorbing aerosols isdiscussed in detail.

Keywords -OMI, aerosol, Eastern Himalayas.

Abstract ID – 126

Climatology of pre-monsoon echoes observed by Tropical Rainfall Measuring Mission's Precipitation Radar over south peninsular India and neighborhood

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Abstract

Climatological characteristics like height, areal extent, reflectivity structure and spatial distribution of echoes observed by Precipitation Radar (PR) onboard Tropical Rainfall Measuring Mission (TRMM) satellite over south peninsular India and neighborhood (SPIN) (3-22 oN/72-82 oE) are studied. 3 dimensional reflectivity (Ze) data for 10 pre-monsoon years from 2005-2014 is used for this. An intense convective echo (ICC) is defined as a set of two or more contiguous convective pixels in which Ze exceeds 30 dBz at any level. 19173 ICC's have been observed by TRMM during 1369 passes over SPIN. Height of 17 dBz is taken as the height of ICC and product of number of pixels comprising an ICC with single pixel area is taken as area of ICC. Height distribution of ICCs is left skewed with single mode with average and median height as 7.8 and 7.3 kms. ICCs with areal extent of >100-1000 km2 (C scale) are most frequent (58.5%) followed by smallest scale called D scale (<= 100 km2) with a frequency of 37.2%. Large scale ICC's or B/C scale echoes (>1000-100000 km2) have very small frequency of 4.2% indicating that very few ICC's organize themselves into mesoscale entities. The average area of D, C and B/C scale ICC's over SPIN are 72.7, 279 and 1932 km2 respectively. The relationship between height and areal extent of ICC's is one to one and indicates that taller ICCs are broad too as indicated by the height of D, C and B/C scale echoes. The mean maximum top heights for D, C and B/C scales are found to be 5.5, 8.7 and 14.2 kms. Maximum height of 30 and 40 dBz serve as indicators of intense convection. The height distributions of 30 and 40 dBz show single peak at 5.5 and 4.75 km and cumulative frequency shows that only 6 and 3% of ICC's cross 10 km height. Average and median height of 30 dBz is 5.7 and 5.5 km while that of 40 dBz is 4.8 and 4.7 kms respectively. The ICC's are also classified in terms of moderate and deep convective cores (DCC) in which the height of 30 dBz and 40 dBz exceeds 8 and 10 km (DCC30, DCC40) respectively. Moderate and strong wide convective cores (WCC) are defined as ICC having 30 (WCC30) and 40 dBz Ze (WCC40) at any height. DCC represent intense convection while WCC represents convection that organizes itself into mesoscale entity. Spatial plot of DCC and WCC show that DCC30 are present both over land and ocean while DCC40 are present only over land indicating that landmass provides necessary buoyancy to air parcel. Over SPIN, they are concentrated near the mountainous regions. WCC30 and WCC40 are present both over land and ocean with maximum frequency over the oceans. Predominance of WCC's over oceans indicates that convection organizes itself into mesoscale entities over oceans easily than over land. Reflectivity structure of most intense ICC's indicates that maximum reflectivity lies between 3 to 4 kms beyond which it decreases rapidly.

Abstract ID – 153

Ground-based aerosol optical and microphysical properties over South Asia: Aerosol climatology and recent trends

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Theme: Aerosols, Atmospheric Chemistry and Weather/Climate.

Abstract

Long-term (2007-2016) aerosol optical and microphysical properties retrieved from 6 AERONET stations across South Asia (SA) were evaluated in terms of aerosol loading, types and size distribution. The recently released version 3.0 direct sun and inversion retrieval algorithms have been used to evaluate the seasonal variability of aerosol columnar loading (AOD), Absorption Angstrom Exponent (AAE), Single Scattering Albedo (SSA), Absorption Aerosol Optical Depth (AAOD) and Volume Size Distribution (VSD).Seasonal Fire count data derived from MODIS Terra+Aqua is used to identify major biomass burning seasons as well as Mann-Kendall test associated with Sen's slope is used to detect and estimate significant trends in aerosol optical properties. A Strong seasonality in AOD was noted overSA mainly attributed to the change in aerosol sources and meteorological variables.SA, particularly Indo-Gangetic Plain (IGP) experienced high aerosol loading throughout the year.The stations at lower IGP (Kanpur and Gandhi college) experienced high AOD and AE notably in post-monsoon (AOD: 0.96, 1.05; AE: 1.3,1.28) and winter (AOD: 0.86, 1.0; AE: 1.25,1.27), indicating aerosol climatology being mainly regulated by fine mode carbonaceous aerosols (Black/Brown carbon) which are highly absorbing in nature (AAE: 1.26, 1.23 and 1.05,1.02, respectively).Over both these sites, the AAOD show decreasing trend with increasing AE and SSA trends, suggesting increased fraction of scattering species such as sulfates and nitrates contrasting well with the decreasing AAE trends. Lahore and Karachi (upper IGP) also exhibit high AOD and low AE particularly in monsoon (AOD:0.71,0.91; AE: 0.83,0.39), mainly dominated by mixed and coarse type of aerosols. Significant positive AE (0.03 decade^{-1}) and negative AAE (-0.04 decade^{-1}) trends at Jaipur suggest increased contribution from anthropogenic aerosols.

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Abstract ID – 163

Analysis of diurnal nature of spatial variability of Land Surface Temperature in Delhi NCR using Sentinel 3 and INSAT 3Dsatellite data during summer,2018

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Abstract

Urban settlements are contributing to climate change is an established fact owing to several studies carried over various urban agglomerations across the world. Urbanization in India is happening over a breakneck pace in last few years. The capital city, Delhi and NCR region is undergoing the aftermaths of increased urban density and resulting escalation in pollution. Thus, it is imperative to look into the climate variables and pollution dynamics over this region with high spatial resolution. Sentinel 3 SLSTR instrument provides global Land Surface Temperature (LST) data at a spatial resolution of 1000m. Using this data, the diurnal LST dynamics can be explored and analysed. This study accounts the presence of nocturnal Urban Heat Island (UHI) effect of about 5-7°C during May, 2018.Also, the Urban Cool Island (UCI) effect is very prominent with presence of urban “cool-spots” with negative UHI of 5-10°C in central Delhi and surrounding urban clusters like Meerut, Greater Noida, Gurgaon, Bahadurgarh etc. during the daytime. We have also deduced that the UHI and UCI effects are not restricted to an overall city span or only urban settlements but can be prominent over micro regions such as major transport route intersections also. The dependence of the LST parameter over Normalized Difference Vegetation Index (NDVI) (from Sentinel 3 satellite) and Aerosol loading (from MODIS Terra satellite) has been assessed to justify the spatial changes of LST diurnally. A negative dependence of both parameters has been established and the formation of UCI due to increased loading of aerosols over urban dense areas and highway intersections during the day time ultimately affecting the short wave incoming radiation is observed. The areas of Central Delhi, Hapur and northern part of area of interest especially show the high aerosol loading and corresponding comparatively lesser temperature during daytime. The average range of aerosol optical depth over Delhi is between 0.4-0.8. Understanding the feasibility of using high temporal resolution (half hourly) Indian INSAT 3D LST data at 4000m spatial resolution for carrying out such studies has been also attempted.A modest correlation of 0.83 between the Sentinel and INSAT datasets has been obtained, however INSAT 3D underestimates the LST substantially as compared to Sentinel 3 SLSTR. The algorithmic differences between the retrieval of LST from the two satellites has been studied and the difference in the LST values has been owed to the basic retrieval algorithms.

Abstract ID – 169

Impact of dust storms on aerosol characteristics and radiative forcing at Jodhpur

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Abstract

Aerosol optical properties and radiation budget are discussed separately during dust storm and normal periods at Jodhpur using the Sun-sky radiometer data of May 2011-April 2012 period. SBDART and HYSPLIT modelsare used for simulation of aerosol radiative forcing andairmass analysis respectively. The daily mean aerosol optical thickness at 500 nm (AOT_{500}), Angstrom exponent ($\alpha_{340-1020}$) and Angstrom Turbidity coefficient (β) for the study period are 0.49 ± 0.29, 0.70 ± 0.35 and 0.32 ± 0.24 respectively while the mean values of corresponding parameters for fourhighest intense days of four dust events are 1.39, 0.37 and 1.08 respectively. Meanof aerosol index (Aura OMI- AI) of fourhighest intense days of four dust events is1.35. Monthlyforcing at the surface andtop of the atmosphere are ranged between -22.1 to -60.1Wm^{-2}and-0.2 to -9.5 Wm^{-2}respectively. Pre-monsoon season negative TOA forcing is less compared to other seasons due tothepossible presence of absorbing dust particles.The SBDRT model is run discretely for four dust event periods to examine the change in ARF during this high dust period. Short wave (SW) ARF at SUF and TOA on the four highest intense days corresponding to four dust events is significantly more than the respective monthly forcing and ranged between -75.8 to -130.5 Wm^{-2}and +4.3 to -14.8Wm^{-2}respectively. Seasonal variation of daily AOT_{500} and α, spectral variation of $AOT_{500}$and single scattering albedo (SSA) and heating rates are the other aspects that are presented.

Keywords -Aerosol Optical Thickness, Aerosol Radiative Forcing, SBDART, HYSPLIT model.

Abstract ID – 173

Size distribution and mixing state of black carbon aerosol in the Indo Gangetic Plain (IGP) outflow

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Theme : selected: Aerosols, Atmospheric Chemistry and Weather/Climate.

Abstract

Black Carbon (BC) plays an important role in the Earth's climate system due to its strong absorbing nature over a wide wavelength range (from UV to IR) that leads to atmospheric warming. Such warming is hypothesised to contribute to changes in large-scale atmospheric circulation, enlarged static stability, abridged convective activity and cloud coverage over regional scales. Further, due to its sub-micron size range and chemically inert nature, BC has longer atmospheric life time which results in changes in its mixing state during 'aging'. This involves coating of other condensable species on BC and such coated BC has amplified absorption due to 'lensing effect' from the scattering coating material. Also, coated BC can act as cloud condensation nuclei, thereby contributing to indirect forcing. Over the Indian region, the potential impact of BC on regional climate, monsoon and hydrological cycleis emphasized by numerous studies. Since absorption potential strongly depends on BC concentration and mixing state, it is imperative that detailed characterisation of BC in spatio-temporal time scales is carried out for regional scale climate impact assessment. Towards this objective, Aerosol Radiative Forcing over India network (ARFINET) observatories of Indian Space Research Organisationhave been contributing significantly. The information on the BC microphysical properties, especially its mixing stateis largely elusive due to lack sufficient observations, and thus become a key source of uncertainty in understanding regional climatic implications. In this context, as part of "South West Asian Aerosol Monsoon Interactions (SWAAMI)" experiment a super site has been established at an ARFINET station at Bhubaneswar. This super site is situated in the outflow of Indo-Gangetic Plain (IGP)which has multitude of aerosol sources, both natural and anthropogenic. Major focus of the observations from this experiment is to delineate the characteristics of the IGP aerosols, especially BC microphysical properties. In this study, we describe the results from the SWAAMI observations carried out using laser-induced incandescence technique to measure the mass and mixing state of individual refractive BC particlesover Bhubaneswar during July 2016-May 2017.BC concentrations were highest during winter when the IGP outflowprevailedover the region, and lowest during pre - monsoon when marine/coastal airmasses prevailed,highlightingtherole of source/sink and atmospheric dynamical processes. Examination of size distributions suggested the nature of sources, with the mode diameters of BC varying between ~ 170-198 nm during the IGP outflow, suggesting mixed sources (both fossil fuel and solid fuel emissions), whereas larger BC cores (>210 nm) during marine/coastal airmass periods, suggested distinct source processes. Importantly the IGP outflow is characterized by thickly coated (>30% coating on the core) BC, owing to aging and higher abundance of co-emitted species which contribute to coating. Present study assumes significance while delineating climatic implications due to distinct microphysical propertiesof BC and changes in its mixing state in contrasting atmospheric conditions.

Abstract ID – 201

Variation of outgoing longwave radiationwithaerosol optical propertiesas observed from space over India

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Theme: Aerosols, Atmospheric Chemistry and Weather/Climate.

Abstract

In Principle, the earths radiation budget attains radiative equilibrium when the incoming short-wave radiation balances the outgoing longwave radiation (OLR). However, the OLR is significantly affected by the atmospheric aerosols resulting in the alteration of temperatures. This study mainly focusses on the variation of OLR in comparison with aerosol optical properties over Indian region for the time period 2010-2017. Level-3 products (Aerosol Optical Depth, Aerosols Absorption Optical Depth and OLR) at 1^0 x 1^0 spatial resolution retrieved from Ozone Monitoring Instrument (OMI) and Atmospheric Infrared Sounder (AIRS) onboard NASA's Aura and Aqua are exploited in this study. The OMI/Aura Near UV measurements (OMAERUV) enables to differentiate the absorbing and non-absorbing aerosols in a more explicit way. The AIRS OLR flux measurements (AIRS IR-Only) emitted by the earth-atmosphere system used in the study are cloud-free and quality ensured. To account the temporal variations, the analysis is carried out for four meteorological seasons; i.e., winter (January – February), Pre-Monsoon (March-May), Monsoon (June – September) and Post-Monsoon (October – December). In order to ameliorate our understanding, variations of AIRS OLR fluxes are also studied along with the ground-based AERONET (AErosol RObotic NETwork) Version 3 Direct Sun and Inversion Algorithm observations over selected sites.

Keywords -OLR, AAOD, AERONET.

Abstract ID – 208

Radiative properties, rainfall scavenging and source apportionment of atmospheric Black Carbon at high altitude station in Western Ghats during the monsoon season

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Abstract

A continuous monitoring of Black Carbon (BC) aerosols was carried over a high altitude station, Mahabaleshwar situated in the Western Ghats of India during monsoon period (June - September) 2016. The present study deals with diurnal and temporal variation, radiative forcing estimation, potential sources and scavenging efficiency due to rainfall by using ground based measurements using Aethalometer (AE-33) observations. The monthly mean of BC mass concentration was found to be high during June (0.428 $\mu g/m^3$) followed by July (0.319 $\mu g/m^3$), August (0.293 $\mu g/m^3$) and September (0.195 $\mu g/m^3$) respectively. Pre-existing BC in the atmosphere by way of local house hold burning and forest fires in nearby surroundings are probably the major causes for the presence of these BC aerosolseven in monsoon period. Negative correlation (r=-0.136) found between daily mean BC mass concentration and daily averaged rainfall (mm) indicating the scavenging phenomenon at high altitude station (mean total rainfall during JJAS-2016: 6665 mm). Optical Properties of Aerosols and Clouds (OPAC) and Santa Barbara SBDART radiative transfer model were run to estimate the ARF for composite aerosols for surface (SUF), atmosphere (ATM) and top of atmosphere (TOA). Presence of BC resulted in positive radiative forcing in the atmosphere leading to warming at ATM and negative radiative forcing in the atmosphere leading to cooling at TOA and SUF in the monsoon period. Strong negative radiative forcing was observed in SUF as compared to TOA, this clearly indicates the considerable influence of absorbing BC aerosols for inducing additional heat to lower atmosphere over high altitude station, Mahabaleshwar. Reasonable higher ATM forcing was observed during July (30.2 Wm^{-2}) followed by June (17.2 Wm^{-2}), August (15.6Wm^{-2}) and September (14.6Wm^{-2}). Identification of probable sources and hydrophobic nature of BC is also addressed in this study.

Keywords -High altitude station, BC aerosols, Scavenging ratio, Radiative forcing, heating rate and source apportionment.

Abstract ID - 209

Heavy Metal Characteristics, Enrichment and Assessment of the Health Risks Posed by Heavy Metals in PM2.5at Indo-Gangetic Site

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Abstract

The present study aims to investigate the concentrations, enrichment and human health risks posed by heavy metals (Cr, Mn, Ni, Cu, Zn, As, Cd, Pb, V and Fe) in $PM_{2.5}$. In this study, samples of $PM_{2.5}$ were collected at an urban site of Agra, India during May 2016 to April 2017. $PM_{2.5}$ samples were collected on 47 mm diameter quartz fiber filter using fine particulate dust sampler (APM 550, Envirotech) at a constant flow rate of 16.6 L min^{-1}. Heavy metals were quantified using Inductivity Coupled Plasma Optical Emission Spectrometry (ICP-OES) after acid digestion. The result indicated that the annual average mass concentrations of $PM_{2.5}$ was 111.26 µg m^{-3} which exceeded the annual average limit of 40 µg m^{-3} set by the National Ambient Air Quality Standards (NAAQS). The annual average concentrations of Cr, Mn, Ni, Cu, Zn, As, Cd, Pb, V, and Fe were 726.64, 118.85, 307.66, 81.85, 761.7, 4.02, 2.32, 1067.25, 5.88, and 1710.14 ng m^{-3}, respectively. Central Pollution Control Board,India (CPCB) establishes annual National Ambient Air Quality Standards only for Pb, As and Ni. These standards are 500, 6 and 20 ng m^{-3} for Pb, As and Ni, respectively. In the present study Pb and Ni concentration exceeded while As concentration was under the limit. Exceedance of Pb at the urban site may be due to mixing of residual Pb in soil and its resuspension in the air due to motor vehicles. Higher concentration of Ni is also a main issue of concern and residents can easily get exposed to it by inhalation. Enrichment factor (EF) was applied to assess the effect of human activity on the contamination of these metals. The result indicated that the EF values decreased in the following order: Pb > Cd > Zn > Cr > Ni > As > Cu > Mn > V > Fe. The metals Mn, V and Fe at the sampling site had EF values <10, and these metals can be considered as minimally enriched and to originate mainly from the wind-blown soil minerals. The metals Cu and As were moderately enriched ($10 < EF < 100$) and produce from vehicle emission, industrial activities such as smelting furnaces and coal combustion. The metals Cr, Ni, Zn, Cd and Pb had very high EF values (>100) and were considered greatly enriched, indicating that their sources were predominantly from anthropogenic activities such as steel smelting, fly ash from coal burning, waste incineration, contaminated soil and other particles reentering the atmosphere, and vehicle emissions. The carcinogenic risks of Ni, As, Cd, Pb and Vfor both children and adults were all lower than the accepted criterion of 10^{-4}, whereas the carcinogenic risks of Cr for children and adults were higher than 10^{-4}. The non-carcinogenic health risk of Mn and Ni because of $PM_{2.5}$ exposure for children and adults were higher than safe level of 1, whereas the non-carcinogenic risks of Cr, As, Cd and V for children and adults were lower than safe level of 1.

Keywords -Urban site, $PM_{2.5}$, Heavy metals, Enrichment factor, Health risk.

Abstract ID – 213

Microphysics of Warm Fog in Polluted Boundary Layer

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Abstract

The in-situ observations on microphysical properties of fog in the polluted boundary was carried out during Winter Fog Experiment (WiFEX) 2017-2018 at India Gandhi International Airport (IGIA), New Delhi, India, investigated. The key microphysical parameters like Droplet Size Distribution (DSD), fog droplet number concentration (Nc), effective radius (Er) and Liquid Water content (LWC) were investigated during the different phases of the fog life cycle. For some fog events, Nc and LWC values were found to be analogues to the values reported for the polluted cumulus cloud. The intense droplet growth due to water vapour condensation and droplet coagulation was found to lead to bimodal size distribution of fog droplets, along with dominances of smaller particles (3 – 7 μm) in all fog events. The high values of liquid water content and droplet number concentration of smaller effective radius are major factors in low visibility for prolong period. Parameter like LWC and droplet number concentration exhibit both linear as well as exponential relation with each other when they scale to medien volume diameter suggesting variable nature of the fog microphysical structure. Finally, we have developed and empirical relationship between considering Nc and LWC for visibility predication.

Abstract ID – 240

Study of Characteristics of ozone and other greenhouse gases with rain and localized sources in different seasons over various places ofIndia

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Theme: Aerosols, Atmospheric Chemistry and Weather/Climate

Abstract

Atmospheric particulates are known to be distributed non-uniformly in space with respect to time due to spatially localized sources and various mixing factors. This study aims at explicitly resolving the statistics of particle concentrationsto determine if and how concentration of various gases varies in nature due to rain and localized sources, which further helps to understand the variability in air pollution, soil pH andinstudying the rain chemistry. Preliminary study was done separately based on size such as PM10(10 μor less in diameter) and PM2.5 (2.5 μ or less in diameter).

Moreover, greenhouse gaseswere analyzed individually *viz.*Ozone, CO_2, NO_2, CO and SO_2. Variation in the hourly concentration of these gases have been studied statistically before and after rain events in the period 2012 to 2014 over Delhi, Nagpur, Pune, Trivendrum, Kodaikanal, in which local stations were individually considered to determine the effect of localized sources, so that Chemical Kinetics may be fit to analyse/ forecast the concentration of air-pollutants. Hourly rainfall data was collected from NDC, IMD and Aerosol data from Environmental Met. Division, IMD, which monitors air pollution levels through equipment supplied by ThermoFisher Scientific under SAFAR project.

To facilitate the study, t-test was performed along with analysis of fractional rate of change (ratio of change in concentration to initial concentration per unit time i.e. $(C_f - C_i) / (C_i * \Delta t)$,where$\Delta t$ is time taken to change the initial concentration (C_i)to final concentration (C_f). In each rain event, 2 time-series of concentration of gases, one before rain and another after commencement of rain were consideredfor the study of chemical kinetics to assess how significantly both time-series are different. Also, mean fractional rate of change was compared for greenhouse gases in different seasons.Some implications of the results are being discussed in the paper.It has been found that concentration of both PM10 and PM2.5 changed significantly after rain, which indicates washout of these matters. On an average, fall in the concentration of PM2.5 and PM10 is seenup to 45-47% with rainat 99.9% confidence level (Fig.1 shows an event of 30th May-2014).

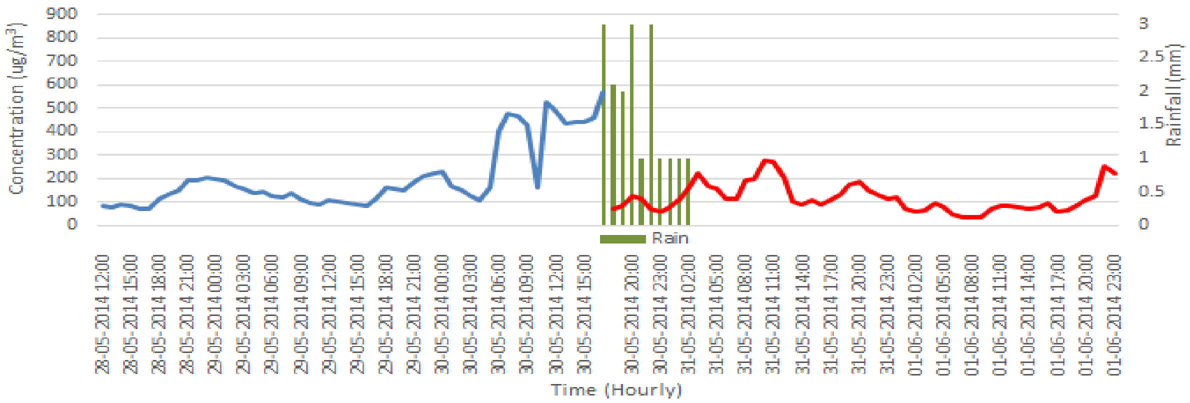

Fig. 1. Hourly concentration of PM2.5 before rain (---) and after commencement of rain(---)

Further, No significant change in hourly concentration of $O_3$was found during rain.Also,mean negative fractional rate of change was analyzed for CO_2, NO_2, CO and O_3 individually to determine the real time atmospheric-chemical kinetics i.e. disappearance characteristics of these gases due to rain, and magnitude of the same was foundto be 0.25-0.35 per hour for CO_2 and NO_2. But, it was very small for CO i.e. 0.05 per hour which clearly indicates its chemically neutral behavior with water. Interestingly, it was negative for ozone, which implied that ozone is formed during rainy period unlike others.However, formation of ozone is seen mainly in lightening events, which supports the phenomena of ozone formation by the chain reaction of hydroxyl ion and NO.

Keywords - PM10, PM2.5, Greenhouse gases, t-test, Fractional rate of change, Hydroxyl ion, SAFAR.

Abstract ID – 242

Aerosol-Cloud-Interactions over the Indo Gangetic Plains: Dominant role of semi-direct effect

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Abstract

Anthropogenic activities have been shown to have significant effect on weather and hence climate. However, discerning them from various observations over certain region including India has been a challenge due to large role played by natural variability. Using multiple groundand space based observations, we show that anthropogenic signals in terms of sub-weekly scale is quite significant (of the order of 20%) in aerosol loading over the Indo-Gangetic Plains. Satellite retrieved cloud macro physical properties, viz., Cloud Optical Depth (COD), Cloud Top Pressure (CTP), Cloud Top Temperature (CTT), Liquid Water Path (LWP) and Cloud Fraction (CF) varies accordingly. These changes are such that high aerosol loading periods are characterized by optically thinner (lower COD) and wider (increased CF) clouds with warmer cloud tops (increased CTT & CTP). In addition, we observe reflectivity (calculated usingClouds and theEarth's Radiant Energy System (CERES) Shortwave radiation flux) of the cloud is less as compared to cleaner days. These changes are also accompanied with increased atmospheric warming (~2 Wm^{-2}) due to aerosol shortwave Direct Radiative Effect (DRE). Overall, we find that increased aerosol loading leads to thinner clouds mostly because of semi-direct effect. Which is further confirmed by observed reduction (~10-15 %) in shortwave and long-wave Cloud Radiative Effects (CRE) estimated using CERES derived fluxes. Our study reveals that these short period's variability in large scale radiative fluxes have potential to modulate regional weather and hence climate.

Abstract ID – 251

Variability and properties of tropospheric aerosol over asemi urban costal station Chennai

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Abstract

The quantitative estimation of vertical distribution of aerosol extinction coefficients, aerosol optical depth (AOD), source and thetypes of aerosol present at different altitude were studied using ground based Micro pulse lidar (MPL) and space based Cloud Aerosol Lidar and Infrared Pathfinder Satellite (CALIPSO) lidar during Jan 2016 to July 2018. The vertical distributions of tropospheric aerosol exhibits large seasonal variability.The value of aerosol extinction is higher at surface during winter and post monsoon season and higher between 1.5 km-2.5 km during monsoon and it elevated from surface to 5 km during premonsoon season. The mean extinction coefficient varies between $0.05\, km^{-1} to\, 0.25\, km^{-1}$ throughout the study period.Similarly, the Aerosol optical depth (AOD) also exhibits pronounced seasonal variability with higher values during premonsoon and postmonsoon season.We used to CALIPSO Vertical Feature mask (VFM) data and Hybrid single particle Lagriangian Integrated Trajectory model (HYSPLIT) for identify the source and trajectory path of aerosol.Finally we present the vertical distributions of source and type of aerosol over this station. It found that there are 6 different kind of aerosol present over this region namely as dust, polluted dust, polluted continental, clear marine, clear continental and smoke. The dust and marine aerosol are observed as the major dominant aerosol in premonsoon and monsoon season whereas during winter and post monsoon the polluted continental and polluted dust are found as major aerosol type over this region.

Keywords -Micro Pulse Lidar, vertical aerosol distribution, Semi urban costal environment, CALIPSO.

Abstract ID – 270

Overview of microphysical, chemical and thermodynamical properties of fog and its forecasting using NWP model: Results from the WIFEX 2015-18

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Abstract

By considering the national interests and key research issues it is important to consider how future research on fog modeling and forecasting will be organized so that it will most effectively address the issues that are important for public services in India. Therefore, Ministry of Earth Sciences (MoES), Government of India (GoI) has taken a multi-institutional lead in understanding broad aspects of winter-time haze and fog formation over northern regions of India, and for developing a suitable fog forecasting system that has relevance to all sectors and policy issues. The WIFEX project was designed to study the characteristics and variability of fog events and improve understanding some of the key questions on fog formation and dispersion. From a numerical modeling point of view the project was designed to improve understanding of the key parameters needed for physical parameterization of fog to improveit's prediction. This paper will present the brief overview of microphysical, chemical and thermodynamical properties of fog from the measurements carried out in Delhi under the WiFEX campaign followed by evaluation of fog forecast demonstrated using the IITM-WRF product. Finally, challenges in visibility forecasting for airport will be discussed.

Abstract ID – 282

Estimates of column Integrated Precipitable Water Vapor from a Network of Ground-Based GNSS Receivers over Indian Subcontinent and Validation with Retrievals of TotalPrecipitable Water Vapor from INSAT-3DR Sounder

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Themes: Aerosols, Atmospheric Chemistry and Weather/Climate.

Abstract

Water Vapour is an important green house atmospheric gas. The concentration of water vapour in the atmosphere is highly variable both spatial and temporal. Conventional in situ measurements of atmospheric water vapour is provided by Radiosonde humidity sensors profile twice a day at 0000 and 1200 UTC mainly from limited land regions. In recent years India Meteorological Department (IMD) computing Precipitable water vapour from INSAT-3DR 19 channel sounder in three layers i.e. 1000hPa-900 hPa, 900-700 hPa, and 700-300 hPa and total Precipitable water vapour in the vertical column of atmosphere stretching from surface to about 100 hPa during cloud free condition. These data were most commonly were validated using spatially and temporally Collocated Radiosonde measurements. In this paper INSAT-3DR satellite retrieved TPW data were validated with column-integrated Precipitable water (IPWV) vapour estimates from a network of ground-based GNSS (Global Navigational Satellite System) receivers in near real time which IMD recently commissioned. Good agreement has been realized between GNSS derived IPWV and from INSAT3-DR sounder under cloud free condition. However the correlation coefficient (R) ranging from 0.8 to 0.9 and root-mean-square (rmse) differences of 5 to 6 mm. In the present work we have shown the real-time computation of GNSS IPWV and its comparison with INSAT-3DR sounder derived TPW.

Key words -GNSS, IPWV, TPWV.

Abstract ID – 284

Role of meteorology in controlling VOCs in megacity Delhi during a winter month

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Abstract

As part of NERC-MoES project APHH (Atmospheric Pollution and Human Health), a winter campaign is organized in Delhi during Nov'2017 to February'2018. Continuous monitoring of 17 VOCs (Volatile organic compounds) was made at 10m using state of the art Proton Transfer Reaction Mass Spectrometer (PTR-QMS 500 model) was deployed in the greener areas in central Delhi (Lodhi Road) to measure VOCs for the period: 1st Dec. 2017-31st Dec 2017. Sensors for temperature, humidity were also employed at the site. Few episodes were observed when VOCs and other chemical species like black carbon show high values. Sonic anemometer data for wind is used inthis analysis. Meteorological variables e.g. wind, temperature and humidity etc. were analysed in this study for the abovementioned period. We found that VOCs varies exponentially with wind speed. Highest mixing ratios of VOCs were observed when wind direction was from 180-215 degrees (South-West) and BLH is less than 100m. High concentrations of VOCs are observed during morning hours when RH was 70-90 %. Oxygenated VOCs like Acetaldehyde and Acetone show different dependence on RH than other VOCS.

Abstract ID – 289

Role of atmospheric Black Carbon Aerosols at a High Altitude location in Southern India

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Abstract

Black carbon (BC) aerosol, emitted during the incomplete combustion of fossil fuel and biomass sources, was continuously measured at Kodaikanal(10°14’N, 77°29’E, 2330 m above msl) for a period from January 2016 to December 2016, using a multi wavelength Aethalometer (AE-31 model).Diurnal and seasonalvariations were examined based on the meteorological parameters and different source characteristics. The diurnal variation of BC had two peaks during the entire study period. Morning sharp peak was the first one that occurred between 06:00 and 09:00 hours (LT) almost an hour after the local sunrise due to fumigation and the afternoonbroad peak that occurred between 13:00 to 17:00 hours (LT). The mean seasonal values of BC were 2.67 ±2.34 μgm^{-3}, 2.01±0.46μgm^{-3}, 0.90±0.03$\mu gm^{-3}$and 3.20±0.58μgm^{-3}during winter, summer, monsoon and post monsoon seasons, respectively. The observed strong seasonal concentrations were due to local and regional sources along with the boundary layer dynamics. NE wind brings large amount of BC concentrations compared to that of the other wind direction towards the experimental site. Source identification was carried out by calculating absorption angstrom exponent (α)at Madurai. The α values ranged from 0.40 to 1.90 with an average value of 1.41 indicating that the major sources of BC in the study location are from biomass burning sources.

Key words -Black carbon, Aethalometer, Absorption Angstrom exponent, Biomass, Boundary layer dynamics.

Abstract ID – 291

Performance of MODIS collection 6.1 (C6.1) aerosol retrieval algorithms over South Asia

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Abstract

In this study, the latest version of MODIS aerosol retrieval algorithms collection 6.1 AOD products has been evaluated against AERONET AOD obtained from 15 sites across South Asia from 2006 to 2016. Dark Target (DT) and Deep Blue (DB) algorithms evaluated in terms of AOD retrieval falling within the DT expected error (EE) envelop (1σ) (0.05 ± 0.15*AOD), root mean square error (RMSE), and relative mean bias (RMB). Over South Asia, DT showed higher retrieval accuracy than DB algorithm in term of EE, RMSE and RMB, DB showed a significant underestimation of AOD especially over a dry region which is dominated by coarse mode aerosol type. The retrieval accuracy of two algorithms temporally evaluated between the seasons, both DT and DB algorithms showed higher uncertainty in AOD retrieval during monsoon season while with higher dissimilarity between the algorithms observed in the same season. The lower accuracy in AOD retrieval during monsoon is attributed to the uncertainty in the estimation of aerosol optical and microphysical properties of the hygroscopic aerosol particles by the retrieval algorithms. DT overestimated AOD in contrast to DB which significantly underestimated the AOD. In term of aerosol retrieval accuracy for different aerosol types, both DT and DB algorithms showed high accuracy in AOD retrieval for fine mode aerosol types and the accuracy of retrieval decrease with increasing the coarser particles in the atmosphere. DT showed higher accuracy over dark vegetated region compare to urban and bright surface region which overestimated AOD due to underestimation of the surface reflectance. The results suggest that the latest version collection 6.1 aerosol retrieval algorithm comparatively showed higher accuracy compared to collection 6 over the highly aerosol polluted of south Asia.

Abstract ID – 292

Spatio-temporal changes in atmospheric aerosol during diwali over India

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Theme :Aerosols, Atmospheric Chemistry and Weather/Climate.

Abstract

Diwali, one of the most celebrated festival all over in India. With the help of satellite data, integrated with the ground data, a detailed study has been prepared to investigate the impact of Diwali event due on atmospheric aerosol. The Aerosol Optical Depth (AOD) increase suddenly during this event but at the same time,Absorption AOD (AAOD) find to be decreased dramatically. Although, AOD decrease during post-Diwali period but that is still higher than pre-Diwali period. The multi fold rise in Single Scattering Albedo (SSA) is mainly due to increase in concentration of larger size of aerosols as similarly observed by increasing trend of Aerosol Exponent (AE) during as well as after this event too. The changes in aerosol properties lead to changes in several atmospheric phenomena. Mention worthy, the PM10 and PM2.5 found to be increased multi-fold all over the country, the northern India followed by the eastern, central and western India are bitterly experienced with this sudden rise in PM concentration while the southern India the rise in PM concentration is relatively lesser than other parts of country. As a result, the diurnal variation of temperature, majorly the minimum temperature is observed to be drastically changed during and after the Diwali event.During post monsoon season when the Diwali is celebrated, the average Planetary Boundary Layer Height (PBLH) across the country is less than 2.5 km. which much lesser than the annual average PBLH over India. It is important because the burned gases with emerged Particulate Matter (PM) are bound to suspend in lower altitude in troposphere, therefore, it cause a high chance of severe air pollution that may result in to many casualties from children to old and regular effects on human health.Therefore, burning of crackers during Diwali results a significant change in atmospheric aerosol as far as the air pollution is concern.

Keywords -AOD, PM10, PM2.5, SSA, Diwali, Pollution, Human health, Air temperature.

Abstract ID – 296

Two Decades of Aerosol Observations in the UTLS region as observed with a Ground-based Mie Lidar at Gadanki

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Theme:Aerosols, Atmospheric Chemistry, Weather/Climate.

Abstract

Presence of aerosols in the Upper Troposphere Lower Stratosphere (UTLS) region leads to long-term climate implications and uncertainty in the radiative forcing. The Asian Tropopause Aerosol Layer (ATAL) was detected with the CALIPSO observations extending vertically between 13 and 18 km in the region covering the Eastern Mediterranean to Western China confined to the Asian anticyclone. Aerosols pumped into the stratosphere may affect climate significantly by scattering sunlight back to space and absorbing radiation locally. As there exist no long-term ground-based vertical measurements covering the UTLS region, sources and pathways for the occurrence of ATAL during June-August period is still not clear. In this context, two decades (1998-2017) of Mie Lidar observations at Gadanki are used to examine the vertical distribution of aerosol extinction in the UTLS region. Another aspect of concern is the frequent occurrence of cirrus clouds. So, it is very important to segregate the cloud-free and cloudy profiles with the identification of cloud boundaries. The details of our developed inversion algorithm using the multiple approaches to derive the profiles of aerosol/cloud (cirrus) extinction coefficient, backscatter ratio, and linear depolarization will be presented. The ground-based Mie Lidar and CALIPSO-derived aerosol extinction profiles in the UTLS region are validated to understand the consistency between them. More detailed results on the long-term trends in the variability of aerosol extinction will be presented in the context of understanding the climate implications due to ATAL.

Abstract ID – 309

Case study of rainfall enhancement through cloud seeding

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Abstract

The State of Karnataka in Southern India falls in the rain shadow region and is highly prone to occurrence of drought conditions. The monsoon rainfall is highly variable and drought conditions are experiences in many parts of the State once in two to three years. Most of the monsoon rainfall occurs in the months of July and August with few rainy days in the north east monsoon season. With most of the agriculture being rain-fed,the impact of deficient rainfall is very high. Most of Karnataka is in the rain shadow region due to being in the leeward side of the western ghats mountain range. This leads to large amount of clouding over Karnataka with potential or sub critical potential for rainfall. In the year 2017, the monsoon rainfall continued to be highly deficient till third week of August leading a spectre of drought conditions on most parts of the State. This led to Government deciding to take up cloud seeding operations as a means to induce rains where potential clouds existed. The exercise was taken up to mitigateto some extend the adverse impact. The basic infrastructure for the cloud seeding operations consisted of installation of threeDoppler radars at the strategic locations viz., Bengaluru, Gadag and Shorapurso as to monitor clouds over the entire State on a continuous basis and provide opportunities for cloud seeding. The hourly INSAT satellite data provided cloud cover, cloud top temperature, cloud motion vector, potential water content. The observations were supported by Radiosonde equipment at Gadag, Bengaluru and Sholapur (closer to Shorapur). The model forecasts for the day issued by Indian Meteorological Department and Space Applications Centre, Indian Space Research Organisation using high resolution model runs was also utilized. All available weather observations were analysedto identify areas of favourable synoptic conditions for cloud convection and prepare a potential area chart indicating areas for cloud seeding based on antecedent rainfall, cloud convection, synoptic situation and current radar observations. Two cloud seeding aircrafts (Beach aircraft King Air 200) with cloud seeding equipment operated to seed clouds based on the advisory. The final decision to seed a cloud system was taken by expert crew based on the aircraft observations of temperature, liquid water content and updraft winds. The dense network of over 6000 automatic and telemetric rainguagesin the State set up by Karnataka State Disaster Management Centre was utilized to analyse the impact of the cloud seeding operations on a day to day basis. The Cloud seeding operations started in mid August and was completed by 10 November2017 totaling nearly 300 hours of flying. Based on the availability of clouds and types of cloud liquid water content, both Hygroscopic and Glaciogenic seeding was carried out. Evaluation of the seeding program was carried out by two ways viz., Physical and Statistical. Radar data is used for the physical evaluation of the seeding effects. The parameters of seeded clouds (target clouds) are compared with the unseeded clouds (control clouds) to estimate the impact of seeding. The results from several case studies are presented in the paper. The quantitative results indicate positive impact of cloud seeding leading to 10-15 % increase in rainfall and improved geographical spread. The cloud seeding carried out in a controlled and systematic basis can emerge as a viable support to recurrent drought hit areas.

Key words -Cloud, Seeding, Convection, Satellite, Drought, Rainfall, Rainguage, Radar, Weather Model, Evaluation.

Abstract ID – 316

Impact of Forest Fire on Black Carbon Concentration and Tropospheric NO2 Over North Eastern Region of India

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Theme: Aerosols, Atmospheric Chemistry and Weather/Climate.

Abstract

Forest fires are one of the principal sources of air pollution. Smoke from forest fire is a mixture of gases and fine particles from biomass burning. They can have significant impacts on local air quality, visibility and human health. Emissions from forest fires can travel large distances, affecting air quality and human health far from the source. These emissions include: particulate matter, carbon monoxide, atmospheric mercury, ozone-forming chemicals, Nitrogen Oxides (NO_x) and volatile organic compounds. The impact of forest fire on air quality is investigated over the North-Eastern region of India, study domain: 20˚N-30˚N and 88˚E-98˚E. It is observed that the region has experienced more than 1 Lakh active fires in a year with a maximum in the months of March/April about 60,000 fire points. In this study active fire data with a minimum 50% confidence level from MODIS, surface mass concentration (kg/m^3) of Black Carbon (BC) at 0.5˚×0.625˚ resolution from MERRA-2, tropospheric columnar NO2 from AURA-OMI at a resolution of 0.25˚, and wind vector from MERRA at 0.5˚×0.625˚ resolution has been used from 2006 to 2017. Results show that there is significant correlation between fire counts, BC concentration and tropospheric NO_2 in the months of March and April. MODIS active fire map showed higher density of fire counts over the Indo-Myanmar bordering areas, and the Meghalaya plateau region. Similarly high BC concentration has been observed in the same month over the places except the Meghalaya plateau. This inverse spatial correlation between fire count and BC concentration over the Meghalaya plateau can be attributed to the synoptic wind patterns, which show a strong westerly wind over the Meghalaya plateau. This leads to a wash out of the BC concentration towards the Indo-Myanmar hills range making for a high concentration of BC over the Indo-Myanmar region but not over Meghalaya.

Abstract ID – 321

Vertical structure of optical and radiative effects of aerosols across the IGP: East - West contrast and seasonality

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Theme: Aerosols, Atmospheric Chemistry and Weather/Climate

Abstract

With a view to understanding the vertical distribution of aerosols and estimating the radiative impacts of elevated aerosols in the lower free troposphere, extensive profiling of the vertical variation of the optical properties, namely the extinction/ scattering and absorption coefficients (respectively σ_{ext} / σ_{scat} / σ_{abs}) have been carried out from three base stations in the Indo-Gangetic Plain (IGP) using an instrumented aircraft, prior to onset of the Indian Summer Monsoon. These stations represented the semiarid western IGP (Jodhpur, JDR), the anthropogenically affected central IGP (Varanasi, VNS), and the industrialized coastal location in the eastern end of the IGP, close to the northern Bay of Bengal (Bhubaneswar, BBR). The vertical profiles of the optical properties differed significantly across these locations and this resulted in a regionally significant heating rate gradient. While the integrated (ground to 3 km altitude) scattering coefficient remained quite comparable across the IGP, the highest absorption coefficient and hence the lowest single scattering albedo (SSA) occurred in the central IGP (Varanasi). The heterogeneous altitudinal SSA stresses the need for region-specific, altitude resolved values of SSA and estimate layer-by-layer forcing and heating rates for more accurate climate impact assessment. Size distribution, inferred from the spectral variation of the scattering coefficient, showed a gradual shift from coarse particle dominance in the western IGP to strong accumulation dominance in the eastern coast, with the central IGP coming in-between. Source speciation of aerosol, using spectral aerosol properties, revealed aerosol system in the west IGP is predominantly natural (dust and sea-salt) and that in the east IGP is highly anthropogenic type (industrial emissions, fossil fuel and biomass combustion).The central IGP exhibited a mixture of both. Atmospheric heating rate profiles with layer resolved SSA and column averaged SSA differed significantly for highly absorbing/scattering aerosol layers. While usage of column average SSA underestimated the heating for highly absorbing aerosol layers it overestimated for scattering aerosol layers.

Keywords -Aerosols, Aircraft, Indo-Gangetic Plain, Vertical profile, Heating, Radiative forcing

Abstract ID – 334

Characteristics of rainfall over a Western Ghats station during 2015 Monsoon season

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Theme:Aerosols, Atmospheric Chemistry and Weather/Climate.

Abstract

The characteristics of the rainfall (orographic and convective) over Mahabaleshwar (MBL), a Western Ghat hill station in India has been studied. The study is presented in two parts. First part verifies the performance of orographic and convective models of rainfall whereas in the second part the variability of rainfall over the site is discussed along with its probable reasons. The site being on the wind ward side of Western Ghat receives it's maximum rainfall due to orography but it will be interesting to examine the contribution of convective rainfall to the total rainfall over the station.It is observed that the station does not receive continuously high rainfall but experiences lull periods also in the monsoon season. The 3-D dynamical model and convective precipitation model are used for estimating orographic and convective rainfall over MBL. For the estimation of orographic rainfall using a 3-D dynamical model, high resolution (0.125° × 0.125°) ECMWF reanalysis data is used whereas in situ radiosonde data over MBL and the ECMWF reanalysis data is used to estimate the convective rainfall. The estimated rainfall using the 3-D dynamical orographic model matches qualitatively very well with the pattern of daily observed rainfall but vary in the magnitude. This estimated rainfall captured the daily variations in the rainfall during the study period. However, the rainfall estimated using convective model shows a lot of difference in the pattern and magnitude when compared to the observed rainfall.It is seen that the synoptic scale systems haveimmense effect on the rainfall over the station. The study of the aerosols and the observed rainfall over MBLreveals that they are significantly correlated with each other. The vertical depth of the westerlies with sufficient moisture over the station have profoundly affected the station's rainfall.

Abstract ID – 341

Long-term assessment of air pollutants at Delhi in the Indo-Gangetic Basin

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Abstract

Many Indian cities, especially those over the Indo-Gangetic Basin (IGB), are amongst the most polluted cities in the world. New Delhi,an urban megacity situated at the north-westIGB in northern India, suffers from the intense pressure of urbanization, industrialization and dense population. These potential factors have caused sequential degradation of ambient air quality over the station, which has received much attention in recent years as it posedpotential health hazards. Additionally, high pollutants also lead to urban and regional haze, deleterious impacts on regional ecosystem, crop yield and climate change. Thus, the precautionary measures are needed to chase the mitigation policy and manage current emissions of air pollutants.

In views of the above, long-term (2005-2012)assessment of near-surface air pollutants has been carried outat New Delhi.Despite of the past efforts, such as cutting down the sulfur content in diesel/petrol, use of clean fuels (CNG/LPG), and shutdown the hazardous industries, the annual average levelsof nitrogen dioxide (NO_2), particulate matter less than 10 µm(PM_{10}), and suspended particulate matter (SPM) were found to be persisted at their alarming levels (62±28, 254±134and530±213 μgm^{-3}, respectively) during the study period. However, the annual average level of sulphur dioxide (SO_2: 13±8μgm^{-3}) has been controlled significantly, which could be attributed due to the above efforts. The 24-hour mean mass concentrations of NO_2, PM_{10} and SPM were exceededon ~27%, 87% and 98% days that of total available measurement daysto their respective National Ambient Air Quality Standard (NAAQS) levels. However, it never exceeded for SO_2. The annual concentrations of NO_2, PM_{10} and SPM showed an increasing trend while SO_2 appears to be decreasing post the year 2008. These air pollutants were found to be highest during the winter/post-monsoon period, which are of concern for both climate and health. The air mass back-trajectory analyses showed that the highest air pollutant concentrations over the station are associated with the North-Northwest trajectories; however, lowest concentrations are associated with the Southeast trajectories.

Abstract ID – 350

Airs retrieved co2 over Indian region : Contrast behaviour of land and ocean

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Abstract

The present study shows spatio-temporal variability in carbon dioxide (CO_2) in the midtroposphericregion over India (0-32N, 60-100E) during 2003-2016. CO_2 data used in the studyis retrieved from Atmospheric Infra-Red Sounder (AIRS). Analysis of 14 years of data showsthat the CO_2 exhibits a linear increasing trend of 2.01 ppm/year. Besides displaying the linearincreasing trend, data show strong seasonal and annual variability. Concentration of CO_2 isobserved to be highest around April-May (summer months), which decreases by 4-5 ppm duringthe monsoon months. Seasonal decrease in CO_2 concentration appeared to be influenced bythe monsoonal activity. Low OLR (proxy of convection) associated with high rainfall duringsummer monsoon via increasing vegetation index (NDVI) appears to be the primary cause forthe seasonal decrease in CO_2 through photosynthesis. Correlation coefficient between Co_2 andNDVI is of the order of -0.90 suggesting vegetation as a seasonal sink of Co_2. Decrease in Co_2concentration takes place at a delay of 2-3 months of rainfall. However, convection seems tobe another component, which causes uplifting of Co_2 during dry summer (April-May) makinghigh concentration in the mid troposphere as shown by increase in the planetary boundary layer(PBL) height in this period. Eastward propagating intra-seasonal oscillations with period 30-40days in OLR anomalies are found to modulate (with a fluctuation of 1-2 ppm) mid-troposphericCO_2. Analysis of seasonal anomalies in CO_2 over four different regions (Northern, Southern,Western and Eastern) of India is also being investigated. The regional variability of CO_2 innorthern region show marginal larger values suggesting more anthropogenic activities especiallyduring late winter.

Abstract ID – 404

Distribution of different aerodynamic size particle in winter season

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Abstract

Aerodynamic diameter is a very significant parameter in study of aerosols because many characteristics of the particles depend upon it. Current study was carried over Ranichauri (a remote location in Himalayan forest region of north India) to investigate the distribution of different aerodynamic size particle during winter season. Data from Aerodynamic Particle Sizer (APS) installed at Ranichauri was collected for December, January, February and March months. The APS sizes particles in the range from 0.5 to 20 micrometers using a sophisticated time-of-flight technique that measures aerodynamic diameter in real time.Number size distribution shows more concentration of fine particles than the coarse particle with an order of 1000 times of 0.5 µm particles comapred to 2.5 µm and 100 times of 2.5 µm particles compared to 10 µm. Aerodynamic size of 10µm, 2.5 µm and 1 µm sized particles are analysed to determine the size distribution of aerosols during winter. Diurnal pattern of size distribution was also studied. Higher number concentration was observed during evening hours. Number concentration increases with the decrease in the Aerodynamic size.

Key words -Aerodynamic size distribution.

Abstract ID – 405

Spatio-temporal variability of columnar water isotope ratios using SCIAMACHY data

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Abstract

Study of isotopic composition of atmospheric water vapor can provide unique constraints on how water is transported, mixed and changes phase in the atmosphere. It also provides useful tool for understanding various aspects of the hydrological cycle. SCanning Imaging Absorption Spectrometer for Atmospheric CHartographY (SCIAMACHY) onboard ENVISAT-1 was a spectrometer designed to measure composition of trace gases in troposphere and stratosphere. It provided global measurements of total columnar HDO and H_2O concentrations using the spectral window between 2338.5-2382.5 nm. We used SCIAMACHY L2 data of these columnar concentrations to compute monthly columnar δD for the period 2003 to 2011 at 2°x 2° spatial resolution. Individual observations were filtered using a quality control criteria Valid observations across all individual orbits within a month were obtained and corresponding columnar concentrations of HDO and H_2O were binned onto 2°x2° grids and monthly global δD maps were generated. The global images show increased HDO concentrations in the Inter-Tropical Convergence Zone (ITCZ) and the latitude effect of isotope variability is quite prominent. Inter-annual mean monthly columnar-δD over Indian mainland ranged from -101 ‰ (March) to -183 ‰ (December). Similarly, columnar- δD over Bay of Bengal varied from -132 ‰ (May) to -232 ‰ (December). These variations have periodic nature across all years and show a decrease in monsoon months of July-September owing to mixing of depleted evaporate arriving from sea. In this paper, we report the spatial variability of δD across the globe and discuss the temporal fluctuations in concentrations of stable water isotopes over India and the adjoining seas.

Keywords -Water Isotopes, Hdo, Sciamachy, Water Vapor, Trace Gas.

Abstract ID – 406

Study of Total Columnar Ozone over India using Aura Satellite Data during 1998 – 2018

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Abstract

A study of variations in Total Columnar Ozone (TCO) levels has been made for 64 cities over India that are located in different climatic and geographical regions in India during the period 1998 - 2018. Data monitored by NASA's AIIRS satellite (MERRA-2 model products) for the 20 years have been used in this study. The locations of stations have been selected in such a way that the study area covers entire Indian region and provides the understanding of TCO variations w.r.t. different latitudes as well as longitudes. The main objective of the study is to analyze the latitudinal variation of TCO at 2^0 as well as 5^0 intervals. The study includes inter-comparison of TCO at Northern Indian stations vs. Southern India; west coast vs. east coast, desert of Thar vs. North-Eastern region and Northern Himalayan region vs. Indo-Gangetic Plane. Analysis of TCO concentrations for the cities located at nearly same latitude and different longitudes have also been done.TCO concentrations for island stations Portblair and Amini,have also been analyzed for the period October 2004 – 2011 using the satellite data recorded by the Aura spacecraft using Ozone Monitoring Instrument (OMI) instrument. Total column Ozone data of these island stations have also been compared with total column Ozone of two inland stations located in peninsular India i.e. Kodaikanal and Chennai. Higher TCO concentration at the stations located in the northern parts of India have been observed in comparison to southern parts of India. TCO concentrations do not show any significant variation with change in longitudes. Monthly averaged TCO concentration shows highest values in pre-monsoon season (March) in north India (320 DU) and lowest concentration as 235 DU in southern parts of India during winter season (January) for the study period 1998 – 2018 with a distinct increase in TCO concentrations for the stations located above 15^0 latitude.

Keywords -Total Columnar Ozone (TCO), Indo-Gangetic Plane, Latitudinal variation and Satellite data.

Abstract ID – 408

Characterization of PM2.5 constituents during Winter Fog Experiment at Indira Gandhi International Airport, Delhi

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Abstract

Data on the concentration of carbonaceous aerosols and water soluble chemical ions constituting $PM_{2.5}$ at Indira Gandhi International Airport, Delhi were compiled through sampling of $PM_{2.5}$ during 16 December 2015-15 February 2016 under Winter Fog Experiment (WIFEX) program of the Ministry of Earth Sciences (MoES) and analysing the samples. The data so generated were interpreted in terms of their variation on different time scales, apportioning their sources and their implications in the development of fog over the region.

It is found that average mass concentration of organic carbon (OC) and elemental carbon (EC) was 24.6±9.3 and 11.6±4.6 $\mu g/m^3$ respectively with no any trend of increase or decrease over the observational period. SO_4^{2-}, Cl^- and NO_3^- dominated over other anions with their overall average concentration 33.5±20.9, 32.5±16.4 and 12.7±8.2 $\mu g/m^3$ respectively. Among cations, NH_4^+ showed highest concentration with an average value of 21.0±10.8 $\mu g/m^3$. Also, it appeared to be dominant neutralizer of the acidic components of $PM_{2.5}$ followed by Ca^{2+}, H^+ and Mg^{2+}.

Variation of daily average mass concentration of these parameters over the period of observation matches well with the variation of $PM_{2.5}$ mass concentration indicating thereby to be the major contributors to the $PM_{2.5}$ mass. NH_4^+ mostly occurred as NH_4Cl and NH_4NO_3 and poorly as $(NH_4)_2SO_4$ or NH_4HSO_4. H^+ ion mostly occurred as H_2SO_4 and occasionally as HNO_3. These component molecules were crucial in the development of fog over the region. Carbonaceous aerosols, SO_4^{2-} and NO_3^- were mainly generated from fossil-fuel combustion, whereas anthropogenic Cl^- was mostly generated by biomass burning. A small contribution of Cl^- may be expected from bleaching activity in the export garment factories and burning of disposed off materials in the landfill areas.

Abstract ID – 433

Spatial and Seasonal Variations of Trends in Aerosol Optical Properties over an Industrial State - Gujarat

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Abstract

Atmospheric aerosols have been recognized as an important climate forcing agent and play a crucial role in regional and global climate change. They affect climate directly by scattering and absorbing both incoming solar radiation and outgoing terrestrial radiation and indirectly by modifying cloud properties. The climate effect of aerosols is determined by their optical properties. So, changes in these properties will alter the radiative forcing by aerosols. Gujarat State falls under arid/semiarid climate with desert conditions over northern parts and maritime conditions over western part. The economy of the state very much depends on industry. Gujarat state is a home for number textile and pharmaceutical companies, ports and refineries. The high rate of industrialization, extensive urbanization and exponential increase in traffic have caused deterioration of air quality to a larger extent and the environmental pollution has become a major challenge for the state. Major festivals like Diwali and Navratri are also found to influence the aerosol characteristics over the state. The state has taken lot of initiative to reduce the pollution such as introduction of BRTS in number of cities, promoting LPG in vehicles, supporting solar power generation etc. Aerosol conditions over Gujarat are getting modulated by inflow of naturally produced dust particles from Arabian region during pre-monsoon period and inflow of polluted air generated by crop residual burning from north during post monsoon period. In this context the spatial and seasonal variations of trends in aerosol optical properties such as Aerosol Optical Depth (AOD), Angstrom Exponent (AE), Absorption Aerosol Optical Depth (AAOD), Absorption Angstrom Exponent (AAE) and Absorption Aerosol Index (AAI) over Gujarat have been analysed using MODIS and OMI data for the period 2002 to 2018. Four different geographic locations of 1o*1o namely Kutch region, Saurashtra region, N. Gujarat region and S. Gujarat region have been selected for the spatial analysis. Seasonal trends over these regions has been analysed for winter, pre-monsoon and post-monsoon periods. Two statistical methods namely the linear least-squares fitting and Mann–Kendall test have been employed to detect and estimate the trend. Results of analysis have been presented with number of figures and table. This type of trend information will be useful for policy makers in improving the air quality and for scientists for understanding in changes in aerosol forcing and their impact on regional climate.

Keywords -Trends in aerosol optical properties, Aerosol optical depth, Angstrom exponent, Absorption aerosol optical depth, Absorption Angstrom exponent, Absorption aerosol index.

Abstract ID – 441

Nature and sources of ionic species in rain water at an urban site, New Delhi over the Indo-Gangetic Basin

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Abstract

We studied rain water chemistry in Delhi, an urban mega city over the Indo-Gangetic Basin (IGB) during the southwest monsoon season of 2009-10. The rainwater samples were analyzed for major anions, cations along with pH and conductivity. Based on pH measurements, about 28% and 14% rain events over Delhi were found to be acidic (pH< 5.6) in 2009 and 2010, respectively. The mean pH of rainwater was found to be alkaline in nature with an average value of 6.15 in 2009 and 6.35 in 2010. The alkaline components (Ca, Mg, Na, K and NH4) contribute ~59% of the total ion mass of measured values during the entire study period. Whereas, the contribution of the acidic components (SO4, Cl, F, NO3 and HCO3) is observed about 41% in 2009 and 37% in 2010. The average conductivity in year 2009 (40.3 µS cm-1) was observed higher than that of year 2010 (30.5 µS cm-1). Further, on the basis of average concentration, the ionic abundance in rain water showed the general trend as Ca2+> Mg2+> SO42-> HCO3-> NO3-> Cl-> NH4+> Na+> F-> K+> H+ in 2009 whereas in 2010 the trend was Ca2+> SO42-> Mg2+> NH4+> NO3-> Cl-> HCO3-> Na+> F-> K+> H+. It was noticed that Ca2+, Mg2+ and SO42- were the dominant ions in Delhi's rainwater during the study period. The weighted mean concentrations of these ions were about 163, 89 and 86 µeq/l in 2009, and about 119, 61 and 79 µeq/l in 2010, respectively. The calcium ion makes the highest contribution to the total mass of the ions due to soil dust. It accounts 32% of the total ionic mass and approximately 54% of total mass of measured cations in 2009 and 28% of the total ionic mass and approximately 48% of total mass of measured cations in 2010. The concentration of Ca2+ was minimum in 2009 where acidic rain was reported (pH=5.4). However, the concentration of Ca2+ was maximum in 2010 where rain was reported to be alkaline (pH=7.1). Sulphate concentration was varied between 26.4 and 211.6 µeq/l in 2009 and 14.7 to 374.1 µeq/l in 2010. Average concentration of SO42- in 2009 was relatively higher (86.4 µeq/l) than the concentration reported in 2010 (79.1 µeq/l). Mg2+ varied between 2.0 and 295.8 µeq/l in 2009;13.8 and 210.6 µeq/l in 2010. Other ionic species in rain water also show variability in the mass concentrations in two different years, which could be due to different emission sources, which have been identified with the air mass back trajectory analyses.

Abstract ID – 447

The Precipitation chemistry Study in Srinagar, a lower Himalayan region

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Abstract

The present study investigates the chemical composition of rainwater done for the Srinagar (Uttrakhand), a lower Himalayan region for the period - July to September in the year 2016 to understand the influence of local, regional and long range transport of pollutants. A total of 36 samples of rainwater were collected during study period and were analyzed for pH & major ionic species using Ion Chromatography (IC) method. Estimation was also done to find out the percentage (%) contribution of each ionic species out of total ionic mass deposited in rainwater. It was seen that almost 60% of samples were acidic in nature as their pH was below 5.6. The chemistry of precipitation reflects the quality of air emissions added to the atmosphere from either natural or anthropogenic sources and helps in evaluating the relative importance of different sources and estimating future possible acidification or buffering capacity. From the study it was also seen that the neutralization factors is less in that region due to lack of urban sprawl of megacity like Delhi. Rainwater directly or indirectly influences the livelihood & health of local people, especially in Himalayan regions.

The average concentration of major three ions observed were NH4+ (23.7 µeq/l), Ca2+ (20.22 µeq/l), Cl- (11.09 µeq/l). Further, on the basis of average concentration, the ionic abundance in rainwater samples analyzed during study showed the general trend as NH4+> Ca2+> Cl-> Na+> SO42-> NO3-> HCO3-> K+ > Mg2+= H+ The ammonium & calcium ion makes the highest contribution to the total mass of the ions due to microbial activities & soil dust respectively. The chemical composition shows that NH4+ was the major contributor (24.7%) among cations followed by Ca2+ (21%) whereas in anions Clcontributed (11.5%). The results of present study reveal presence of more cationic species in rainwater.

Abstract ID – 453

Do boundary layer pollutants reach UTLS during Indian Summer Monsoon over Indian region?

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Theme:Aerosols, Atmospheric Chemistry and Weather/ClimatePreference.

Abstract

The existence of elevated aerosol layer in the troposphere is common over India during monsoon season. Though its sources are well explained through long-range transport, its formation and maintenance is not explained to date. The formation and maintenances of an elevated aerosol layer in the tropopshere, starting from ~2 km and extending up to ~5.5 km noticed is explained using two nearby lidars located at Gadanki (13.5°N, 79.2°E) and S.V. University (13.6° N, 79.4°E), in peninsular India. Existence of a cleaner environment with low aerosol loading below 2 km is attributed to the wet scavenging and existence of no strong local source. The low level jet (LLJ) from Arabian Sea persisting between 2 and 3 km is the main mechanism suggesting strong role of dynamics in the formation of these elevated layers. Persistent strong shears existing between LLJ and tropical easterly jet during this season restrict the up-liftment of aerosols to the higher altitudes. However, prominent aerosol layer in the upper troposphere and lower stratosphere (UTLS) is being detected both in ground base lidar (Gadanki Lidar) and space based lidar (CALIPSO) observations. From the detailed analysis it is found that long-range transport through tropical easterly jet persisting over Indian region during Indian Summer Monsoon is responsible for the observed UTLS aerosol layer over Gadanki. Nevertheless the role of deep convection in the observed UTLS aerosol layers is expected from head Bay of Bengal region but not over other regions in India. Observed features are explained in the light of dynamics, meteorology and long-range transport.

Abstract ID – 478

Seasonal variation of PM2.5 and associated organic aerosols

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Abstract

Seasonal variation of aerosols in the atmosphere of any geographical area is controlled by numerous natural and anthropogenic factors. Aerosols particularly $PM_{2.5}$ is of major concern because of their probable effects on health and climate. This work is based on the detection of the organic functional groups present in $PM_{2.5}$ aerosols over New Delhi which is one of the major polluted regions ofthe Indo-Gangetic plains. For this analysis, Open Path-Fourier Transform Infrared Spectroscopy (OP-FTIR) at National Physical Laboratory (NPL) was used. In this study, the samples were collected on the PTFE(Polytetrafluoroethylene) filters using fine dust sampler for 24 hours (July-December, 2017) at NPL, New Delhi. The concentration of $PM_{2.5}$ was calculated using the gravimetric method.

The result shows the increasing trend in average concentration of aerosols from monsoon to winter season [16.80µg/$m^3$to 166.28 µg/m^3]. Lower $PM_{2.5}$ concentration during monsoon period is due to wet scavenging of particles due to rain while in winter period the ventilation coefficient decreases and accumulation of aerosols takes place in atmosphere leading to higher concentration of $PM_{2.5}$.

The samples were also analyzed using OP-FTIR instrument for organic functional groups of aerosols. OP-FTIR is an analytical technique which uses active and passive infrared source and generates the interferogram with different spectral peaks which are finally analysed using NIST (National Institute of Standards and Technology) library. Each peak denotes absorbance(in infrared region) of a specific organic functional group which lies between the range600-4000 cm^{-1}.The results show the presence of functional groups viz. Alkenes, Hydroxyl group and Aliphatic acids for entire sampling period while Cyclic Ketones, Alkyl nitrile, Aldehydes were reported duringsmog events. During the winters, the concentration of aromatic compounds was found to be comparatively higher than the rest of the months. Nearby trees at the sampling location may also be responsible for releasing the biogenic VOCs like Isoprene and other secondary organic aerosols.

Keywords -$PM_{2.5}$, Organic functional groups, OP-FTIR.

Abstract ID – 493

Long term satellite based study on aerosol and trace gases over the capital city of Assam, Guwahati

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Abstract

The variability and trend in aerosol optical depth (AOD) by using the Moderate Resolution Imaging Spectroradiometer (MODIS) level 3 Collection 6 data at 550 nm for the period January, 2004 to December, 2016 and tropospheric columns of nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) data by using Ozone Monitoring Instrument (OMI) has been studied for the period October, 2004 to December, 2016 over capital city of Assam, Guwahati. The monthly average AOD value varies from its highest value (0.63±0.09) in March to its lowest value (0.23±0.05) in October for the study period over Guwahati. The seasonally averaged AOD reached its maximum in pre-monsoon (0.61 ± 0.06), followed by winter (0.47 ± 0.07) and monsoon (0.41 ± 0.04), with the minimum occurring in post-monsoon (0.25 ± 0.06) season. The observed Ångströmexponent value varies from its minimum value (1.18 ± 0.05) in monsoon season to its maximum value (1.35 ± 0.09) in post-monsoon season. Considerable long-term annual increasing trends in AOD, Ångströmexponent and tropospheric NO_2 column are observed over the study location. Increasing trend of number of vehicles along with their emissions degrades the air quality and thereby contributing to the increasing trend of AOD over Guwahati.Significant correlation between long term averaged MODIS AOD and OMI NO_2 tropospheric columns with same seasonality indicating their same source of origination. Long term increasing trend in Ångström exponents (~0.008 per year) signify the contribution of smaller size aerosols attributed to urbanisation and human activity over Guwahati. The monthly average visibility in Guwahati is highest (27.5 km) in October with a moderate reduction observed during the monsoon, reaching a minimum of 7.2 km in March. With increasing AOD values, horizontal visibility decreases over Guwahati.

Abstract ID – 500

WRF-Chem model simulation during typical dust storm event over North West India

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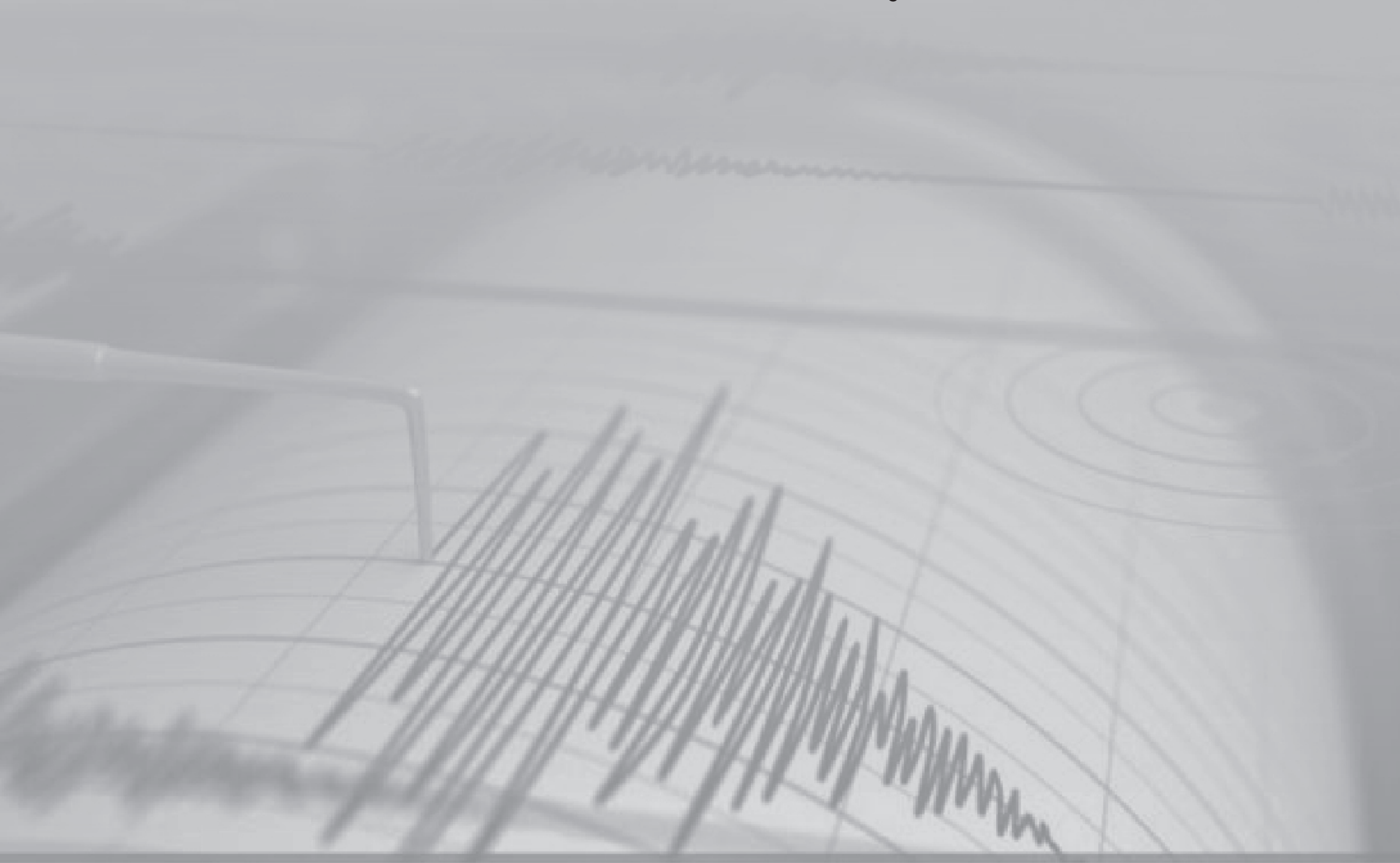
Abstract

In this study the WRF-Chem model has been simlatued to access the air quality over the regions (17^{o}N - 36^{o}N and 65^{o}E to 86^{o}E) of Northwest India during the pre-monsoon period. During the pre-monsoon period Northwest India observe significant increase in dust aerosols. The WRF-Chem model has been simulated to assess Particulate Matter (PM) concentration with respect to time. The model results have been evaluated using NASA Moderate Resolution Imaging Spectroradiometer (MODIS) and Aerosol Robotic Network (AERONET)'s Aerosol optical depth (AOD) observations for simulated period. Specific parameterization scheme is used to simulate the meteorology and emissions of Anthropogenic, fire and biogenic are taken from Emission Database for global atmospheric research (EDGAR), Fire Inventory from NCAR version 1 (FINN) and Model of Emissions of Gases and Aerosols from Nature (MEGAN). Model output of particulate matter having an aerodynamic diameter less than 10 µm is evaluated along with satellite retrieved AOD for the same region to better estimate the air quality during the study period. The model PM_{10} match well with that of hourly observations of PM_{10} of Delhi station and is also well correlated (Correlation or R =0.83) during the satellite overpass time. Other stations like Jaipur, Jodhpur, Kota, and Delhi are compared with daily data with a correlation of 0.81, 0.70, 0.77 and 0.78 respectively.The averaged MODIS and WRF-Chem AOD (550 nm) values for Jaipur, Jodhpur, Kota and Delhi during this period are estimated (0.38 ± 0.28 and 0.30 ± 0.20), (0.57 ± 0.34 and 0.19 ± 0.16), (0.37 ± 0.12 and 0.22 ± 0.16), and 0.65 ± 0.20 and 0.49 ± 0.23) respectively. Furthermore, with respect to appropriate input data this system relatively is able to quantify the air quality in other regions also.

Keyword -MODIS, AOD, WRF-Chem, Particulate Matter, Pollution.

Theme 7

Seismological Research for Society



Abstract ID 61

Earthquake vis-à-vis Weather prediction

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Abstract

Application of chaos physics suggests that six to seven parameters are needed for the predictability of meteorological parameters like atmospheric temperature, atmospheric pressure and humidity etc. Almost same number of parameters are needed for the predictability of earthquakes. This is however, intriguing because accuracy of weather forecasting is increasing day by day particularly through high resolution modelling and observational systems like satellites, radar and GPS systems. On the other hand, earthquake prediction lagged behind to the stage of climatological or statistical methods for hazard assessment for specific regions. The major difficulty is in diagnosis of proper parameters/ precursors and fixing threshold values for them. Inaccessibility of the earthquake source regions is another obstacle in diagnosis and prognosis of earthquake process.

All we have are sparse networks of seismological and geophysicalobservatories away from earthquake source region. Still researches on earthquake prediction are continuing in different parts of the world. However most of these attempts are in post mortem sense i.e after the occurrence of the earthquake to evolve methodology for earthquake forecasting. A number of cases of precursory pattern of the past earthquakes have brought to light seismic quiescence prior to an earthquake. However, difficulties arise on synthesis of their results due to major differences in the patterns even at the same place and similar focal depth. This is attributed to the non-linearity in the stress build up and release. Of late, there has also been a growing trend of using non seismological parameters like OLR or thermal anomaly, ionosphere perturbations or electron anomaly through GPS. Since these parameters are more often effected by the meteorological or other phenomenon like solar flares, their applications to devise operational models is more difficult. Keeping this in view, most of the countries have shifted their efforts to develop and apply earthquake hazard assessment techniques so that safer buildings and other structures can be designed.

Abstract ID – 199

The phase velocity method gives more accurate thickness of Love seismic surface waves from seismogram data than that found by group velocity method

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Abstract

By Fourier integral, impulsive seismic vibration can be represented as a sum of harmonic vibration, and the sum of two cosine curves with nearly equal frequencies generates beats and it is also known that the vibration in the form of beats travels with the same speed as the waves. The speed which is equal to phase velocities of any harmonic vibration is the group velocity. Earthquakes give rise to wide spectrum of vibration of short duration. By applying Dirac's limiting delta-function, it is seen that Dirac's impulse acts at stationary phase. Then by Kelvin's method of stationary phase, it exhibits that the evalutiation of the integral is exact when the time is large. When time varies, the vibration can be represented by a cosine curve called quasicosinusoid (with a time dependent period). The amplitude of the quasicosinusoid depends on the group velocity and its derivative at the stationary point. Thus we get the basic formulas determining the velocities of Love seismic surface waves or layered media waves (Rayleigh type). For a definite seismic station the distance is known and it is fixed. Now for some values of time, the group velocity and the frequency of the stationary point has been calculated. The ordinates of the curve have been found out for a given time, the seismogram should take the sum of the all ordinates. It should be noted that the seismic surface wave have two stationary points. This determines the values of transverse wave velocity in the layer and the half space for Love wave and the higher mode of Rayleigh waves. As the stationary point has two values corresponding to every coordinate of time, two branches appear for every group velocity, the short period and the long period respectively. Thus the estimation of actual thickness of the layer can be found out by superposing on the curves the observed velocities for various periods of time. The phase velocity equals the ratio of the distance in the direction of wave propagation to the difference between the instants of onsets of these identical phases. From this analysis we get the phase velocity (of Love waves) which is in between the transverse wave speeds. From these phase velocities, we can find out the thickness relates to the interval between the stations. The group velocity determined for the whole wave path corresponds to the layer of a constant thickness over the path, and this is usually not true. The phase velocity method is free from this drawback, since, we use the record of two seismograms at two locations near to one another and the vibrations of seismic waves differ but little. As a result we get more accurate thickness of Love seismic surface waves from phase spectrum analysis.

Key words -Quasicosinusoid, Half Space, Short Period And Long Period.

Abstract ID – 332

Perturbation in Atmospheric and Ionospheric parameters prior to Gorkha Nepal Earthquake

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Abstract

Spectral analysis as well as statistical analysis of total electron contents (TEC) derived from ground based GPS have been applied to study the preseismic signature due to Gorkha Nepal Earthquake occurred on April 25, 2015 (M = 7.8) with its biggest aftershock on May 12, 2015 (M = 7.3). The anomalous perturbations in the TEC were observed from few days to few hours prior to the main shock of the earthquake. Perturbation depends on distance as well as direction of observation point from the epicenter. In addition to ionospheric perturbations, the wave-like features in detrended TEC (DTEC) were also identified. The spectral analysis of DTEC data showed an efficient tool to distinguish the perturbation between seismic induced perturbations from other sources.In addition to ionospheric perturbations, the wave-like features in DTEC were also identified. The wave like oscillation occurs few days to few hours before the main shock and associated periodicities in DTEC data varies from 20 min to more than 100 min. Ground and satellite based measurements have been used to investigate variation in atmospheric parameters such that aerosol optical depth and angstrom exponent after the Earthquake. Analysis found significant variation in it. Simultaneous signature in atmospheric and ionospheric parameters reported in this study is strong evidence for lithosphere-atmosphere-ionosphere coupling.

Keywords -Earthquake, GPS, Gravity Waves, Plasma Bubbles, Atmospheric Aerosol, Ozone.

Theme 8

Socio-Economic Impacts of Climate Variability and Change

Abstract ID – 11

Socio economic impacts of extreme weather events in relation to landslides over India with respect to climate change

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Theme: Socio economic impacts of climate variability.

Abstract

The Global warming and its impact have attracted the attention of common man as well as the scientists all over the globe. The anthropogenic climate change is not only the rise in the global temperature but is also reflected in sea level rise, changes in rainfall distribution and increase in the frequency of extreme weather events.

As per WMO study, a changing climate leads to changes in the frequency, intensity, spatial extent, duration and timing of extreme weather and climate events and could result in huge impact on the environment and society. Fatalities reported during the recent decades due to extreme weather and climate events compiled by the WMO showed, India as one of the five worst affected countries in the world. A scientific analysis had concluded that climate change had increased the chances of the rainfall that caused the flooding by an estimated 43%. The potential for damage from such extreme events is also increasing, as higher river levels put more properties close to the flood plain at risk from flooding.

Landslide is a natural phenomenon which is caused majorly due to heavy rains, floods, earthquakes, construction etc. In the present study, the frequency & casualties due to landslides have been worked out. The synoptic conditions for these major hazards have also been analysed and discussed. It is seen that unsustainable growth, urbanization and deforestation add to losses of lives property substantially.

The synoptic factors show that major landslides are associated with heavy rain in hilly areas and cloud bursts. The landslide occurred on July 30th, 2014, in a village Malin of Pune, Maharashtra, due to heavy rainfall (108 mm in 24 hrs) about 200 people were died and 100 people went missing after the disaster, and around huge tract of the village were submerged. Similarly heavy rains on Jun 15th, 2017, have triggered a series of landslides and floods in Bangladesh and Northeast India, killing at least 156 people over two days, are an examples.

Key words - Global warming, Anthropogenic, Climate change, Extreme weather events, Floods, earthquakes etc.

Abstract ID – 66

Using Smart Phones and Crop Model for yield estimation prior to harvest Developing of a tool for demand supply balancing

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Abstract

Managers of Indian economy have been facing a herculean task of striking a balance between demand and supply of Agricultural Products particularly food items.
Crux of the problem lies in mechanism to have an assessment of the expected harvest before crop is actually harvested and brought to the market. Recently, the Ministry of Agriculture has set up a National Crop Forecasting Center (NCFC) with the object of examining the existing mechanism of building forecasts of principal crops and developing more objective techniques.
BKC launched an App (Fasal Salah) which is unique giving advisories to the farmers for their crop, combining weather forecast for their own village with physiology of the crop concerned.. A large number of farmers are already connected to BKC on Fasal Salah platform.
There are two important features of the app FasalSalah which helps in estimation of yield of farmers.
First, the farmer chooses the crop he is going to grow and inputs the actual variety and date of sowing besides giving information if the crop is being grown on irrigated or rainfed basis. This helps in determination of duration of the crop and mapping its precise location based physiological requirements of the crop of in respect of radiation, sunshine, soil temperature which have major impact of crop yield.etc.

Farmers also send pictures of their crop which are geo located at various stages at predetermined intervals in a prescribed manner. At the back end a detailed procedure is laid down for the manner in which the pictures are to be processed to assess status of nutrition or incidence of pests and diseases. Individual pictures are broken into segments and then deeply machine analyzed for various parameters reflecting yield.
Model determined yields are then correlated with the yield parameters of pictures to arrive at projected yield. Later same are compared with actual yields obtained.
This experiment was run for two crop years 2016-17 and 2017-18 for wheat for selected farmers of Punjab and Haryana and results further compared with actual yields arrived at by crop cutting experiments.

Results demonstrated that the crop yields predicted by BKCs model and pictures combine had significant correlation to actual yields which were obtained later after maturity when crop cutting experiments were performed.

Abstract ID – 145

Impact of Climate Change on Butterfly Population over a Metropolis of India

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Abstract

Evidences are accumulating that climatic change in recent decades (IPCC, 2015) has had a major effect, leading to species declines and extinctions. Literature reveals that the impact of the expected future changes on the populations and distribution of butterflies will be huge, and action is urgently needed.

Butterflies in Kolkata (22.5726° N; 88.3639° E) are facing enormous changes in their environment.

In this study butterflies and their diversity in different locations of the urban city, Kolkata is attempted. Diversities in the butterflies is estimated in three different locations; Jadavpur University area (South), Victoria Memorial (Central) and Rabindra Bharati area (North) of Kolkata metropolis in the winter of 2017. Analysis on diversities and species abundance of butterflies over these three locationsreveals thatRabindrabharati possesses healthier environment than other two sites. The bio-diversity and species abundance is good and balanced. Assessments of air quality index also suggestthat Rabindrabharati University area is less vulnerable in comparison to other two sites.

Keywords - Pollution, Air Quality Index, Butterflies, Biodiversity.

Abstract ID – 326

Some aspects of extreme rainfall event and associated flood risk in Gujarat (India)

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Abstract

Extreme rainfall events and associated disastrous floods are increasing significantly particularly in many regions of the country during monsoons. Extreme rainfall event during south west (SW) monsoon season over Gujarat (India) for the duration of 20-27 July, 2017 brought about a huge loss to lives and property. In this study an attempt has been made to highlight the associated weather and synoptic features as causative factors for extreme rainfall event and to quantify the accumulated runoff (flood risk) for the study region using high resolution rainfall, land use and land cover (LULC), soil and elevation data. An adaptable and widely used technique based on Soil Conservation Service-Curve Number (SCS-CN) method including the process of the generation of flow direction and flow accumulation is adopted for modeling the accumulated runoff. Modeled accumulated runoff show high spatial variation during the study period with maximum value amounting to ~460 mm. It was also noticed that the northern parts and central Saurashtra region of Gujarat showed higher values of accumulated runoff indicating higher flood risk areas/zones compared to the western and south eastern parts of Gujarat. It could also be seen that the accumulated runoff has mostly followed the rainfall pattern, though; there were some deviations, which could be attributed to variation in soil types and LULC classification. Modeled accumulated runoff is compared qualitatively with available surface flooding footprint of Scatterometer Satellite -1 (SCATSAT-1), which shows reasonable agreement by and large.

Abstract ID – 331

Studies on Land Surface Temperature, Vegetation Indices and Water Indices for monitoring winter wheat crop over Ghazipur, U.P (India)

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Abstract

Landsat 8 is one of the Landsat series of NASA (National Aeronautics and Space Administration). Landsat 8 dataset is freely available on USGS (United States Geological Survey) Earth Explorer website. Landsat 8 satellite provides images of the entire earth once in 16 days. In the present study, the TIR bands 10 and 11 were used to estimate the brightness temperature, bands 4 and band 5 were used to generate NDVI and band 4 and band 2 were used to generate NDWI of the study area. This study present a method for the analysis of satellite image based on Normalized Difference Vegetation Index (NDVI), Land Surface Temperature (LST) and Normalized Difference Water Index (NDWI). NDVI, LST and NDWI are important factors in many areas like climate change, heat balance studies, a key input for climate models, drought analysis, agriculture crop monitoring, spatial distribution such as roads, urban areas and water resources and theses are easily interpreteted by determining these Index. LANDSAT Data has given a lot of possibilities to study the land processes using remote sensing. This study has been made to estimate NDVI, LST and NDWI using QGIS over Dildar Nagar, Ghazipur district, Uttar Pradesh, India, using LANDSAT 8 satellite data. The LST has been estimated with respect to Normalized Difference Vegetation Index (NDVI) values determined from the Red and Near Infrared bands and NDWI has been determined by Blue and Red bands. The present study focuses on QGIS Raster functions and Raster calculation using the LANDSAT 8 from November 201 7 to April 2018, thermal Bands (10 & 11). The results show that the NDVI during November is greater than that NDVI of April month. The month of March and February shows the highest NDVI over the selected area for the study. This means that during their maturity stages, NDVI was high and also when compare with LST shows the negative relation that is higher the NDVI lower the LST and vice-versa. Above result suggest that there is good chance of wheat crop yield over the study region.

Abstract ID – 462

Major Episodic Smog and fog Events of New Delhi in 1981-2018, their Scaling, Severity, Linking them to Local and distant Sources, Meteorological Factors and Impact of its Trends on Urban Climate

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Abstract

New Delhi has been a great focus of attention by climate change and air quality activists for its alarming pollutions trends, a many-fold growth rate in urbanization and vehicular traffics in the city. Besides the killer London smog of Dec 1952 which caused severe losses to lives(UKMO, 2012), development of many incidents of thick haze and smog/fog cases and their effect historically, have been reported in media and research publication from time to time for various major mega cities in the world using both airport visibility data for older days and in terms of air pollutants concentration like particulate matter and gaseous pollutants in recent years and the latter pollutant reporting has been mostly started from late 2000s by many cites in the developing countries. The city Delhi has few pollution reporting measurement cities regularly available from late 1980s from both central and state depts. until more stations were available during start of CWG 2010 by Ministry of earth Sciences. Besides, Delhi IGI Airport, also has visibility and other meteorological data available at 30-minute and 3-hoursly intervals since 1960s, it has special collected fog microphysics and chemical analysis of fog/smog sample from various 31 types of measurements started from Dec 2015 as three part of WIFEX projects 2015-2018 conducted at IGIA Delhi.

In the present study, we analyzed visibility data hourly basis, for mid Oct- end Feb 1998-2017 for the period when Delhi is vulnerable of high pollutants and mixed up to form dense Smog and fog spells in case high moisture. We find among all months, severe smog types of events with less fog mix up, form in 1st half of Nov, mostly occurred, just during start of pre-winter phase and after cessation of monsoon pattern in the city and during the same period, the city Delhi has witnessed three of its ever worst episodic smog pollution such has 28 Oct - 8 Nov 2012, 29 Oct-7 Nov 2016 and 6 Nov-13 Nov 2017. The most concern is last two of these severe smog spells, which have occurred consecutively, have put a serious of worriness to city authorities and its people as severely affected their health. Further study of local and regional scale circulation pattern on day to day shows they were triggered during a period when cyclone frequencies of north Indian Ocean is highest and incidentally all these extreme episodes when we further studied meteorologically in terms of moistures incursion, wind conditions and subsidence for creating inversion at northwest India where Delhi is located, are linked to formation, movement and intensification of cyclonic system over Bay of Bengal during same period e.g. Nilam, Kyant and one system which was just at pre-cyclone phase respectably, all of which crossed east coast of east India. Dynamics shows it is an interactive process occurred between Delhi region and areas at southeast coast located 1000-12000km

far from Delhi in terms of cyclone creates ascending motion with its descending cell at latter areas. Such severe cyclone formation and movement at east coast of India linked to dense fog formation across northwest India across Delhi also identified till end of Dec when, an extreme dense fog spell formed and persisted almost all days after 10 Dec 1998 till 31 Dec 1998 over most Indo-Gangetic plains including Delhi has been found triggered by Cyclonic storm formation and movement to west as crossed as SCS Arabia coast at Oman coast during 11-17 Dec 1998 in terms of moisture/wind and cloud flow from INSAT. There are ten such cases of spells with most of them at severe category of smog/fog spells which we found those linked to cyclones. We have further analyzed data for finding episodic spells of severe longer spells of smog/fog events if any as occurred in remaining winter part over Delhi for months of Dec to Feb. Though, we find a number of episodic spell with more sever and prolonged spell in terms of extreme poor visibility in various winters months e.g. 1997, 1998 and 2016 for Dec months and 2003, 2010 and 2014 for Jan months, where duration and days of severe poor visibility spells with below 200m continuing for 10-15 days and 100-hours, but these spells were more loaded with pure dense fog droplets obstructing the visibility severely, formed in very high humidity containing a very high LWC where, associated smog/pollution content are not as alarming as they formed in 1st half of November.

In two of our earlier (ref 1 and 2) studies, when we did trend analysis of such low visibility and fair visibility for Delhi, for Dec-Jan, both the peak winter months using longer period data of 1964-2017, we find that the city's clean visibility of 1960s have been deteriorated very highly as Results from 5-years data average for 1964-2017 shows for dense fog/smog duration per day at vis <= 800m and 200m respectively for Dec-Jan have increased by 15-20 times by late 1990s(6-10 times respectively during the period with worst effect in late 1990s and late 2010s in contrast, the trend of fair vis of >5000m which was 17-18 hours per day during 1960s has reached to zero hours-nil in 1990s and latter. Hence by presuming longer period smog/fog coverage cut-off sunlight to surface, we further studied the impact of such increased smog/fog coverage in late 1990 and 2000 on overall trends of average monthly max/min temp of Delhi during 1969-2017. For 1990-2017, we have analyzed daily max and min temp data for all episodic severe fog/smog spells and also studied how occurrences of such sever and prolonged spells smog and fog coverage till late afternoon in most dates in these spells in peak winter have caused to record many lowest max temp days and thus severe cold days at Delhi.

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Abstract ID – 486

Impact of weather variability on the power demand scheduling and renewable energy generation forecast and solutions to maintain grid security and grid balance in the multifaceted country like India

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Abstract

We have experienced the power and load demand variability in the diurnal bases because of the rapid changes of weather pattern valid in the specific region. The present study is focused on the estimating the power-load demand forecast based on the available weather resources in the market. According to the Central Electricity Regulatory Commission, power and load demand scheduling occurs at 15 minutes time block. Since, there is limited number of weather forecasting companies which gives minute cast weather parameters, the study also defines the challenges of renewable energy generation such as Solar and Wind.

In this study, we have focused on Delhi and Uttar Pradesh state power and load demand variability according to the weather pattern and some effects of severe weather events on the power distribution centre.

Introduction: In the fast-growing country like India, it is necessary and mandatory to provide continuous 24x7 power supply to the industry, farmers, hospitals schools and public properties like railways, roadways, airways etc. It can only be done with proper power demand and supply scheduling and forecasting, in this way, we can maintain grid balance and grid security. The weather pattern is more than 95% correlated with the power demand and 100% correlated renewable energy generation.

Methodology: Current study has taken the two states Delhi and Uttar Pradesh. However, we are doing the similar exercise for the Haryana, Gujarat, Madhya Pradesh, Chhattisgarh. In the case of load demand, we have ingested Temperature, Relative humidity, Dewpoint, wind speed and precipitation to the in-house Artificial and Machine learning models with the 15 minutes interpolated horizon. As these weather parameters change hourly and daily, on this basis load varies accordingly. In the case of Solar and Wind energy generation, we are getting the surface insolation flux and hub height wind speed respectively.

Weather Data Sources: IMD Delhi and Lucknow Radar and Meteograms, ISRO satellite data also third-party APIs like Weather Underground, AccuWeather, Dark sky, Weather Risk many are taking into account.

Power Demand Data: Delhi and UPPCL state load dispatch centre every 15 minutes database.

Experimental design: We are fetching the hourly weather data from many sources mentioned above and interpolating into 15 minutes that synchronizes load demand. We have developed in-house Weather Combiner and Optimizer that switches based on the accuracy among available source and reacts accordingly sudden changes of weather events like the thunderstorm and heavy rainfall.

Results:

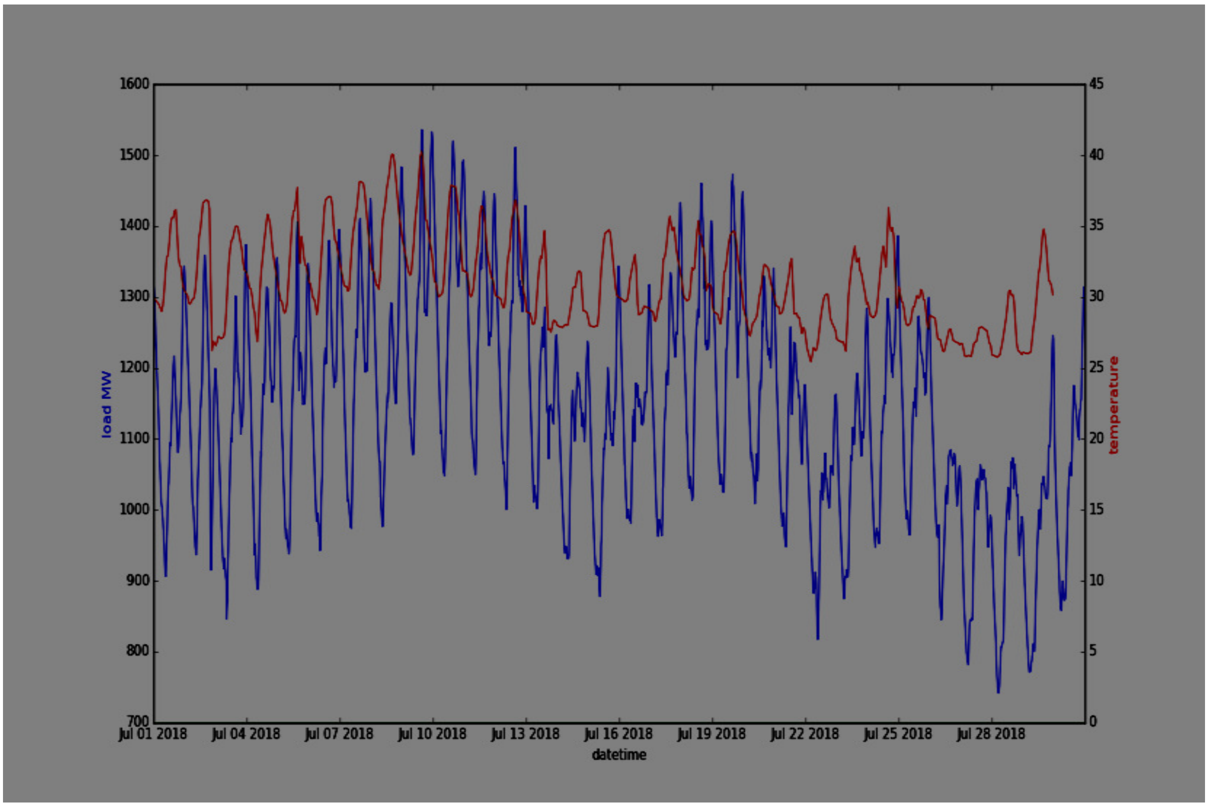

Fig 1: Indicates the load variability according to the temperature variability in the one of the main monsoon months July 2018 in the Delhi region.

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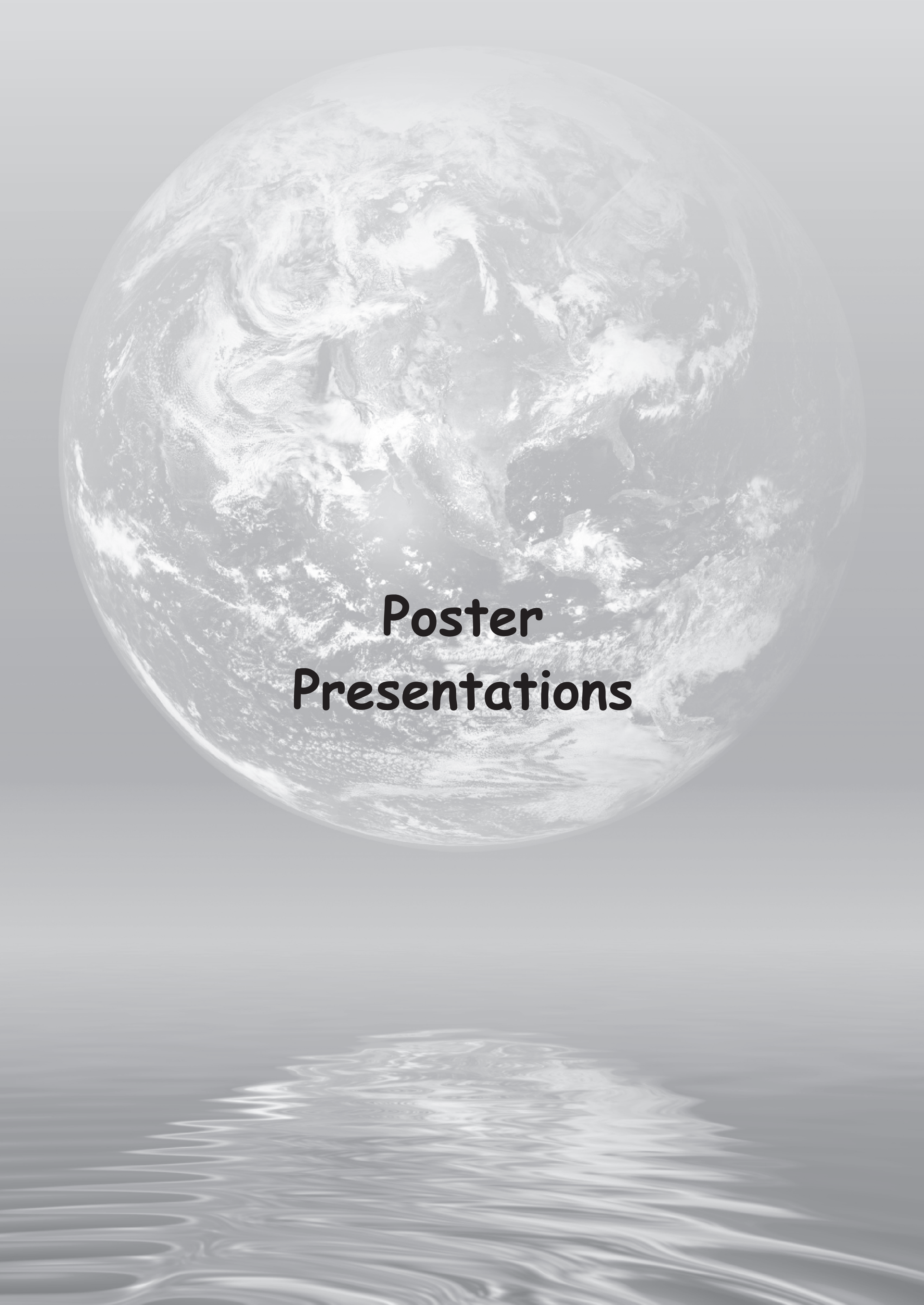

Poster Presentations

Abstract ID – 36

Study of cloud micro-physical properties of low height warm cloud from MODIS level-2 data over Indian region

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Abstract

Satellite retrievals of cloud properties plays a very important role in understanding impact of cloud system on earth's radiation budget and on climate systems. Cloud effective radius and cloud optical thickness estimated from non-absorbing(slightly absorbing) and absorbing wavelengths are the two most important independent variables retrieved from sensors on-board many satellites including Earth Observing System (EOS) satellites Terra and Aqua. From cloud effective radius and cloud optical thickness other properties can be derived like cloud liquid water path, droplet number concentration etc. In this study MODIS level-2 cloud product from Terra have been used to asses micro-physical properties of low height, single layer warm clouds over entire landmass of India. Cloud top height has been set less than 2 km whereas cloud top temperature was set greater than 0°C. Such cloud scenes of an entire year have been filtered out to study cloud effective radius, cloud optical thickness, cloud droplet number concentration, cloud liquid water path and cloud geometrical thickness. Data points retrieved for a whole year (2013 Nov 2014 Oct) over entire landmass of India. Data pixels averaged over 0.2 x 0.2 degree grid for latitude 10 to 30 and longitude 70 to 90. Comparative analysis of these properties also carried out for different climatic regions of India. Three different regions from west to east in the Indo-Gangetic plane have been chosen for this study. Three regions have been designated as Zone1 to Zone 3 respectively and they approximately fall in Arid, Humid subtropical and Tropical wet and dry regions. In our study it is revealed that annual average cloud effective radius is lowest (7.5 micron) for zone 1 which falls approximately in arid region and highest for zone 3 (9.5 micron) i.e, increases form west to east. Droplet number concentration varies form 320 (per cc) (zone 1) to 200 (per cc) (zone3). But in case of cloud liquid water path zone 1 shows lowest value (63 gm /m^2) and other zones more or less same value (75 gm /m^2). Annual average of cloud optical thickness and cloud geometrical thickness is highest for zone 2. To best of our knowledge this study is first of its kind over this region and gives quantitative estimation of some cloud micro-physical variables for low lying warm cloud and would help better understanding of the cloud system and its impact on earth's radiation budget and on climate systems.

Abstract ID – 90

Role of geo-potential height in estimating the variability in ISMR: A comparative Study with NCEP-NCAR and CFSR Reanalysis

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Abstract

The inter-annual fluctuation in the amount of precipitation during summer monsoon (JJAS) season generates remarkable inconvenience in the economic growth of India, which is mainly based on agricultural production. This study attempts to identify the variability in synoptic conditions over the Indian region during the Indian summer monsoon (ISM) season to detect the causes of deficit or excess rainfall using NCEP- NCAR Reanalysis 2 and Climate ForecastSystem Reanalysis (CFSR) products. The CFSR is the latest reanalysis product with first guess from a coupled atmosphere – ocean - sea ice - land forecast system from National Centre for Environmental Prediction (NCEP). The period of study (1979 to 2010) is categorised into above normal, normal and below normal rainfall years. The spatial variability of geo-potential height (GPH) at 1000, 850, 700, 500 and 200 hPa pressure levels and Outgoing Long wave Radiation (OLR) is examined for the three categories of Indian summer monsoon rainfall (ISMR). The precipitation rates of CFSR and GPCP are also compared. The said parameters are well represented by both the reanalyses however, the pattern of GPH obtained from CFSR generally agrees with NCEP- NCAR Reanalysis 2 except at a few places mainly, over the ocean and for above normal category of ISMR. The result shows that the average GPH for above normal rainfall is greater than normal and less than below normal rainfall category. The difference in GPH between the two reanalyses is maximum for the above normal years and over the oceans. The CFSR reanalysis shows a wet bias for regions with higher precipitation rate. The bias is more for normal and above normal rainfall years compared to below normal years. OLR value is observed to be minimum in southern India for all the three categories of rainfall. The difference in OLR is also observed to be more for the above normal rainfall with the two reanalysis. Negative anomaly is observed in the above normal years for all the parameters except precipitation rate while for below normal years positive anomaly is observed except for precipitation rate and geopotential thickness that shows negative anomaly.

Keywords -NCEP-NCAR Reanalysis, Climate Forecast System Reanalysis, summer monsoon,geo-potential height, precipitation rate and OLR.

Abstract ID – 94

Long-term variability of Surface water and agriculture in Ganga basin

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Abstract

Ganga basin is the largestcatchment area of India which depends mainly on monsoon rainfall. The river basin is largely fed by snow melt and precipitation in the catchment. The river basin is also known for intensive agriculture and source for food bowl for India. The recent climate variability (short term and long term) have raised concern for policy makers for sustained food security. The aim of the study is to assess the long-term variability of climate, surface water and agricultural during 2000-2015 particularly in summer monsoon period (June, July, August and September) as the maximum area is cultivated during this period and its impact on surface water and cropped area. The study uses time series satellite data of Terra MODIS (250m spatial resolution) fortnightly Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI), and snow cover (500m) products and climate (rainfall) 0.25*0.25-degree spatial resolution. The satellite data accessing and processing have been carried out using cloud computing platform- Google Earth Engine (GEE) and mapping in ArcGIS and ERDAS. The study analyses the spatial temporal variation of surface water, rainfall and cropped area and their variability. Even in coarse resolution (250m), the surface water and agriculture shows high temporal correlation and identifies the anomaly. The study also uses meteorological drought using Standard Precipitation Index (SPI) and combines with satellite observation to identify agricultural drought. The study is being extended for the winter and summer seasons also to understand agriculture performance in varying climate during 2000-2015.

Keywords -Surface water, Agriculture, Cropping season, Precipitation, Google Earth Engine, Standard Precipitation Index, Meteorological drought.

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Abstract ID – 102

Monitoring soil wetness estimation for recent Jammu and Kashmir flood using microwave channel from NOAA/Metop satellites

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Theme: **Weather forecasting Services at Different Time Scales.**

Abstract

Microwave remote sensing involves emerging capabilities to monitor global hydrological processes. Most of the satellite-based techniques use microwave data their high sensitivity to water content in the soil. AMSU (Advanced Microwave Sounding Unit), flying aboard NOAA (National Oceanic and Atmospheric Administration) satellites, a new methodology for soil wetness estimation has been proposed. The Soil Wetness Estimation (SWE) has been computed from the data acquired by real time using microwave radiometer AMSU (Advanced Microwave Sounding Unit), flying aboard NOAA (National Oceanic and Atmospheric Administration) polar satellites. A multi-temporal analysis of AMSU channel 15 (at 89 GHz) and channel 1 (at 23 GHz) have been used to find out the variation of SWE from real time direct broadcast (DB) receiving systems installed at India Meteorological Department (IMD), New Delhi. In this study, the analysis have been attempted to evaluate the reliability and the efficiency of the proposed technique in identifying different amounts of soil wetness estmation in different observational conditions.

In particular, we have obtained the data for Jammu and Kashmir flood case in September, 2014, which shows the deviations from the "normal behavior" in terms of soil wetness of investigated soils one month before the beginning of the main meteorological event and one month after which caused the flood phase within the study area. This analysis of August and September, 2014 involve the evolution of soil wetness changes. In some circumstances,SWE brought out changes of soil wetness very well. This study highlights of early signals of anomalous value of soil water content, which plays major role for forecast capabilities over the tropics and can be used as operational purpose.

Abstract ID – 111

Impact of Positive and Negative IOD Events on the Regional Climate based on Rainfall Pattern Associated with Heat Budget Components

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Abstract

Indian Ocean Dipole (IOD) phenomenon plays vital role on the spatial variability of monsoon rainfall and this is important in the climate change scenario. Analysis is carried out to understand variation in air sea interaction processes over the Eastern and the Western equatorial Indian Ocean during the months of September and October for one positive IOD year (2006) and one negative IOD year (2010). The objective of the study is to bring out the Impact of the different IOD events in regional climate in terms of Indian Summer Monsoon Rainfall (ISMR), East African and Australian Rainfall. East African Rainfall increases during positive IOD event. On the other hand, Australian Rainfall increases during negative IOD event.

In 2006, anomalies in precipitation overlaid with surface pressure and surface wind for September and October have been examined. It has been observed that anomaly in precipitation is positive over east Africa and India (0 to 4 kg m^{-2} day^{-1}) whereas negative precipitation anomaly is observed over south of Indonesia and entire Australia (-2 to -8 kg m^{-2} day^{-1}).

However, in 2010, negative precipitation anomaly has been found over the east Africa (0 to -2 kg m^{-2} day^{-1}) whereas positive precipitation anomaly has been found over the south of Indonesia (2 to 6 kg m^{-2} day^{-1}) and positive precipitation anomaly has been found over most part of the central Australia (0 to 2 kg m^{-2} day^{-1}).

An attempt is made to bring out a detailed account of the evolution of positive and a negative IOD events during 01 September to 30 October in 2006 and 2010 through air-sea interaction processes utilizing NCEP reanalysis radiation data, surface wind, surface pressure and precipitation rate. Further, the relationship between Dipole Mode Index (DMI) and Nino 3.4 index have been examined. It has been found that in the case of Positive IOD event (2006), in phase relationship exists between SST anomaly of Nino 3.4 region (ONI) and DMI, with a lag period of 3-4 months. Whereas, during Negative IOD event (2010), both these events i.e., La-Nina- SST anomaly of Nino 3.4 region (ONI) and DMI peak occur simultaneously during July to September. It is also pertinent to note here that enhancement in precipitation over the western Indian Ocean (WIO) and subdued precipitation over the eastern Indian Ocean (EIO) during positive IOD event and reversal occurs during negative IOD event. Thus it can be stated that not only SST, but heat budget components also viz., surface pressure, precipitation patterns exhibit a dipole like behavior in the equatorial Indian Ocean. Hence one can infer that the IOD has significant impact on regional climate.

Abstract ID – 128

Subseasonal response of Lower Stratospheric water vapor to the Asian summer monsoon

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Theme: Observations in Climate Variability and Changes.

Abstract

While water vapor in the upper troposphere and lower stratosphere (UTLS) of the Asian summer monsoon is known to exhibit close linkage with the seasonal monsoon convective activity, there are ambiguities with regard to the distribution of water vapor in this region on subseasonal scales. Here, we analyze the subseasonal behavior of lower stratospheric (LS) water vapor using daily data from the Aura Microwave Limb Sounder observations, reanalysis circulation products and satellite derived rainfall for the period 2005–2016. Our analysis reveals a bimodal behavior of the LS water vapor on subseasonal scales. We find that this LS water vapor distribution is governed by the dynamical shifts in upper level Asian summer monsoon anticyclone linked to the monsoonal convective activities.

Abstract ID – 148

Characteristics of thermal internal boundary layer(TIBL) over a tropical coastal station Chennai

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Abstract

The sea breeze circulation prevails on land, changes in the temperature structure, humidity and roughness occur in the air adjacent to the coast and lead to formation of a thermal internal boundary layer (TIBL) (Stull 1988).The characteristics of Thermal internal boundary layer (TIBL) has been carried out in presence of sea breeze circulation during all the seasons, in the study period of Jan, 2016 – June 2018, over tropical coastal Chennai (12.83 N, 80.04E) on east coast of India.For this study we used high temporal resolution, ground based mini micro pulse Lidar it is located at SRM ISTChennai(12.83°N, 80.04°E).and radiosonde observationdata from IMD Chennai (13°N, 80.06°E), for finding sea breeze onset we used surface automatic weather station (AWS)wind direction, speed and temperature data from During the study period. weobtain total 557 micro pulse Lidar observations and 870 RS observations during the period, out of this 451 observations from MPL and 696 observations from Radiosonde are clear sky days 17:30 IST. In summer season (March – May) the onset of sea breeze takes place between 10:00 – 12:00 IST with high magnitude of wind and, in southwest monsoon season theonset takes between 13:00 – 16:00 IST, the sea breeze is in both seasons from south east direction. In post monsoon and winter seasons the onset of sea breeze is takes place between 9:30 – 12:00 IST under the influence of synoptic wind. The details of quantitative results will be present during the conference.

Abstract ID – 150

Bathymetry retrieval from Multi- and Hyper- spectral remote sensing data in Optically-Shallow water

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Abstract

The optical remote sensing inversion models utilize spectral information over optically shallow waters to retrieve optical properties of the water column, bottom depth and reflectance. In this paper, airborne hyperspectral (AVIRIS-NG) and satellite multispectral (LANDSAT-8 OLI) sensors were investigated by radiative transfer equations that used to derive water depth from remote sensed data over Hoogly river and Gulf of Kutch. Two algorithms- a linear logarithm ratio model and hyperspectral optimization process exemplar (HOPE) – were compared through analysis of satellite imagery against NHO bathymetry. The regression analysis of model derived depths with NHO depth shows the promising results with R2: ~0.8 and ~0.9 respectively. The observations suggest that the logarithm ratio model performs well for retrieving bottom depths of deep waters (>10 m) whereas optimization performs well for optically shallow water (< 5 m).

Abstract ID – 162

Spatial and Temporal extent of Oil Spill by using SAR imagery

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Abstract

Space-borne remote sensing is an important tool in monitoring marine oil spills due to its wide spatial coverage and regular revisit capability.The detection and identification of Oil Spill is crucial for identifying the threat to marine ecosystem due to spill accidents, etc. In this present study, an attempt made to detect and identify the Oil spill, off Visakhapatnam coast, East coast of India,by using High resolution images like SAR, RISAT, and Radarsat-2.The C-band SAR data acquired from RISAT are from 12th to 15th of May 2015 and all are processed. An oil films appear as dark patches on SAR Images.An iterative application of several filters resulting in better observation of the slick was done although an initial filter applied to remove speckle noise. The identified oil spill and spill path of the ship can be obtained.The spatial and temporal extent of oil spill can also be detected from the successive images through these processing techniques by applying concern filters. Frequent Spill accidents over the sea surface can be monitored by processing the long term satellite imagery data.

Key words - RISAT, SAR, Radarsat-2, Speckle noise, Oil Spill, Slicks.

Abstract ID – 166

A simplified laboratory analogue for the turbulence structure of low-level jets

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Abstract

Monsoon Low-Level Jet (MLLJ) is a large-scale phenomenon peculiar to Indian monsoons where persistent (throughout the day and night) strong westerlies occur quite close to the surface (around 850 hPa) with wind speeds decreasing on either side of the velocity maximum in the vertical direction. In general, LLJs occur in a variety of situations and for a variety of different reasons. However an understanding of the structure of turbulence contained in LLJs is still somewhat lacking and this could lead to unjustified modeling assumptions. Specifically it is not clear whether the shear-dominated near-surface turbulence in the lower part of the jet - below the velocity maximum (or the jet core) - interacts with the turbulence in the upper part of the jet. Given very limited temporal resolution of atmospheric profiling instruments, the in-situ measurements of the turbulence structure and interaction between these parts is extremely challenging. To this end, we propose a simplified laboratory analogue - called the "wall-jet" - that appears to model quite well not only the mean wind profile but also the essential aspects of shear-dominated turbulence in the LLJ flow. We present evidence from the literature towards this proposal and also present some preliminary measurements of the wall-jet flow carried out at the Fluid Dynamics Laboratory, IITM, Pune.

Abstract ID – 170

Bengalurueans get 2 litres of water from rainfall per day

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Abstract

Bengaluru (12N, 73E, 927 amsl) is a metropolitan city and attracted the entire world due to comfortable climate and weather, where it gives a potential growth for the city in terms of industriessince last two decades. This has caused an exponential growth in population and expansion of city limits, radial outward. The built-up area in the metropolitan area was 16% of total in 2000 and is currently estimated to be more than 25%. The rest of the area is occupied by either agriculture lands, quarries or other vacant land. On this ground, a preliminary study is carried out on the total amount of rainfall received, temperature anomaly, city expansion and the amount of rain water received for the entire city. The meteorological data has been analysed for the period from 1969 to 2017. The temperature data is processed for pentad normal and rainfall for monthly normal. This study reveals that, since last 4-decades there is no much change in rainfall amount received over the region, excluding the drought years. The monthly mean maximum temperature account for not more than 35 ^{0}C for entire period, and on few occasions it exceeds this number. The total rainfall for the period varied from 587 mm in 1994 to 1696 mm in 2017 with a mean of 1019.9 ± 35.3 mm, having a median of 1024.3 mm. From the last 5-years of data sets on rainfall and city expansion, it shows that each person residing in Bengaluru will get 2 litres of water per day for their consumption. However, the temperature and rainfall patterns follow the normal trends. The details of results and anomalies are presented.

Abstract ID – 177

Assessment of groundwater quality suitability for drinking and irrigation purposes in Panipat district, Haryana, India

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Abstract

Present study was conducted in Panipat district of Haryana, India to evaluate the suitability of groundwater quality for drinking and irrigation purposes. 45 groundwater samples were collected in post-monsoon season, 2015. The relative anionic abundance of groundwater samples was in the order of HCO_3^->Cl^->SO_4^{2-}>NO_3^->F^-whereas cationic abundance was Na^+>Ca^{2+}>Mg^{2+}>K^+. Groundwater suitability for the drinking purpose was determined by comparing the physico-chemical assessment of various water parameters with World Health Organisation (WHO) guidelines. Water Quality Index (WQI) was calculated for 42 samples and revealed that none of the groundwater samples belongs to excellent water quality class. The water quality analysis results were further processed to evaluate the suitability of groundwater samples for irrigational purposes by analysing several parameters including electrical conductivity, sodium absorption ration (SAR), permeability index (PI), magnesium ratio(MR), percent sodium(%Na), residual sodium carbonate (RSC). The USSL diagram for EC versus SAR indicated that majority of the samples belongs to C_2S_1 and C_3S_1 water type. Doneen's plot for permeability index exhibited that 86.7% groundwater samples belong to class I. Kelly's ratio affirm that 80% groundwater samples were suitable for irrigation purposes.

Keywords -Groundwater, Water Quality Index, Irrigation, Sodium Absorption Ratio, Permeability Index.

Abstract ID – 198

Seasonal dynamics of solar radiation over Varanasi U.P.

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Abstract

The present research paper deals with the analysis of seasonal dynamics of solar radiation i.e. Direct, Diffuse, and Global Radiations over Varanasi, Eastern Uttar Pradesh,and India. The current research focuses on 5 years (2010-2014) solar radiatonrecorded data to study direct, diffuse, and global solar radiation. The measured data for the average seasonal and monthly solar radiationover Varanasi are compared. Solar radiation has been divided into four seasons namely winter (December, January, and February), summer (March, April, and May), monsoon (June. July, August), and post monsoon (September, October, November). The results shows thatglobal solar radiation and diffused solar radiationwas maximum during summer(2.9 W/m^2) and monsoon (1.37 W/m^2)respectively.

Key words -Solar Radiation, Scattering, Diffusion, Temperature, AOD.

Abstract ID – 212

INSAT-3D derived OLR variability with rainfall during monsoon over Indian region

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Abstract

The relationship between the outgoing long wave radiation (OLR) and rainfall over the central India region was examined by using daily OLR data and rainfall data from the RAPID tool of the INSAT 3D exclusive meteorological satellite which is launched on 26th July, 2013 from French, Guyana using ARIANE rocket. The study was carried out using data collected from June to July in year 2018 which covered a region of central India. The plot between observed OLR with the Time (UTC) according to the actual line of monsoon in the month of June and July in various phases. A multiple linear regression equation is developed to interpretive the Indian summer monsoon rainfall using these indexes and the empirical relations are verified on independent data.

The flood resulting from monsoon-related weather disturbances, exert a devastating impact on the socio-economic well being of country. Here With the help of OLR values we can correlate the rainfall over a given region. Data from the RAPID tool has been observed and with the help of correlation between OLR and rainfall during the monsoon season 2018. Result shown, OLR anomaly is higher from mid of June to the last week of June. Therefore, we can clearly observe that the rainfall is less according to the prediction over the period observed.

Keywords - OLR, Rainfall, INSAT3D, RAPID.

Abstract ID – 228

Effect of incoming short wave and outgoing long wave radiation on air temperature

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Theme : Observations in Climate Variability and Changes.

Abstract

Sunis the main source of energy for the Earth. The solar radiation incident at the top of the atmosphere on a unit surface kept perpendicular to their radiation at meansun-earth distance is known as solar constant. As the solar ray pass through the atmosphere, its energy is depleted by scattering due to air molecules and aerosols in the atmosphere. The solar radiation that covers entire region of electromagnetic spectrum, reaches the top Earth's atmosphere, but when it reaches earth surface contains only part of the electromagnetic spectrum limited to 0.2 to 30 micron. On surface of the earth on a clear day, at noon, the direct beam radiation over Bengaluru without clouds will be roughly 900 Wm^{-2}. Radiative transfer in planetary atmospheres involves an ensemble of waves with a continuum of wave lengths and frequencies, the energy that it carries can be partitioned in to the contributions from various wavelength bands. The most obvious aspect is the brightness of the Earth's cloud cover. A significant part of the Earth's reflectivity can be attributed to clouds and a reso important in the Earth's climate. The data sets on meteorological observations and short/long wave radiations were obtained from Mini Boundary Layer Mast (MBLM) of ISRO situated at Jnanabharathi campus (12°53′N, 77°30′E, 840 amsl) of Bangalore University, Bengaluru. The albedo of Earth depends on the geographical location, surface properties, and the weather and on an average the Earth's albedois ~0.3. This fraction of incoming radiation is reflected back into space. The other 0.7 part of the incoming solar radiation is absorbed by our planet. Continuous observations were made by making use of pyranometer and pyrogeometer for incoming solar radiation and the radiation emitted by the Earth's surface for one year and analyzed. The link between the earth's atmospheric temperature with short and/or long wave radiation and their correlations are studied in detail and presented.

Abstract ID – 234

Some characteristics of the changing pattern of temperature in Odisha- A statistical and diagnostic approach

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Abstract

Climate and weather are two important factors in day to day life of each common man around the globe. The global climate can be understood as an integration of many weather phenomenon. Climatologist and meteorologists generally use the statistically defined parameters e.g. mean, median, standard deviation etc. of weather parameters to explain the climate of a particular season. But before using these statistical parameters it is very essential to understand that these parameters not all the climate. Climate may include many more parameter values. For example climate changes might be occur if particular aspects of the statistical distributions of extreme events change although the mean value does not change. In the study of climate and weather, extreme events are very important. Extreme events are directly related to the daily socio-economic activities of public of any country. Extremes and concerned changes in their variability is required a crucial and rigorous analysis based on daily data.

Based on the climatologically data received from National Data Centre (NDC), India Meteorological Department, Pune, India in respect of maximum and minimum temperature of eighteen stations for a period of 1969-2016, in this paper a changing pattern of temperature in Odisha has been studied. The results are represented in the form of different statistical series and diagrams.

Abstract ID – 235

Cloud Radiation interactions over the Indian region

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Abstract

In this study,we haveinvestigatedthe interactionsbetween clouds and radiation on the daily, intraseasonaland seasonal time scales over the Indian region using observations, mainlyduring the pre-monsoon and monsoon seasons. As land-ocean-atmosphere coupled interactions during the pre-monsoon and monsoon seasonsare highly important in determining the genesis and strength of the Indian summer monsoon and its variability on different time scales, we have focused on understanding such interactions and their implications for land-ocean-atmosphere feedbacks at the surface.

It is found that clouds affect the surface shortwave downward and upward radiative fluxes by decreasing them in the monsoon season in all sky conditions. Longwave downward flux is found to be high in the monsoon season whereas upward flux is high in the pre-monsoon season over the region. Furthermore, on the intra-seasonal time-scale it is noted that the shortwave upward and downward radiation fluxes are low during active days over India with higher variability than break days. Although the outgoing longwave radiation also depicts similar features, the variability during active days is higher than break days.

These insights shall help us to understand ambiguities and systematic errors inthe representation of cloud-radiation interaction processes in the tropical region in coupled models in orderto further improve them.Detailed results shall be presented and discussed.

Abstract ID – 241

Surface Urban Heat Island of Upper and Middle Gangetic Plain : A Satellite Based Approach

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Theme :observations in climate variability and changes.

Abstract

The uncontrolled rapid urbanization result in concretization, deforestation and severe modification of local environment . Consequently making detrimental impacts over micro climate causing several problems to living components. Nowadays an urbanisation induced modification to local meteorology as a spatial anomaly in temperature gradient is being observed at fine spatial scales, also known as Urban Heat Island (UHI). In this phenomenon urban areas show a significantly greater temperature than its rural environs, this effect is reported to be more significant in nighttime. The UHI affects the local atmospheric environment in various ways, apart from discomfort, UHI causes heat related illness, increases energy demands and causes poor air quality by affecting the physical and chemical dynamics of atmosphere. The present research estimates Nighttime Surface Urban Heat Island (SUHI) for a time period of 15 years over five major Cities/Towns Upper and Middle Gangetic Plain namely, Bijnour, Kanpur, Allahabad, Varanasi and Mirzapur. By using MODerate resolution Image Spectroradiometer (MODIS) data. The present study quantified satellite derived Land Surface Temperature(LST) under different zones (viz. Urban, Suburban, Rural) classified using Land Use Land Cover (LULC) of the landscape, to measure Intensity and trend of SUHI. The study also envisage intra-city spatial variability of Surface Urban Heat Island Intensity (SUHII). The study using Mann-Kendal Trend Analysis showed a significant increasing trend of SUHII. This trend shows a detrimental modification of local climate, which may cause increase in air pollution, heat related biohazards etc. in near future. The study shows the need of environmentally sound town planning and Urban greening for the region to mitigate these ill changes.

Key words -Microclimate, Surface Urban Heat Island, Upper and Middle Gangetic Plain.

Abstract ID – 258

Interferometric sar flat earth effect removal

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Abstract

Interferometric synthetic aperture radar (InSAR) has been widely used in remote sensing field, which can reflect actual topographic trend or possible surface deformation. The precision of interferometric phase is critical to the final measurement. Due to the orbit attitude influence, such phase difference between the scattering elements on the same height level, which is named as flat-earth phase, usually causes the complex interferogram dense and difficult to be used in further processing. Before phase unwrapping, interferogram must be flattened to derive accurate topographic or deformation information.In this paper we make comparison of the two methods of flat earth removal, one using imaging geometry and other using precise orbital information. Index Terms - Flat Earth Effect, Interferometric SAR, polynomial fitting 1

Abstract ID - 276

Microphysics of raindrop size spectra over a coastal station Thumba during cyclones

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Theme: Weather and climatic extreme events

Abstract

This work uses raindrop size distribution (DSD) spectra measured at the surface and aloft using Joss-Waldwogel disdrometer and micro rain radar respectively in tropical cyclones observed over west coast Thumba. These DSD spectra are used to determine the best-fit gamma distributions parameters. The physical processes responsible for those parameters and their relations to the measurable radar reflectivity Z and rain rate R are then explored. The cyclones observed over Thumba have been divided into Convective (C), Transition (T), and Stratiform (S) regimes. Using the retrieved DSD parameters a gamma parameter diagram (GPD) has been generated to understand the microphysical process undergoing during each cyclone passages. Results reveal that median volume diameter (D_m) increases from S to T to C segments of the rain while the range of the slope parameter decreases in the same sequence of S to C. The exponent and coefficients in the Z-R relationship are different in different rain regimes. In particular, the coefficients of convection differ from transition and stratiform rain in large magnitude for the cyclones originating from Arabian sea (AS) than that of Bay of Bengal (BOB). These results highlight the presence of larger drops for the cyclones originating in AS during pre-monsoon (March, April, May) than post monsoon (October,November) seasons. The concentrations of medium and small size drops are large in number during post monsoon whereas big drops are scarcer for cyclonic DSD of AS origin than that of BOB. There are distinctive clusters of the Normalized number parameter (N_W) versus D_m between AS and BOB.

Abstract ID – 278

Calibration of Ground Radar with Space Radar Using Alignment Methodology

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Theme:Weather/climate modelling at regional & global scales

Abstract

Calibration of radar data is important in order to get the correct estimation of weather interactions over the observed regions. In the present work, a methodology based on aligning the space and ground radar data onto common footprint geometry after accounting for different viewing angle, etc. is proposed. For this purpose, data from Dual Polarization Ground Radar (GR) maintained and operated by Indian Meteorological Department (IMD) at IMD Delhi is utilized. IMD Delhi has collected radar data which was shared to the Continental Tropical Convergence Zone (CTCZ) program sponsored by Ministry of Earth Sciences during 2011 to 2013. The present study utilizes monsoon data collected during four months viz., June, July, August and September (JJAS) in the year 2013. The space radar used for the calibration purpose is TRMM PR (Tropical Rainfall Measuring Mission Precipitation Radar) aboard TRMM satellite. After alignment is performed, thecalibration is performed using linear regression. The results obtained will be presented during the conference.

Abstract ID – 280

A study of rainfall pattern near Angul, Odisha region using Eigen Analysis

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Theme: Weather/Climate Modelling at Regional & Global Scales

Abstract

Angul district in Odisha houses a number of industries that releases flue gases from chimney and water vapour from their cooling towers within the planetary boundary layer. Under certain environmental condition, these flue gases acts as nucleating sites for the water vapour to condense upon and form clouds at a greater heights. Further condensation of water vapour may result in formation of induced rainfall. Analysis from previous studies has shown some variation in the pattern of induced rainfall as compared against "natural" rainfall. In the present study, an Eigen vector based approach is used to study and contrast the rainfall pattern in and around the Angul region. Monthly averaged precipitation data at $0.25^{\circ} \times 0.25^{\circ}$ resolution from Tropical Rainfall Measuring Mission (TRMM)'s data products during the period 2006 to 2017 has been considered for this analysis. This data is divided into two groups; first set of data centred onAngul and second set is away from the Angul site. Eigen vectors of both the dataset is found and compared to systematically study the difference in rainfall pattern. Results show that the rainfall pattern of the Angul region is different from the surrounding regions which indicate inhomogeneity in rainfall pattern due to anthropogenic as compared to climatic effect. Detailed result will be presented in the meeting.

Abstract ID – 300

Air Sea fluxes over the North Indian Ocean during three consecutive deficient Monsoon years

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Abstract

The summer monsoon rainfall over India, exhibits a large interannual variability in terms of the amount of rainfall received over various meteorological sub divisions. In the present study, we have looked at the air sea fluxes over the North Indian Ocean (NIO), during three consecutive deficient monsoon years, namely, 1985 (76 cm), 1986 (74.3 cm) and 1987 (69.7 cm) using the TROPFLUX data.Both 1985 (23-25 August) and 1986 (23-31 August) had one break in monsoon condition, where as in 1987 (El Nino) had three breaks (23-25 July; 30 July- 4 August; 9-13 August). Further, the years 1985 (15-17 July;30 July- 2nd August; 6-8 August) and 1986 (21-24 July; 13-15 August) had more active monsoon conditions than 1987 (24-29 August). The monthly rainfall data for the study period was extracted from the IITM, Pune website. The precipitation data over the ocean was taken from the Global Precipitation Climatology Program project. The 850 hPa used in the present study has been extracted from the NCEP/NCAR reanalysis dataset. Of the above three years, 1987 was a strong El Nino year. The effect of El Nino in reducing the summer monsoon rainfall has also been studied. We looked into the role of various ocean atmospheric parameters such as Sea Surface Temperature (SST), wind speed, Latent Heat Flux (LHF), Sensible Heat Flux (SHF), Net Heat Flux (NHF) and Outgoing Longwave Radiation (OLR) for the above years. An analysis of the pentad plots of various air sea fluxes for both break and active monsoon conditions of the above three deficient years showed several interesting features.

Key words - Sea Surface Temperature, Latent Heat Flux, Net Heat Flux, Active, Break, Monsoon.

Abstract ID – 327

Diatom bloom detection in the east coast of India (Bay of Bengal) using MODIS fluorescence data

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Abstract

A Diatom bloom appeared on March 2012 along Off Godavari delta covering Kakinada and Yanam in the East coast of India in the Bay of Bengal. MODIS satellite data, bio-optical field measurements were used to detect the Diatom bloom. MODIS fluorescence line height (FLH inw m^{-2} μm^{-1} sr^{-1}) data showed the highest correlation with near-concurrent in situ chlorophyll concentration(r = 0.93). In contrast, the band-ratio Chlorophyll product of MODIS showed more inconsistency with in situ chlorophyll data due to the interference of other water constituents. High FLH value patches >0.2 were confirmed to be located at the medium to high concentrations of diatom species of SkeletonemaCostatum with a high concentration of Fucoxanthin as the biomarker for diatoms from the HPLC pigment analysis. The FLH imagery also showed that the bloom started in early March along coastal waters, Off Godavari delta covering Kakinada and Yanam in the East coast of India, and developed and moved to the North East along the coastal regions. Observed, it can ensure that diatom bloom can be detected from MODIS-A using 550 nm spectral band. The results revealed that MODIS FLH imagery plus in situ data are adequate tools for Diatom bloom monitoring.

Keywords -MODIS, FLH, Chlorophyll, Diatom bloom.

Abstract ID – 330

मौसमी घटना का खगोल विज्ञान से सम्बंध

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सार

ऋग्वेद के शब्द यह जिज्ञासा ,जो कि भारत मौसम विज्ञान विभाग का स्लोगन भी है 'आदित्यात् जायते वृष्टिः' दि सूर्य के प्रभाव से वर्षा होती है तो अन्य मौसमी घटनाओं विशेषकर विनाशकारी घटनाओं पैदा करते हैं कि य इसी ;नक्षत्रों का अवश्य प्रभाव होना चाहिए है-पर भी ग्रहसे प्रेरित होकर मैंने यह सम्बन्ध ढूंडने का प्रयास किया है इस अध्ययन के लिए । का विवेचन प्रस्तुत है नक्षत्रों से सम्बन्ध-यहाँ पर मैं चक्रवाती तूफ़ानों के ग्रह । साइट पर-विभाग की वेब**1990** से **2017** तक के उपलब्ध सभी **106** चक्रवात के आंकड़ों का उपयोग किया है ।

यह अध्ययनस्वामित्व के आधार पर ही किया ,दृष्टि ,की स्थिति (नक्षत्रों-ग्रह) यथासंभव मात्र खगोलीय पिण्डों , ग्रहों की दृष्टी में । त अनेक ज्योतिषीय गणनाओं को विषय क्षेत्र से बाहर रखा गया हैइनसे सबन्धि ,गया है राहू व केतु हमेश । वक्री दृष्टी को भी शामिल किया गया हैा वक्री होते हैंस्थिति ही ली -इसलिए वक्री ग्रह , खा कि ग्रहों के विभिन्न राशियों में मैंने दे ,उत्साहवर्धक रहे-इस अध्ययन के निष्कर्ष मेरे लिए अति । गयी है चक्रवाती तूफान । पारगमन से स्थापित संबंध ही समस्त मुख्य घटनाओं के घटित होने का कारण बनते हैं की उत्पत्ति में निम्नलिखित ग्रह:स्थितियों का प्रबल योगदान अवलोकित हुआ है-

1. यदि राहू सूर्य ; मंगल या शनि के साथ या इनसे दृष्ट हो ,**60/106।**
2. यदि मंगल ;राहू या सूर्य के साथ या इनसे दृष्ट हो ,शनि ;**47/106।**
3. यदि तीन या तीन से अधिक ग्रह भरिणी विशाखा और ,कृत्तिका ,अनुराधा नक्षत्रों में हों ; **24/106।**

इस अध्ययन से चक्रवात की उत्पत्ति के समय का मोटे तौर से अनुमान लगाया जा सकता लेकिन इससे जुड़ी अन्य अनेक पहेलियों को सुलझाने के लिए गहण। शौध की आवश्यकता है-

Abstract ID – 335

Analysis of SW monsoon over Central India during recent years – Case studies with major systems causing heavy to very heavy rains

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Theme :Weather and climatic extreme events.

Abstract

Performance of SW monsoon over M.P. varied from year to year. The study of SW Monsoon over M.P. during 2015 to 2017 was carried out with forecast as well as realization of weather using tools *viz.* synoptic products, NWP(Numerical Weather Prediction) Products/ five daysdistrict level products and their value addition, satellite products and nowcast by DWR(Doppler Weather RADAR) products for detailed analysis. The study included some case studies for each of the year, which resulted in heavy to very heavy rainfall in the State. During 2015, 2 cyclonic storms (AshobaaandKomen), 6 Monsoon depressions and 3 monsoon low pressure areas formed. The salient weather systems included analysis of Komen, which formed over NE BoB on 25th July,2015. On 3rd August it entered E-MP as WML, which on 4th concentrated into a depression and ultimately became less marked from Central-MP on 6th August. Ujjain flood during 2015 occurred due to heavy to very heavy rainfall within Ujjain district during 19th, 20th July (Table 1) due to LOPAR. Harda railway accident due to very heavy rain occurred during 3rd to 5th August as a result of WML, which weakened into LOPAR over Central parts of M.P. (Table.2).During 2016, a LOPAR over NE-MP during 7th to 9th of July resulted in heavy to very heavy rainfall, even extreme heavy rainfall in parts of the State. The deep depressions on 9th and 11th August, resulted in heavy rainfall in parts of areas over the State . During 2017, a WML during 12th to15th July resulted in heavy to very heavy rainfall over NE- MP. As WML it moved over W-MP on 14th July and then became less important for the State. Another WML over NE- MP moved towards NW-MP from 27th to 28thJuly , 2017 and became less marked on 29th . This system also resulted in heavy to very heavy rainfall in those areas of MP .The analysis of deep depression during 19thto 24th September 2017 resulted good rainfall over E- MP and Central-MP. The study revealed that during 2015, rainfall activities over the State was active on 21 occasions and vigorous on 9 occasions; During 2016 active monsoon occurred in State on 31 occasions and vigorous on 7 occasions; While during 2017, monsoon was active on 28 occasions and vigorous over 5 occasions. The paper provided in depth study of salient systems over central India during past three years alongwith associated extreme events (heavy to very heavy rainfall, even extreme heavy rainfall).

Key words – SW monsoon, Central India, WML (Well marked low), LOPAR(Low pressure area), Depression, Deep depression, Active, Vigorous, BoB (Bay of Bengal)

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Acknowledgements : The author is thankful to ShriShrivastava, Smt. Khusnuma of M.C.Bhopal and Smt. Vaidya, O/o CR&S, IMD,Pune for their assistance.

Table 1

Actual rainfall during 19th to 21st July 2015 within Ujjain district

Station /Dates	Rainfall in mm		
	19/7	20/7	21/7
Badnagar	*251.0*	*158.4*	*137.0*
Khachrod	*95.0*	*272.0*	*90.0*
Mahidpur	*77.0*	*81.0*	*61.0*
Tarana	*88.0*	*97.0*	*177.0*
Ujjain	*319.0*	*161.0*	*108.0*

Table 2

Actual rainfall during 3rd to 5th August 2015 within Hoshangabad division

Station/ Dates	Rainfall in mm		
	3/8	4/8	5/8
Harda	0.8	40.6	123.9
Khirkiya	0.0	41.2	289.4
Hoshangbad	9.6	34.2	7.0
Pachmarhi	14.0	206.0	74.0
Betul	12.0	101.6	119.9

Abstract ID – 364

Spatial and temporal evolution of tropical Indian ocean sea surface temperaturedecadal variability

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Abstract

About one third of the world population is living around the Tropical Indian Ocean (TIO) rim countries, so thestudy of decadal variability of TIO SST is crucial with the changing climate.The different aspects of decadal variability in the TIO remain unexplored and so is a potential research problem. Further, how the decadal mode of TIO linkages with other dominant decadal variabilities is also not well understood. We considered 30 °S to 30 °N and 40 °E to 100 °E asTIO in this study. ERSST and HadISST data available during 1870 to 2016 with spatial resolution of 1°x1°are used for detailed analysis.These monthly data sets are converted to annual mean data and corresponding trend of SST is removed to carry out further analysis. Wavelet analysis of detrended SST time series data shows that TIO SST exhibits decadal variability and it was strongest during 1939 to 1952 having the time period of about16 years.Wavelet analysis further directed to apply 9 to 30 year filter to the detrendedtime series data set to study temporal evolution of decadal variability in last hundred and forty six years. Empirical Orthogonal Function (EOF) analysis is carried out to know the spatial mode of decadal variability of TIO SST. ERSST as well as HadISST data display dominant mode as a Decadal Indian Ocean Basin Mode (DIOB)with explaining about 50% of the total variance of decadal signal, whereas the second mode is dipole mode explaining about 20% variance. TIO SST decadal variability strength is of the order of Atlantic MultidecadalOscillation (AMO) and about 30% and 40% to that of Pacific Decadal Oscillation (PDO and InterdecadalPacific Oscillation (IPO) respectively. To know the consistency of this TIO SST decadal variabilitywith other dominant variability lead lag relationis studied using correlation and cross-correlation analysis. PDO/IPO and TIO SST shows in phase relationship upto 1985,andthe linkage between them weakens after 1985, however no such changes in linkage is found for the AMO. How this TIO SST decadal variability influences the Indian summer monsoon (ISM) is also studied for the strongest mode, which clearly supports that ISM has in phase relation with the decadal variability of TIO SST.

Abstract ID – 371

Evaluation of scatterometer derived winds with altimeter derived winds

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Abstract

Global ocean surface wind speeds from Oceansat-2 Scatterometer (OSCAT) for 8 months (Apr,2013-Dec,2013) and SCATSAT- Scatterometer for 20 month (Oct,2016-May,2018) were compared with wind speeds estimated from SARAL-AltiKaand JASON altimeters for representative months to investigate the consistency in wind speeds between these sensors. The comparison was carried out through statistical analysis. The spatial window used for comparison with SARAL-AltiKaand JASON altimeters was 0.25 km for OSCAT and SCATSAT. The results of the inter-comparison indicate that SCATSAT wind speeds are almost as consistent with SARAL-AltiKa andJASON as OSCAT wind speeds.

Abstract ID – 376

Comparisons of reanalysis dataset for simulation of tropical cyclones evolutions over North Indian Oceans

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Abstract

Several reanalysis datasets are being used for understanding different physical mechanisms and the role of environmental factors associated with tropical cyclone evolution. In this work, we have compared different reanalysis datasets for evaluating the representation of track, intensity and structure, rapid intensification, eyewall replacement cycle, and rapid weakening observed during the evolution of tropical cyclone from 2006-2015. The reanalysis datasets viz., European Centre for Medium-range Weather Forecast (ECMWF) ERA-Interim reanalysis, Global Forecast System (GFS) reanalysis, Japanese Meteorological Agency's (JMA) Japanese 55-year reanalysis projects (JRA-55) reanalysis, Modern-Era Retrospective analysis for research and applications, version 2 (MERRA-2) reanalysis are used for this study. The track, intensity and minimum sea level pressure errors in the reanalysis datasets are estimated with respect to IMD observations. It is found that generation of high resolution datasets is essential to capture the spatiotemporal evolution of different physical processes occurring in tropical cyclones. Therefore high resolution (6km) reanalysis was generated using 4DVAR and hybrid ETKF-3DVAR data assimilation schemes and Weather Research and Forecasting model (WRF). The comparison of vorticity, wind speed, specific humidity, equivalent potential temperature, diabatic heating and divergence at different level have been analysed to study the period of rapid intensification and eyewall replacement cycle of the cyclones. It is found that JRA-55 and high resolution reanalysis captures the evolution of cyclones more realistically.

Abstract ID – 382

Analysis of Summer Monsoon rainfall over Maharashtra

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Abstract

For proper understanding of climate change, study of trends of monsoon rainfall and linkages with El- Niño and La- Niña events is important as these events have a significant correlation with Summer Monsoon Rainfall. This study is based on the analysis of observed data of monthly and seasonal rainfall over Maharashtra state of Indian region, for the period 1901-2017 during Indian Summer Monsoon (ISM) viz., June through September. This analysis is carried out over Maharashtra's four sub-divisions, where mean rainfall received for JJAS (1901-2017) is more over Konkan& Goa and east Vidarbha and low over Madhya Maharashtra which also shows high coefficient of variation. Seasonal index shows the distribution of rainfall over these four subdivisions of Maharashtra, understood for different decades. Decadal difference in Seasonality Index is carried out to identify changes in seasonality index. A coherent relation is identified between El Niño and La Niña events and rainfall anomalies, which show that monthly and seasonal rainfall, are modulated by variations in SSTs of tropical central Pacific Ocean. Thus this study aims to analyse the changing pattern of rainfall over Maharashtra region which may help us to understand impact of climate change over Maharashtra and further attempt to link with El-Niño and La-Niña events.

Abstract ID – 383

Upper wind variability over shar region with special emphasis on tropical easterly jet during 1980 to 2017

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Abstract

SDSC-SHAR, space port of India equipped with Meteorology facility has upper air balloon soundings, crucial input for Rocket launchings.In present study monthly mean of Zonal and Meridional wind over SHAR region using Radiosonde and RADAR observations have been analyzed. Intensity and height of Tropical easterly jet (TEJ) stream was made.The analysis herein using 38yr (1980to2017) of data reveals that TEJ over SHAR region is maximum during July Month. Decadal Variation in TEJ peak and mean is less in July month compared to June and August months. Trend analysis reveals that is there is no definite trend of TEJ over one particular location for four decades. stastical analysis of upper wind over SHAR Region for monsoon months with special emphasis on TEJ was made. An attempt made to compare the observation data with reanalysis data.

Abstract ID – 409

Salinity variability in the Bay of Bengal during Indian Ocean Dipole and El Niño/La Niña

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Abstract

The response of salinity variability in the Bay of Bengal (BoB) during the two phases of Indian Ocean Dipole (IOD) and co-occurrence with El Niño and La Niña are examined utilizing Simple Ocean Data Assimilation for a period of 61 years (1950-2010). In this study, an index based on salinity anomaly is used to identify 13 positive and 17 negative IOD (nIOD) events during 61 years. The most striking feature of pure positive IOD (pIOD) and its co-occurrence with El Niño is the presence of comparatively saline water confined to the western BoB south of 15°N. This is attributed to the changes in the circulation pattern associated with these climatic events. In addition, during pIOD, difference in salinity between southwestern and southeastern BoB is least. However, during combined pIOD and El Niño substantial freshening is observed south of 7°N throughout May-December. El Niño results in drought like condition and La Niña events are characterized by lowering of salinity (0.3 psu) in many regions of the BoB similar to flood years. Therefore, the manifestations during each event are non-uniform from north to south. The changes in the circulation pattern associated with these climatic events are found to play a major role in the salinity variability of the bay.

Abstract ID – 417

Validation of INSAT 3D derived land surface temperature product

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Abstract

Land surface temperature is a temperature of earth's surface at a particular location. Being the direct driving force behind exchange of OLR and turbulent heat fluxes at the planetary boundary layer land surface temperature (LST) is one of the most important parameters in the physical processes of surface energy and water balance at local through global scales. Hence it is needed as an input parameter to various atmospheric, hydrological and bio-geo-chemical studies.

In-situ land surface temperature observations are very limited and unevenly spaced owing to the geographic conditions. Geostationary satellites on the other hand are able to monitor large geographical area with high temporal resolution. One of the satellites based product which caters to this requirement is LST. This product from INSAT 3D satellite is available in the domain of 81.04°S - 81.04°N and 0.84°E - 163.15°E are retrieved at 4 × 4 km on half hourly basis. However the satellites also have limitations such as the spectral, spatial resolution and obstruction of surface by cloud. Hence this satellite derived product also needs to be validated continuously against the actual observations in order to achieve and maintain its accuracy.

In this study we have validated this satellite derived product against the in situ temperature observations by Agricultural observatories of IMD. The hourly data of cloud free LST is compared with the hourly land surface temperature data. The LST is able to capture the diurnal variation well. Both the data is subjected to the statistical scrutiny and the results are discussed in details in the study.

Abstract ID – 420

Retrieval and application of high resolution low-level visible winds from INSAT-3DR Imager

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Theme: Observations in Climate Variability and Changes.

Abstract

Atmospheric Motion Vectors (AMVs) are basically derived by selecting and tracking the clouds and water vapor features from geostationary satellite images. Satellite-derived AMVs are extremely helpful in understanding synoptic-scale atmospheric dynamics and circulations and also potential input parameters to numerical weather prediction models. In India, till now operational derivation of low level visible AMVs are retrieved using coarser resolution (4 Km) images from INSAT-3DR. In this study, high-resolution low-level visible AMVs are derived from INSAT-3DR high resolution (1 km) images. Operational wind retrieval technique is followed for high resolutionvisible wind derivation. The accuracy of the new high resolution visible winds significantly improves compared with corresponding operational VIS winds retrieved at coarser resolution when both are compared with numerical model wind analysis. The statistical comparison has been carried out by calculating root mean square vector difference (RMSVD), speed bias and number of collocation points. These retrieved high- and coarse resolution visible winds are further assimilated in the numerical model to assess their impact on short-range weather forecast during Indian summer monsoon.

Key words -Atmospheric Motion Vectors (AMVs),Visible images, INSAT-3DR Meteosat-8.

Abstract ID – 427

Seasonal variation of raindrop size distribution over the wettest place on earth, Cherrapunjee

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Theme: Observations in Climate Variability and Changes.

Abstract

Cherrapunjee in Meghalayais one of the wettest places on Earth which receives around 12000 mm of rainfall every year, with almost90% of the rainfall occurringduring the pre-monsoon (April-May) and monsoon (June-Sept) seasons.Data from a Joss-Waldvogel disdrometer installed at Cherrapunjee has been used to study the raindrop size distribution (RSD) for pre-monsoon and monsoon season for the year 2017. The RDS data from disdrometer is grouped according to rainfall rates of 10mm/hr, 30mm/hr, 50 mm/hr and 90 mm/hr for both the seasons and compared. Fig. 1 below shows variation of RSD of pre-monsoon and monsoon season for similar rate of rainfall, and it can be concluded that the pre-monsoon rains consists of larger drops compared to that of the monsoon rains for all rainfall rates.

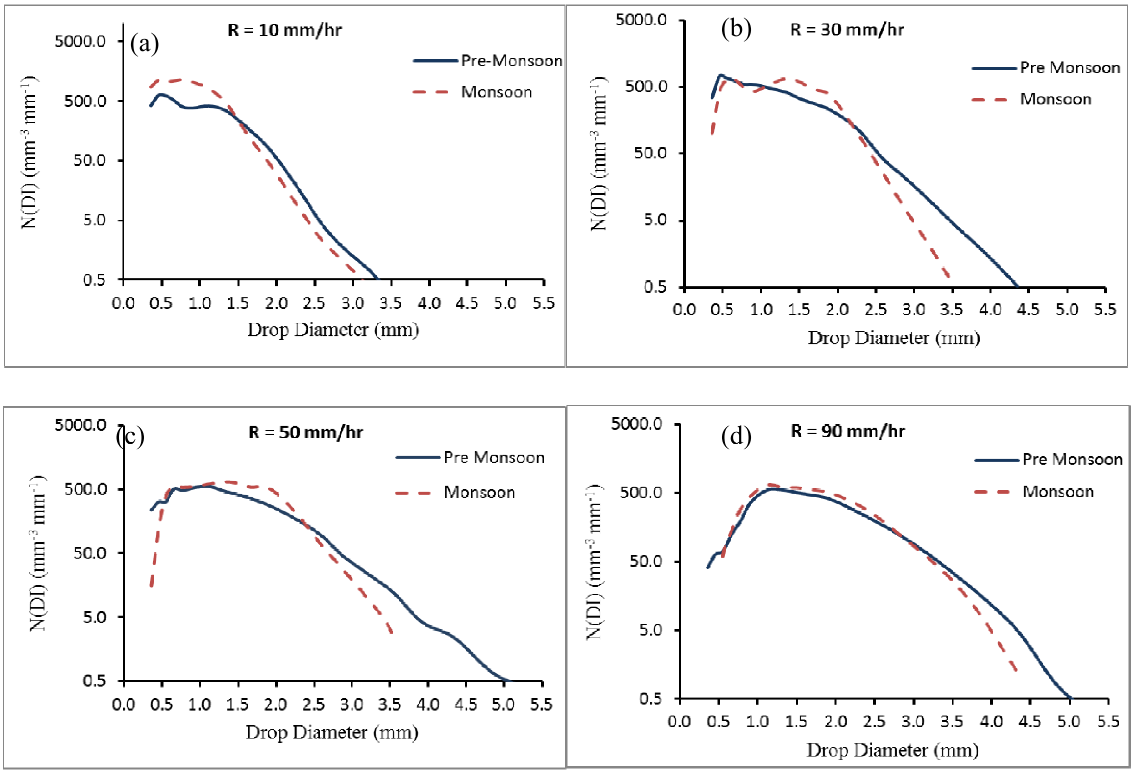

Fig. 1. Pre-monsoon and monsoon season raindrop size distribution for (a) 10 mm/hr, (b) 30 mm/hr, (c) 50 mm/hr and (d) 90 mm/hr rainfall rates

The RSD is further used to calculate Radar reflectivity factor $Z(mm^6/m^3)$ for different rainfall rate R (mm/hr). During pre-monsoon season, due to larger sized rain drops, a significantlyhigh Radar reflectivity factor *Z*is observed compared to that of the monsoon season. The correlation coefficient between Z and R is found to be 0.962 and 0.968 for pre-monsoon and monsoon season respectively.

These *Z* and *R* values are further used to estimate the coefficients A and b of the Marshall-Palmer relation $Z=AR^b$, with an objective to use the coefficients to improve the rainfall estimation using the data from a S-band polarimetric Doppler Weather Radar installed at Cherrapunjee. The calculated Radar reflectivity factor Z is plotted against the respective rainfall rate R for both the seasons as shown in figure 2 below.

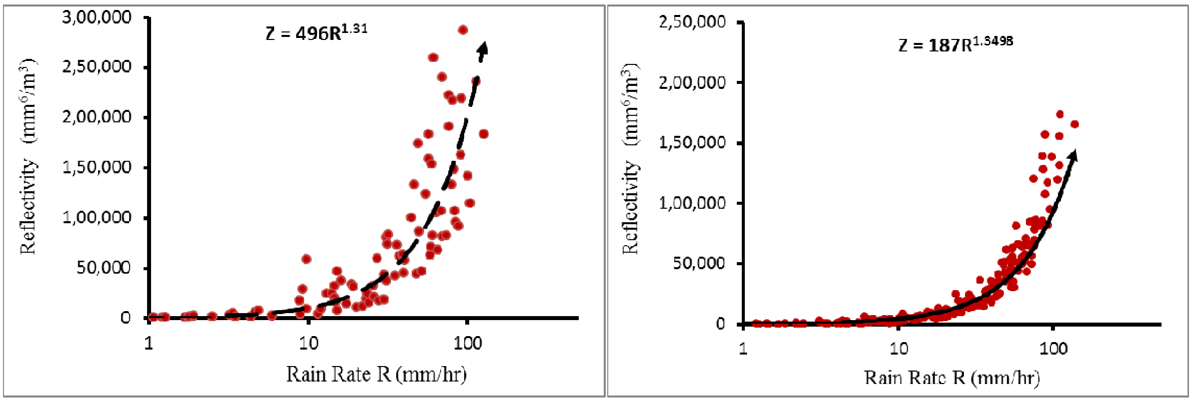

Fig.2. Rain rate Vs Radar Reflectivity plot for Pre-monsoon Rain (left) and monsoon season (right)

In the pre-monsoon season the Marshall-Palmer coefficient values are found to be A= 496 and b= 1.31 whereas for the monsoon season the values are A = 187 and b= 1.3498. The above result suggested that we should use separate coefficient values for Pre-monsoon and monsoon time to estimate rainfall using DWR Cherrapunjee.

Abstract ID – 431

Identification ofdroughthotspotsover the Eastern Gangetic Plain using high resolution data

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Theme:Observations in Climate Variability and Changes.

Abstract

Drought, being a natural hazard, is often referred as a “creeping phenomenon” and has varyingimpacts across the regionsfor a same time period. The meteorological drought in India arises due to significant deficiency of rainfall for abnormal periods over an area.The Eastern Gangetic Plain (EGP) of India is one of the most densely populated regions in the world, with a large *Kharif* crop production area feeding a considerable population in India. The EGPobservesfrequent drought conditions with a large impact on agriculture and water resources during the Indian Summer Monsoon (ISM) season. Also, it is noted that one of the most important elements in the drought risk managementis its monitoring and assessment using long-term and continuous high-resolution precipitation data. The present study analyses Indian Summer Monsoon Rainfall (ISMR)for the time period 1961-2013over differentagro-climatic zones of EGPin the states of Uttar Pradesh (UP), Bihar and West Bengal (WB) using high resolution gridded dataset(0.25°×0.25°). For this, precipitation data is collectedfrom the India Meteorological Department (IMD) and Standard Precipitation Index (SPI) based on rainfall deficit is calculated.SPI quantifies the precipitation deficiency on multiple time scales showingthe impacts of precipitationdeficiency.The results show SPIintensity which denotes the magnitude of drought and its severity for the considered time period. In addition to it, frequency and probability of various drought categories are calculated to identify the hotspots of drought with more than 50% likelihood of drought occurrences each year over the EGP.The probability and frequency ofdroughtover the EGP is found to be decreasing with respect to time.

Keywords - Meteorological drought, Agro-Climatic Zones,SPI, Drought Hotspots,Eastern Gangetic Plain (EGP), Frequency, Probability.

Abstract ID – 448

Inter comparison of rate of ionization obtained from Radon and NAIS measurements during New Particle Formation (NPF) events at Pune, India

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Abstract

Ionization process during New Particle Formation (NPF) events is studied from the simultaneous measurements of Neutral Air Ion Spectrometer (NAIS) and Radon (RTM 2200) at Pune, India in the year 2012. Total 28 NPF of events have been identified from January-December 2012. The increasing small ion concentration during morning, at about 08:00 LT, and evening hours, 18:00-20:00 LT, from NAIS coincides with the Radon and Polonium observation, which is treated as the primary source of near surface ionization. Ion-pair production rate has been estimated from ion – aerosol equilibrium equation, and it has a daily mean of 07 ion pairs $cm^{-3}s^{-1}$, whereas 15-20 ion pairs $cm^{-3}s^{-1}$ obtained during event days with the peak of 30 ion pairs $cm^{-3}s^{-1}$. Radon concentration varies high as 17.2 Bqm^{-3} during event period with the annual of mean of 7.6 Bqm^{-3}. During non-event days, estimated ionization rate from radon measurement provides the daily mean of 3.3 ion pairs $cm^{-3}s^{-1}$, where during event period it may rises from 7- 10 ion pairs $cm^{-3}s^{-1}$. Increasing Radon concentration eventually enhances the surface ionization in a significant order (>2-fold). At observation site, the radioactive molecules are deposited from the hilltop by the katabatic wind during morning hours, which probably behaves as an additional source of ionization that may substantiate the particle formation along with favorable atmospheric conditions. Equilibrium ions concentration (dia, 0.36-1.5 nm) has been derived from Radon observation and compared with NAIS measurements. The study has also computed the conductivity for positive and negative ions concentration during event and non-event days and the results are consistent with earlier observations.

Keywords -Air Ion observation, Radioactivity, Small ions distribution, NPF, Surface conductivity.

Session: Aerosols, Atmospheric Chemistry and Weather/Climate.

Abstract ID – 449

Thermodynamics of monsoon onset

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Abstract

In this project, entitled "THERMODYNAMICS OF MONSOON ONSET", we have studied the thermodynamic response of the atmosphere during the transition phase from premonsoon to monsoon period over southern station Cochin. The characteristic features of the coastal boundary layer of Cochin, and how it is transformed by the onset of monsoon is investigated with observational data corresponding to onset period of monsoon, 2017. We have observed quite a lot of significant transition features in various parameters like the increase in moisture content of the boundary layer and middle layers, the mixing height variations, Lifting Condensation Level, CAPE, and other thermodynamic variables etc. denoting the convection and instability potentials in the atmosphere. The microwave radiometer profiler data has given us a picture of how sharply the middle layer and boundary layer moisture increases preceding the onset of summer monsoon. It is possible for us to distinguish the convective activity of premonsoon characterized by intermittent deep convection moistening of the middle layers and monsoonal period with consistent and periodic patterns of stratiform clouds. The dry middle layers observed prior to the onset has moistened consistently and were supported by strengthening of low-level jet(LLJ). The monsoon moistening is noted by the low Lifting condensation Level (LCL) height compared to the mixing height.. It can be observed that the Wetbulb Zero Level (WBZ) height (level to get melting of hail hydrometeros) comes down to as low as 2 km during the premonsoon time indicating chances of hail. Additionaly, it also shows constant WBZ before and after the premonsoon storms. However WBZ shifts gradually to higher altitudes as the onset of monsoon occurs and that almost matches the freezing level, indicating sustained convection with a greater depth of moistening. This variability in WBZ height may help in the predictability of monsoon onset, based on further investigations.

Thunderstorms are characteristic to the premonsoonal period especially over coastal regions like Kerala. The various thermodynamic parameters and instability indices studied here could be possible tools for nowcasting of such deep convective systems. We have observed a general increase in mixing height, CAPE, and WBZ height succeeding the onset date. Some efforts are also made to investigate the coastal boundary layer such as the signature of sea breeze, identifying the onset of sea and land breeze, identification of return flow, thermal and dynamical structure of these features. The onset of sea breeze causes an overall reduction in temperature and rise in moisture content of the atmosphere. The sea breeze together with the return land flow initiates strong convective activity due to the trapping of dry and buoyant premonsoonal air within the cool and moist air from the sea. The convection initiates as the return flow weakens and a front is developed. The study has, hence summarized, some of the observed boundary layer features during the transition from premonsoon to monsoonal period using observational data of monsoon 2017.

Abstract-ID - 452

Climatology and distribution of cirrus and sub visible cirrus clouds over Indian summer monsoon region

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Abstract

The cirrus clouds influence the climate and greenhouse effect globally and have a direct impact on the Earth's radiation balance. Tracking of cirrus clouds and their close investigation is a complex task. Uncertainty in shape, size and micro-physical properties of ice in higher altitude clouds makes it difficult for their accurate representation in climate models. The high clouds (especially cirrus) produce a positive feedback effect on the climate system. The climatology of high clouds over the Indian summer monsoon region has been derived from the CALIPSO satellite dataset (2006-2017). The frequency of distribution of cirrus cloud and sub visible Cirrus cloud is also derived from the CALIPSO data. The condition for Cirrus Clouds with optical depth greater 0.03 and temperature less than -40°C and for sub visible clouds with optical depth less than 0.03 are used for the study.

The composite of spatial distribution of cirrus and sub visible cloud during monsoon period (June to September) shows that the frequency of occurrence of high clouds is more over the Bay of Bengal, the Tibetan plateau and some of the central and north eastern parts of India. This could be attributed to deep convection associated with monsoon circulation. The shift in ITCZ plays a prominent role in the formation of deep convection during monsoon period and hence the formation of high clouds in the northern hemisphere. There is extensive coverage of cirrus cloud between 18° N to 30°N latitudes and 90°E to 110°E longitudes. The analysis showing the effect of wind on the distribution of Cirrus and sub visible cirrus Cloud over Indian Subcontinent during monsoon period.

Abstract ID – 455

Validation of sea surface temperature from different global reanalysis products in Indian waters usingin-situ OMNI Buoy observations

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Abstract

Sea Surface Temperature (SST) is a vital parameter in assessing the ‘climate change’ on a global scale. Various numerical models have been developed on global scale and continuous improvements are sought using reanalysis and satellite data assimilation. Different models developed by different countries generally use nested grids having very high resolution in their regional seas and at areas that are globally important and a coarser resolution elsewhere.Their temporal resolution also varies. The improvement due to assimilation of satellite products also depend on their coverage, periodicity and is not uniform globally. It suffers land boundary effects as well as representation errors. As the numerical models and satellite observations suffer their respective short comings, *these global productshave to be validated with in-situ measurements* at strategic locations to understand the degree of mimicking the nature in *Indian Waters* through modelling. This exercise is necessary in order to ensure the degree of confidence to the user community as well as to quantify the uncertainty aspects and therefore, to look for measures to tackle them by probing further.In this regard, in the present paper, SST from reanalysis products is validated using observations from moored buoys in the Bay of Bengal (BoB) during the year 2016. SST reanalysis data sets from ERA Interim reanalysis,Global Ocean 1/12° Physics Analysis and Forecast (from CMEMS) andSimple Ocean Data Assimilation (SODA)are utilized.The three datasets, with varying temporal resolution i.e., 6 hourly, daily and 5 day mean for ERA Interim reanalysis, CMEMS and SODA respectively are compared with in situ measurements from NIOT moored buoys (OMNI buoy data sets) in the BoB which are available at 3 hour interval. The reanalysis products with different temporal resolutions are chosen so as to infer how this would influence the correlation. The degree of correlation (validation) at different buoy locations that are strategically placed to capture specific phenomenon have been analysed and the reasons for their varied performance areexplained.

Abstract ID – 460

Temperature trend analysis of Bhubaneswar City, India

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Theme: Observation of long term climate monitoring.

Abstract

Climate change poses the major environmental threat ever known by humankind. India has observed significant irregularity in natural inconsistency of temperature and rainfall patterns and has experienced more frequent and lethal catastrophes in recent decades. As the majority of the world's population is living in urban environments, there is rising interest in studying local urban climates.This paper effort to study temporal variation in temperature over Bhubaneswar city, India during the period of 1953 to 2017. The long-term change in temperature has been estimated by Mann-Kendall rank statistics and linear regression trend. From the population trends Less Urbanized Period (LUP) and More Urbanized Period (MUP) were identified. The analysis reveals significant increase in mean maximum temperature (MMaxT), mean minimum temperature (MMinT) and mean annual temperature (MAT). This increase in temperature is more noticeable during the summer season which can be ascribed to a significant decrease in the amount of suspended particulate matter (SPM) in the ambient air during the last decade.

Key words -Climate change, Catastrophes, Urban climate, Mann-Kendal, SPM.

Abstract ID – 466

Effect of deep convective events on the thermal structure of the troposphere and lower stratosphere including the tropical tropopause layer (TTL)

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Abstract

Influence of deep convective events on the thermal structure of Troposphere and Lower Stratosphere (TLS) is investigated using radiosonde data, obtained from Trivandrum (8.5°N, 76.9°E), Gadanki (13.5°N, 79.2°E), Bhubaneswar (20.25°N, 85.83°E), Kolkata (22.65°N, 88.45°E) and Singapore (1.37°N, 103.98°E), collected during the period 2008–2014. During deep convective events, the temperature showed lower tropospheric cooling, an upper tropospheric warming and an anomalous cooling (warming) below (above) the cold point tropopause (CPT) with respect to the clear-sky value. While warming in the upper troposphere is strongest (~2–4 K) around 10–12 km, anomalous cooling (warming) below (above) the CPT is maximum around 15.5 km (17.5 km) with values in the range of –2 to –4K (3–6 K). These temperature perturbations are observed 4–5 days prior to the convective events. In response to deep convection, surface cooling up to ~–4 K is also observed. This study showed that the magnitude of cold and warm anomalies increases with strength of convection. During deep convection, the potential temperature (θ) shows a decrease (<5 K) in the tropical tropopause layer (TTL) from the TTL-base up to CPT compared to that on clear-sky days, confirming the vertical mixing of convective air from the lower atmosphere to the TTL-levels. Correlation analysis between different TTL parameters suggests that, as the cloud top altitude increases, along with the adiabatic process, diabatic process also plays a major role in the TTL. An interesting feature observed during deep convection is the ascent of TTL-base by ~1.5 km and descent of CPT and TTL-top by 0.5 km, which effectively thins the TTL by ~2 km.

Abstract ID – 470

Analysis of long term climatic trends in rainfall events over Madhya Pradesh in twentieth century (1871-2016)

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Abstract

Madhya Pradesh, India's second largest state, occupies 9.38% area of the country comprises of two meteorological subdivisions viz. East MP & West MP and ten agro-meteorological zones. The varying climatic conditions in ten agroclimatic zones and various geographical features have been responsible for drought and flood conditions in different parts of the state. Increasing urbanization, population and economy of the state are causing adverse impacts on the natural environment. The long- term trends of rainfall are required for the planning of optimum adaptation strategies for the sustainable use of natural resources such as water. Detection of past trends, changes and variability in the time series of rainfall is very important in understanding the impact of climate change at regional scale on water resources. An attempt has been made to study temporal variation in rainfall at annual, seasonal &subseasonal (monthly) scale over East & West MP meteorological subdivisions and MP state as a whole during the period 1871-2016. The long-term changes in rainfall characteristics are determined by nonparametric Man Kendall and Sen's slope estimates. In monthly trends the rainfall over West MP has shown a significant decrease during June while a significant increase during August, whereas the seasonal and annual trends of rainfall are not significant in West MP. In East MP, annual as well as seasonal rainfall during monsoon season have shown significantly decreasing trend which is most prominent in June and July months. Monsoon rainfall is showing a rapid decreasing trend of 4 mm per year along with significant decrease in annual and June month rainfall over the MP state as a whole. Although, the winter and premonsoon rainfall showed increasing trends for the East as well as West MP and for MP state as a whole; however the post monsoon rainfall showed a significantly decreasing trend over West MP and over MP state as a whole during past 50 years. The state obtains major rainfall during monsoon season only and rests of the season contribute only ten percent to its annual average. Due to this decreasing tendency in monsoonal and hence annual rainfall, the urban and semi urban areas of the state are facing problems of daily usable water availability mainly in pre-monsoon season. The changing rainfall trends during monsoon season are affecting kharif crop sowing pattern and its productivity. The significantly decreasing monsoon and post monsoon rainfall pattern are causing high electricity consumption by farmers to support the crop water requirement.

Keywords -Trends, Mann-Kendall Test, Sen's slope, Crop water requirement, Tendency.

Abstract ID – 494

Changing relationship of Southern Oscillation with Indian summer monsoon rainfall

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Abstract

This study explores the influence of Southern Oscillation on Indian summer monsoon rainfall during June-July-August-September (JJAS) season for the time domain of 1982-2013. The monthly Southern Oscillation index (SOI) data have been taken from the Climate Prediction Center of National Oceanic and Atmospheric Administration (NOAA), USA and observed rainfall dataset have been taken from India Meteorological Department (IMD) over the land points of India during 1982-2013. The correlation coefficients (CC) between the SOI and Indian summer monsoon rainfall during JJAS season shows the significant correlation pattern over the two regions (Reg1: 70°E-80°E,13°N-20°N and Reg2: 70°E-80°E,27°N-33°N). The regression map of rainfall over India corresponding to the SDI index also shows the similar pattern. The study is further extended to identify the physical mechanism of this impact, and it is found that the composite rainfall over India for the years having positive (negative) SOI events shows an excess (deficient) rainfall over these two regions by modulating the circulation pattern. The present study will be further extended to investigate the exact processes of this interaction through some modeling experiments.

Abstract ID – 503

Sustained Global Climate Observation System Upper Air Network (GUAN) of IMD

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Abstract

Using global standard high quality radiosounding systems, India Meteorological Department (IMD) has established GUAN standard radiosounding network at its regional head quarters namely New Delhi, Mumbai, Kolkata, Chennai, Nagpur and Guwahati during August 2015. These stations have been equipped with M/s GRAW radiosondes, Germany make, high quality GPS based radiosounding system model No GS-E along with DFM-09 radiosondes. Based on their performance of one year, IMD requested GCOS secretariat through Secretary General, WMO, for inclusion of these station into GUAN network. IMD's claim was discussed and approved by Atmospheric Observation Panel on Climate (AOPC-22), Exeter, UK, 27-31st March 2017. Since then, the performance has been closely monitored and found that these stations are fully compliant for the commitments made by the WMO Member for inclusion of a radiosounding station into the GUAN network. All the 6 stations have achieved minimum observational requirements like Nos. of sounding in a month, soundings observed beyond minimum requirement of 100 hPa level, and in most of the cases approach up to the target requirement of 5 hPa level. The RMS departures in case of geo-potential height, observed temperatures and wind vectors have been found well within the minimum requirements (MRQs) and very near to the target requirements (TRQs)-which establishes the accuracies of observed data. The biases observed in monthly climatological averages are observed within the MRQs and approaching to the TRQs. These stations actually fulfilled the essential minimum requirements of radiosounding observations for a GUAN standard radiosounding station, with respect to all the parameters of observation, and very closely approaching the target requirements of GUAN standard radiosounding observatories continuously. The network has sustained without a break since the establishment, performing well meeting all the standards, and committed for continuation.

Key words –Radiosonde, Minimum requirement (MRQ), Target requirement(TRQ), Bias, Standard deviation (SD), Root mean square error (RMSE), GUAN network, GPS.

Abstract ID – 508

Role of Indian and Pacific Ocean in subsurface variability in Southern Indian Ocean (SIO)

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Abstract

We investigated the subsurface temperature variability of tropical Indian Ocean (TIO) during the time period 1980-2015. The temperature and salinity data is obtained from the Simple Ocean Data Assimilation (SODA) product. The Empirical Orthogonal Function (EOF) analysis is performed on the detrended dataset to identify the dominant mode of variability in subturface temperature anomalies during 1980-2015 for three seasons namely Sep-Oct-Nov (SON), Dec-Jan-Feb (DJF) and Mar-Apr-May (MAM). The pure IOD, pure El-nino and co-occurrence years are identified based on the conventional definitions. A Subsurface Dipole Mode index (SDI) is used in this study to quantify the intensity of north-south dipole mode of the temperature profile. Lead-lag correlation analysis is performed to demonstrate the change in the relationship between Dipole Mode Index (DMI), Oceanic Nino Index (ONI) and SDI with time. The forcing mechanism has been indentified for the subsurface variability. It has been re-asserted that ONI has dominance over the DMI after its demise on the subsurface variability of the TIO. It is found that El-Nino effect is moving northward of 10°S when it comes to the subsurface of TIO.

Abstract ID – 520

The analysis of monthly and seasonal variation of minimum and maximum temperature over India and its homogenous regions

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Abstract

Since the late 19th-century, an increase in concentrations of GHGshasled to increase in the annual mean global temperature by 0.9°C(NASA 2017).Based on the current increasing trend of GHGs emissions,it is estimated that the global mean surface temperature will vary between1.5 to 4.0°Cby 2100 with respect to 1850-1900 (IPCC, 2014).After industrialization, various reasons such as natural phenomenon i.e. reduction in western phenomenon, thunderstorm activities and reduction in precipitation, and anthropogenic activities i.e., exploitation of natural resources, pollution of air and water, increasing GHGs due to fossil fuel burning, land use changes, deforestation, chemical fertilization, industrialization and infrastructures, improper management of wastes, unplanned urbanization, increasing population etc. are responsible for rise in temperature. Seasonal and monthly trends in maximum and minimum temperature over India and its homogenous regions mainly in Interior peninsula, North-central and North-west have been assessed during the period of 1901-2007 with the help of mean and linear regression trend line. Data for the analysis was obtained from the Indian Institute of Tropical Meteorology, Pune (www.tropmet.res.in).

Most of the higher increasing trends in recent years in both maximum and minimum temperature have increased sufficiently in cold days than the maximum temperature. Variations occur for different regions on the basis of different time scales as pre-monsoon and monsoon in lasttricade(1978-2007) whereas post-monsoon and winter in recent decades have shown the highest rates of increase in temperature compared to previous years(1901-1950).After comparing homogenous regions of India, maximum increasing trends in temperaturewere observed in winter and post-monsoon seasons in recent years.The third decade in pre-monsoon (1921-1930), temperature has the highest rate of decreasing trend in the maximum temperature and minimum temperature.In tricadal variation of the minimum and the maximum temperature, the highest rate of increasing trend of temperature was mostly recorded in the last tricade (1978-2007) of winter season all over India with its homogenous regionsbut in case of minimum temperature pre-monsoon showed highest rate in North-central, monsoon in Interior peninsula region and during maximum temperature pre-monsoon showed highest rate of temperature.The rate of increasing trend is found to be maximum in thewinter season as well as in Post-monsoon season on basis of decadal mean temperature and for different time-scales.To minimize the increasing trend of temperature a collaborative effort is required where both government and private sector may work together to alleviate the negative impacts as well as to find ways to minimize the current trend of increasing temperature.

Key words : Temperature, India, Greenhouse gas, Linear regression, Season**.**

Abstract ID – 35

Volume and heat transport of Indonesian throughflow using a fine resolution ocean model

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Abstract

Indonesian through has its effect on Indian monsoon and global climate system which has a large impact on its socio-economic system. Indonesian throughflow magnitude and variability are still source of major uncertainty for both the modelling and observational oceanography studies. Though general circulation models are gradually improving, they are unable at present to reproduce the narrow passages and convoluted bottom topography of the internal Indonesian seas in order to adequately resolve the structure and variability of the ITF transport. They are the dominant sources of error in the basin-wide heat and freshwater budgets for the Pacific and Indian Oceans. I this research a high resolution ocean general circulation model used to study the dynamics of Indonesian throughflow. The mean mass transport of the Indonesian Throughflow channels are wide-ranging, from near zero to 30 Sv (1 Sv=10^6 m^3 s^{-1}). The heat and fresh water carried by the Indonesian Throughflow potentially impact the basin budgets of both the Pacific and Indian Oceans. Heat transport ranged from 0.5 to 2.0 PW (petawatt, with 1 PW=10^{15} W) as the throughflow was assumed to be surface-intensified, and reflect the relatively warm temperatures found in its western Pacific source waters. Heat transport is calculated as volume transport multiplied by temperature, density and specific heat, using reference temperatures between 0 °C and 4 °C.

Abstract ID – 37

Evaluation of CMIP5 climate model projections of surface wind speed over the Indian Ocean region

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Abstract

Global Climate Model (GCM) simulations of Coupled Model Intercomparison Project Phase 5 (CMIP5) are being widely used for the projections of future climate change. In this study, we have systematically evaluated the future simulations performed under four contrasting Representative Concentration Pathway (RCP) scenarios obtained from 35 GCMs. The current wind climate (2006-2016) in GCM simulations have been assessed relative to the merged altimetry derived wind speed. The skill assessment of GCM in representing the mean variability of speed was further evaluated using the Taylor's skill score and thereby converging to a suite of best-performing models was selected. Multi-Model mean (MMM) corresponding to four RCP scenarios were constructed from ACCESS1.0, CanESM2, CMCC-CMS, HadGEM2-AO, HadGEM2-CC, HadGEM2-ES, MPI-ESM-MR, MIROC-ESM, MRI-CGCM3 and NorESM1-M. The MMM wind climate estimated from these groups of models tend to perform better than individual models with significant improvements over most of the Indian Ocean region. The MMM skill score obtained from the four RCP scenarios were found to be similar, as the radiative forcing in these climate model experiments do not vary significantly for the recent decades. Despite the high similarities of RCP4.5 and RCP8.5 across the multiple evaluation metrics, our study indicates that the RCP4.5 scenario seems more realistic in representing the current wind climate for the Indian Ocean region. The study also evaluated future wind changes under the realistic scenario RCP4.5 and a very high emission scenario RCP8.5 for the two periods 2026-2045 and 2080-2100. Significant changes in wind climate projections with reference to the historical period (1993-2005) are observed in the north Indian Ocean region, the zonal band of 30^{o}S and region south of 40^{o}S. Consistent reduction in wind field of 0.4ms^{-1} (0.85ms^{-1}) in bias corrected RCP4.5 (RCP8.5) is observed for the south eastern Arabian Sea by the end of 2100. In the Southern Ocean region intensified wind speed change of 1.3ms^{-1} (2ms^{-1}) is accounted in RCP4.5 (RCP8.5) simulations after incorporating necessary bias correction. Future projected changes in surface wind patterns are found to be moderate for the 2026-2045 periods and wind speed climate pattern will be significantly changed by greenhouse gasforcing by the end of 21st century.

Keywords - GCMs, CMIP5, RCPs, Wind climate, Projections.

Abstract ID – 113

Indian Summer Monsoon variability over North East India (NEI)

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Abstract

North East India is hotspot of diverse and abundant biodiversity. These lifeforms are particularly adopted to the local climate over the region.In the climate change scenario, the precipitation and temperature patterns in the recent decades have drastically changed over North East India (NEI).The surface energy budget is a possible cause for the local climatic processes. Such processes are resultant of the surface sensible heat and release of latent heat from the surface to the atmosphere. Hence, this is a cyclic process of evapotranspiration, condensation and precipitation over the land that has changed in the recent past. In the present experiment the surface energy budget is analyzed using IMD, CRU, ERA-Interim and CORDEX model data sets for the period 1951-1985 and 1986-2015. The present experiment shows a small increasing trend in near surface temperature during the span of 1951-1985 (35 years), while a strong significantly increasing trend is observed in the span of 1986-2015 (30 years). The precipitation trend in first period is significantly increasing, but decreasing trend is observed during the second span at 95% significance (especially over Shillong plateau). This is further governed through the surface net solar and thermal radiation. The precipitation trend over NEI is found to be significantly decreasing during recent decades. The possible reason for this phenomenon is an imbalance of the surface energy budget over this region.

Keywords - Latent heat, Sensible heat, Evaporation, Solar radiation, Thermal radiation andtemperature.

Abstract ID – 115

Investigation of dry bias in a coupled regional land-atmosphere model over Indian region

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Abstract

In the present study, an attempt is made to evaluate the performance of coupled land-atmosphere regional climate model (RegCM4-CLM4.5) in simulating the Indian Summer Monsoon. For this purpose, ERA Interim dataset is regionally downscaled for the period 1990-2007 over Indian region using MIT-Emanuel convective parameterization scheme within RegCM-CLM4.5. An eastward shift in the monsoonal precipitation in RegCM-CLM4.5 simulations with larger dry biases over Indian landmass is found. An attempt is made to further find out, whether the imbalances in different components of radiation in the model simulation owing to representation of the surface features using CLM4.5 leads to such an unusual behavior. The JJAS mean climatology of the surface net downward shortwave flux, clear sky net downward surface shortwave flux, and net top of the atmosphere upward longwave flux is well captured in the model simulation. The lesser precipitation over the Indian landmass is explained by an underestimation of the total fractional cloud cover with respect to observation. This is also accompanied by a substantial underestimation of the surface downward and upward longwave radiation fluxes,which affects the atmospheric heat and energy budget in the model simulation. This further could have implications for the simulation of kinetic energy, moisture convergence, total precipitable water and therefore the precipitation in the simulation using CLM4.5 coupled to RegCM4 atmospheric model.

Keywords - Indian summer monsoon, Dry bias, RegCM4, CLM4.5, Radiation budget.

Abstract ID – 141

A Study on Variability of Equatorial Indian Ocean Currents by using OSCAR, Model and observed in-situ current data

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Abstract

Indian Ocean is unique and dynamic in nature when compared to the Atlantic and Pacific Oceans as it is strongly coupled with the seasonally reversing monsoons and shows large variability both on spatial and temporal scales. The Equatorial Indian ocean currents play an important role in weather and climate of the Indian sub-continent especially monsoon system.We made an attempt to study the variability in the observed currents at Equator, 77E in the EEQIO during 2014-16 periods using Synergy data from insitu, satellite and model data.The availability of new high-frequency satellite wind data, HYCOM model data and in situ observations were used for the present study. Accurate estimates of surface winds with high time and space resolutions from the Quick Scatterometer (QuikSCAT), the long-term time series currents data collected at a number of deep-sea moorings and HYCOM model data help to resolve the sub-seasonal variability.The monthly variability of zonal and meridional currents shows much variability only in zonal currents with the predominant semi-annual variation. OSCAR shows that the dominant annual and semi-annual periodicities, known to exist in these systems, have been faithfully picked up by OSCAR, The zonal component of OSCAR-current is in good agreement with corresponding observed current component. The daily averaged time series zonal currents data are subjected to spectral analysis by applying 10-day low-pass filter to understand the dominant variability in the observed zonal currents in the deeper equatorial Indian Ocean.

Key words -Equatorial currents, OSCAR Currents, Monsoon, Indian Ocean, Zonal, meridional.

Abstract ID – 143

Assessment of hydrometeorological variables over the Pahuj River basin using WRF model

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Abstract

Temperature is one of the key variables which influence the nature of other meteorological variables. The Pahuj River basin (Datia, Madhya Pradesh) has been selected as a study area. The National Centers for Environmental Prediction (NCEP) global reanalysis dataset is downscaled using the Weather Research and Forecasting (WRF) model for estimation of surface temperature over the Pahuj river basin and compared against observational gridded data of India Meteorological Department (IMD). The temporal period under investigation is from 2005 to 2015. The performance statistics - Correlation, Root mean square error (RMSE), Percent Bias (PBIAS) are used for the assessment of temperature datasets. Correlation analysis is showing the strong positive linear relationship between the observed (IMD) and Modelled (WRF downscaled) temperature data. IMD and WRF Temperature data over Pahuj river basin are showing strong positive (r=0.99) linear relationship. While IMD and WRF Temperature shows very low RMSE (1.61) and PBIAS (1.6).

Abstract ID – 189

Modeling of raindrop size distribution over Darjeeling (India): Using Micro Rain Radar

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Abstract

A study of raindrop size distribution (DSD) where theMicro Rain Radar (MRR-2) observations have been carried out over Darjeeling (27.05°N, 88.26°E), India. MRR-2 provides the measurement of the DSD (number of raindrops and rain rates with the time interval of one minute) with the altitude profiles and rain rates. The MRR-2 data is simulated using the general formula of the moment of the gamma DSD. In order to check the true estimation of DSD, we applied the model to the exponential, lognormal, and gamma functions and found that gamma model holds the best with both lower order and higher order moments. The DSD of empirical model is derived on the basis of fit parameters evaluated from experimental data. It is observed that data fits well in gamma distribution over Darjeeling. The relation between slope (Λ) and shape (μ) shows the best resemblance at the height 150 m (above the ground surface/radar surface) for the lower order moments irrespective of the rain rates. However, by linear or polynomial fits, the relationship between μ and Λ do not resemble for any rain rates that holds for many other studies over study sites.

Abstract ID – 196

Skill of Indian summer monsoon rainfall prediction in multiple seasonal prediction systems

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Abstract

We use seasonal forecasts from the Climate Historical Forecast Project (CHFP) to study the skill of multiple climate models in predicting Indian summer monsoon precipitation. The multi-model average of seasonal forecasts from eight prediction systems shows statistically significant skill for predicting Indian monsoon precipitation at seasonal lead times. Rapid convergence of tropical rainfall skill with ensemble size means that the skill of seasonal monsoon rainfall forecasts improves only marginally when using multi-model ensemble (MME) means as compared to the single most skillful single systems. There is also a large range in the skill of individual models. Some individual models show correlation skill as high as 0.6, which is similar to the MME mean, while others show low skill. We also investigate the effect of spatial averaging on the skill of predicting monsoon rainfall and show that predictions averaged over a larger area than the verifying observations can yield higher skill due to the extended spatial coherence of monsoon rainfall variability. We also document current errors in seasonal prediction systems and show that these are more strongly related to errors in El-Nino Southern Oscillation (ENSO) teleconnections than they are to mean rainfall biases. Finally, we examine the ENSO-monsoon relationship and confirm that this relationship is likely to be stationary, despite fluctuations in the observed relationship, which can simply be explained as sampling variability on an underlying stationary teleconnection between ENSO and the Indian monsoon.

Abstract ID- 236

Influence of aerosols on monsoon: a case study over Bengaluru

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Theme : Weather/Climate Modelling at Regional & Global Scales

Abstract

The atmospheric aerosols varying from few nm to micron are of major concern in changing the weather phenomena and also for account of climate change. However, the records of global aerosol distributions have only become available recently from dedicated satellite observations such as MODIS and MISR. Despite much progress made recently in using satellite data to derive surface aerosol concentration over land, several challenges exist. By making use of the satellite data on aerosols, the monthly and seasonal variations are studied for Bengaluru environment, where the range covers 1^0 by 1^0 with mean moves over Bengaluru. The size distribution of aerosol is having a great control on the formation of cloud condensation nuclei and its influence is evident from this study. To know the variability in aerosol content, the back trajectories were obtained from HYSPLIT to see the origin and possible source from where air masses have arrived. The result clearly shows temporal variations with maxima during summer and southwest monsoon compared to pre- and post monsoon seasons. As a preliminary study the data has been analyzed for the period from 2001 to 2017 and the results are discussed in detail.

Abstract ID – 288

Skill of Rainfall simulation of NCUM global weather forecasting model during Indian Summer Monsoon 2018: Large Scale Aspects

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Abstract

India receives more than 60% of its annual rainfall during summer monsoon season, thus accurate prediction of its rainfall variability holds great importance for agro-economy sector. In this study, medium range rainfall forecast from Unified Model based global forecast system (NCUM) operational at National Centre for Medium Range Weather Forecasting Unified Model is analyzed. The NCMRWF upgraded the resolution of the model from 17km to 12km on June 2018. Study period was chosen to be 20th May to 18th July (60 days) during which model output at both resolutions were available. Model data were available with lead forecast time of day-1 to day-10. Considering day-1 to day-3 forecast to have reasonably good skill this study concentrated upon day-5 to day-10 forecast skill verification. Further, forecast of northward propagation of rainfall during onset and progress phase of monsoon is analyzed.

Statistical parameters like mean error(ME) and root mean square error(RMSE) has been computed at every model grid point using observed IMD-NCMRWF merged gridded rainfall data. Weekly observed and forecast anomalies are computed against mean rainfall during the study period and anomaly correlation coefficient (ACC) is analyzed. To study northward movement of rainfall, Hovmoller diagram was plotted for both observed and forecast values with 60-day daily rainfall data. Model skill has also been verified during two wet spell and two dry spell over central India in between the span of 60 day study period.

Results show that the model skill decreases as forecast lead time increases from day-5 to day-9. Both the model has reasonably good skill in simulating rainfall and shows wet bias over Western Ghats and Himalayan foothills. Spatial RMSE plots shows higher error value at areas where model predicted rainfall amounts are also higher. Errors grow gradually from day-5 to day-9 forecast. ACC values also show an immediate drop as forecast length increases from day-5 to day-9. Maximum value of ACC at day-5 forecast has gone up to 0.6. Both the model depicted northward propagation of isochrones quite well. In few cases model has created false propagation pattern, thus some mismatch with the observed propagation pattern has been noted.

Abstract ID -297

Predictability of Indian summer monsoon rainfall using ensemble of regional climate model output

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Abstract

The predictability of Indian summer monsoon rainfall (ISMR)is investigated using 10-ensemble members of regional climate model (RegCM4.5) during the years 2000 to 2014. The signal to noise ratio(SNR) is used to measure the predictability of the ISMR. The RegCM4.5 is run at a horizontal resolution of 50 km under the Coordinated Regional Climate Downscaling Experiment (CORDEX) framework over the South Asia domain. The land surface processes are incorporated with Biosphere-Atmosphere Transfer (BATS) scheme.The simulated output of ensembles members is evaluated against the available observations and reanalysis data. It is found that the ensemble mean model results show realisticsimulation of the spatial structure of lower and upper level circulation, temperature, and precipitation of the region of study. The ensemble members show a systematic dry bias over the central Indian region and a large wet bias over the Arabian Sea (AS) and Bay of Bengal (BoB) during the summer season. However, the dry bias over India is reduced in the ensemble mean output.

Abstract ID – 351

A study of high intensity rainfall events in the NCEPCFSV2 model and comparison with observation

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Abstract

In the current scenario of increasing frequency and intensity of extremeprecipitation events in a developing and heavily populated country likeIndia, which is highly vulnerable to the after effects of monsoon variabilitiesand widespread extreme events, it is indeed necessary and at most urgent toverify and quantify the reliability of the model used for understanding andpredicting these events. The present study provides a platform for appraisingand understanding the skills and expertise in simulating the frequency andintensity of extreme rainfall events of the National Center for EnvironmentalPrediction (NCEP, USA) Climate Forecast System (CFS) version 2, at tworesolution CFS T 126 and CFS T 382 which is used for seasonal andextended range prediction in India. This study utilizes high resolution (1 ° ×1° lat./long.) gridded daily rainfall dataset over Indian region, prepared byIndian Meteorological Department (IMD) and free run data from the twoindividual components of the state of the art model CFSv2. From theanalysis of departure and bias of both the components of model with respectto IMD observation it is observed that dissimilarity in simulating highintensity rain events exists between these models which should be otherwisesame. Both the models capture intensity and frequency differently whichshould be corrected and verified so as to improve the predictability of thewidespread extreme precipitation events.

Abstract ID – 353

Impact of Ocean mixed layer depth initialization on simulation of tropical cyclones over Bay of Bengal using WRF-ARW model

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Theme :Weather/Climate Modelling at Regional & Global Scales.

Abstract

In this study, the sensitivity of simulated Tropical Cyclone (TC) intensity and track to the different ocean mixed layer depth (MLD) initializations is studied using a coupled weather research and forecasting (WRF) and Ocean Mixed Layer (OML) model. Four sets of numerical experiments are conducted for the two pre and post monsoon TC cases (Vardha and Nargis) such as by initializing the WRF model with SST update (control run), with the coupled WRF-OML model using MLD of constant depth (50m),by initializing the model with MLDestimated from temperature and finally with MLD estimated from density criteria. The analysis of the model simulated track and intensity with the best track estimates of IMD reveal that there areconsiderable differences in the track, intensity, and structure of TC, and simulated rainfall between simulations of coupled OML and uncoupled model of WRF. With all the simulations, the storm intensity is slightly underestimated. The uncoupled simulations, i.e., with only SST update, exhibit early storm's deepening with a faster translation movement leading to early landfall and producing large track deviations compared to observations. While the coupled OML model simulations captured the deepening phase close to the observed estimates, resulting in the reduction of errors in both vector and along tracks of the storm. The initialization of the different MLDs in WRF-OML shows that the simulations of TC intensity and translation speed are sensitive to the initial representation of MLD.But these initial variations of MLD show little impact on the simulation of vector tracks. The improvements in translation speed and intensity of the storm with the realistic representation of OML are mainly due to the representation of MLD alters the storm induced cooling resulting changes in the enthalpy fluxes supplied to TC, leading to the better representation of secondary circulation and the evolution of deepening phase of the storm.

Key words -Tropical Cyclone, Model initialization, Mixed layer depth and translation speed.

Abstract ID – 396

Advancement in the algorithm of physical initialization of numerical models

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Abstract

Recently, increase in the frequency of extreme episodic rainfall events are major threat to the population and also pose a great challenge in the prediction of the same to the scientific community. With this agenda in mind, advanced initialization techniques have been used to force the operational models like Weather Research and Forecasting (WRF). It has been studied that a huge improvement in the prediction skills pertaining to the nowcasting of rain rates is possible with physical initialization schemes. The algorithm for Physical Initialization method developed by Dr.Krishanmurti is used to improve short term (day 1-2) forecast targeted at more than 95% skill rate. In addition to the nowcasting of severe rainfall, the algorithm is also tested with cases of cyclones and monsoonal rainfall. In both the cases, we have obtained similar skills as in extreme rainfall events. Current research is to implement the advanced algorithm in the WRF Model. With this better initialization, much higher skills in the forecasts can be achieved. Another aim of the study is to provide site-specific forecasts. The present skills have been achieved with the help of assimilation of GPM/IMERG rainfall data which has a spatial resolution of 10km. Three different genres of case studies i.e., Hurricane Harvey (2017/08/27 – 2017/08/28), Heavy Rainfall Event in Uttarakhand (2013/06/15 – 2013/06/16) and Monsoonal Rainfall (2017/08/28 – 2017/08/28) will be discussed. The improved version of the physical algorithm would involve in the implementation of the scheme in cloud-resolving model physics. High spatial resolution datasets using rain gauge, radar can be used for this purpose.

Abstract ID – 422

Impact of assimilation of satellite winds in simulating tropical cycloneOckhi features

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Theme :Weather& Climate Modeling at Regional and Global Scales.

Abstract

Tropical cyclone Ockhi generated over Equatorial Indian ocean and was rapidly intensified over Arabian sea. The cyclone also showed rapid weakening over north Arabian Sea. In this work, a high resolution (6km) reanalysis is created by using mesoscale model WRF by assimilating SST and scatterometer winds. The satellite wind data from scatterometerASCAT, SCATSAT-1 and CYGNSS satellites are assimilated. The resolution of ASCAT and SCATSAT-1 winds is 25km x 25km while CYGNSS winds are available at 0.2 degree resolution. Themesoscalere analysis is compared with IMD observations and other global reanalysis data sets like ERA Interim, MERRA2 to assess the impact of assimilation of satellite winds. WRF model is initialised with GFS analysis. The track, intensity and structure of the Ockhi cyclone is computed from WRF reanalysis data is compared with the reanalysis data sets. The assimilated products generate better features of the Ockhi cyclone than the global reanalysis data sets. The results on the study will be presented at the conference.

Abstract ID – 435

High-resolution numerical weather prediction model approach to analyse a land depression during 2017 Indian Summer Monsoon season

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Theme: Weather/Climate Modelling at Regional & Global Scales.

Abstract

In association with the active phase of 2017 Indian Summer Monsoon season, a low-pressure area formed over Indo Gangetic belt in the second half of July month. It intensified gradually and concentrated into a depression over northwest Jharkhand in the morning of 23rdJuly. Till early morning of 27thJuly, it moved north-westwards and maintained the intensity of depression. It weakened into a well-marked low presser zone in the morning of 27thJuly. This study is focused on the numerical simulation of the above-discussed land depression event using the advanced core of Weather Research and Forecasting (WRF) model. Dynamics of the land depression has analysed to enhance our understanding of the system. Spatial distribution of the depression induced rainfall, surface wind and central sea level pressure has validated with observations. Model results are found good in this direction and have fulfilled the motivation of the study up to a great extent.

Key words -Land depression, WRF, Rainfall.

Abstract ID – 440

Prediction of heavy rainfall events by NCMRWF ensemble prediction systems

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Abstract

The global Ensemble Prediction System of NCMRWF (NEPS)was upgraded to 12 km resolution recently and has been made operational from 1st June 2018. The initial condition perturbations are generated by Ensemble Transform Kalman Filter (ETKF) method. The model uncertainties are estimated by the Stochastic Kinetic Energy Backscatter (SKEB) and Random Parameters (RP) schemes. Surface parameters like Sea-surface temperatures, soil moisture content and soil temperature are also perturbed in the initial condition to remove the deficiency of lack of ensemble spread near the surface.

The present study aims to evaluate the ability ofNEPS in predicting heavy rainfall events. A few cases of heavy rainfall events that occurred during June-July 2018 have been studied to evaluate the performance of 12 km NEPS. The performance of 12 km NEPS is compared with that of the previous version of NEPS (which has 33-km horizontal resolution and 45 (44 perturbed + 1 control) ensemble members) to assess the prediction improvements. Probabilities of exceeding certain threshold rainfall amounts and brier scores have been computed to verify the model predictions. Higher amounts of ensemble mean rainfall are estimated with the higher resolution 12 km NEPS for most of the cases. Rainfall exceeding 2.5, 15.6 and 65.5 mm/day are predicted with more certainty in the 22-member 12 km NEPS as compared to that with 44-members of 33 km NEPS.

Abstract ID – 442

Diurnal cycle of convection and precipitation over the Indian region

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Abstract

Diurnal cycle is one of the most fundamental modes of variability in the global climate system due to its association with well-defined, large, and external diurnal variations of solar forcing. Diurnal cycles in precipitation are closely related to the atmospheric deep convection in the Indian region, especially during the monsoon season and are poorly understood. Here we use brightness temperature and rainfall datasets for studying the diurnal variations of precipitation over the Indian region. The primary data used is globally-merged pixel-resolution IR brightness temperature (half hourly, 4 km) for the time period of 2005 to 2014 with a temporal resolution of 30 minutes. The 11 µm brightness temperature is one of the most important parameters to study convection, as high sampling frequency makes it very useful in the study of temporal evolution of cloudiness and convection. We derive the diurnal cycle of deep convection from the 11 µm brightness temperature dataset. The diurnal cycle of deep convection is analysed along with the precipitation diurnal cycle (derived from TRMM) to understand the link between them.

Abstract ID – 446

Characteristic of diurnal rainfall pattern over India

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Abstract

The Indian region is characterized with diverse surface conditions such as topography, vegetation and rainfall distribution. With varying surface conditions, the rainfall distribution over the region highly differs in both temporal and spatial scale. The region often observes convective rainfall in late afternoon and orographic rainfall in early morning in various part of the country. In the present study, the TRMM-3B42 3 hourly rainfall at 0.25° is used to analyze the diurnal distribution of rainfall pattern over Indian regionfor the period 1998–2014. There are differences in rainfall amount between TRMM and IMD gridded rainfall (0.25°) climatology. The frequency and intensity of hourly rainfall from AWS station observation are analyzed at Kolkata, Chennai, New Delhi and Gujarat as representative of east, south, north and west region of India for the period 2009–2013.Rainfall has diurnal distribution over Indian region and it varies with geographical locations. In general, maximum rainfall occurs at 09–12 UTC and minimum rainfall occurs at 03 UTC. However, over south peninsular India, Maximum rainfall occurs at 18–21 UTC. The diurnal distribution of TRMM 3 hourly reasonably follows station observations. The IMD daily rainfall (0.25) redistributed to 3 hourly using i) TRMM 3 hourlymonthlyclimatological distribution ii) TRMM 3 hourly actual distribution. The both the data sets found to have reasonable skill when validated with hourly AWS observation over India. The 3hourly dataset generated using actual TRMM rainfall distribution is superiorthan other.These datasets are expected to be useful for future studies that need a high resolution gridded rainfall dataset.

Abstract ID – 465

Monsoon Active/Break analysis over Indian region: An assessment using CMIP5 climate models

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Abstract

Climate change studies suggest that changes in climate would bring massive changes in the precipitation patterns all over the world. Indian Summer Monsoon Rainfall (ISMR) has been affected significantly corresponding to slight changes in the climate. The study focuses upon the intra-seasonal variability in the ISMR using reanalysis data and investigates the intra-seasonal variability in selected Coupled Model Intercomparison Project (CMIP5) General Circulation Models (GCMs). The analysis also helps in understanding the equatorial teleconnections. The high/low intensity phases within a season called as Active/Break Phases are identified on the basis of the Webster Yang Index (WYI). The WYI which takes into account the horizontal wind differences across vertical pressure levels is selected as a basis for the selection of Active and Break days within a rainfall season. This index tries to correlate the circulatory patterns and their variations with the Active and Break rainfall intensities. WYI index is basically applied on monthly averaged data but in this study, we have applied it on the daily dataset to examine the Active and break days. The threshold for distinguishing an active and a break day is decided based upon statistical measures like the standard deviation of the WYI values. The study takes into account the active and break phase composites throughout the rainfall season (May, June, July and August) extending over the span of 27 years (1979-2005) in reanalysis data set Era-Interim. The study also tries to integrate a comparative study across 3 CMIP5 models namely CCSM4, CNRM and NorESM to understand the model performance over the Indian region. At the same time other dynamic parameters which play a significant role in global teleconnections are also related with the changing precipitation patterns in order to correlate them with the Active and Break phases. The objective of the study is mainly to examine whether CMIP5 models closely relate to or follow the same trend and patterns as by the reanalysis ERA-Interim data. The study would be able to answer the query regarding which global model is the most effective model for explaining the relation between the regional phenomena of ISMR and the global climatic dynamics. It would further give an idea about which model could be used to better explain the impact of global teleconnections upon the ISMR. This study examines three parameters (Moist static energy, precipitation and wind anomalies) dynamics during the Active and Break monsoon phases for the monsoon period over 27 years. Based on the analysis CNRM and CCSM4 CMIP5 models have shown good agreement with reanalysis data monsoon dynamics.

Climate Change - Active and Break Phases – Teleconnections – CMIP5 models

Abstract ID – 481

Interannual variability of Indian summer monsoon rainfall as simulated by JMA EPS model

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Abstract

The seasonal forecast skill of the Indian summer monsoon rainfall during June to September (JJAS) by the Japan Meteorological agency (JMA) Seasonal Ensemble Prediction System is analysed. The hindcast output valid for JJAS rainfall based on 5 ensembles each of March, April and May initial conditions for a period of 32 years (1979-2010) have been used in this study. Associated with significant forecast skill of El Nino the skilful forecast of All India Summer Monsoon Rainfall (AISMR) is found in April ensembles (Significant at 99% level) followed by that of March and May ensembles. The JMA model could capture the AISMR forecast reasonably well during the deficient years of 1982, 1987 and 2009 and the excess year of 1988, whereas, the excess monsoon of 1983 was not captured in the model. Similarly the strongest El Nino year of 1997 associated with slight positive AISMR departure was also not captured in the JMA model. The performance of JMA model in simulating the monsoon rainfall during normal year (1997), excess year (1983) and deficient year (2002) was better understood when the variability of El Nino, Indian Ocean Dipole (IOD) and Equatorial Indian Ocean Oscillation (EQUINOO) in the model are considered simultaneously.

Key words - Indian monsoon, Ensemble Prediction System, Seasonal forecast, Coupled climate models, El Nino, IOD, EQUINOO.

Abstract ID – 488

Summer monsoon rainfall distribution over the Indian homogeneous region using RegCM-4.3

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Abstract

Indian subcontinent is adherent with inhomogeneity due to its vastness and topographical feature with regards to climatic parameter. Climate change impact the monsoon influencing sectors over Indian subcontinent such as agriculture, water resource, human health, forestry etc. In India, its inherent spatial and temporal variability of ISMR will be helpful for scientist and policy maker. Hence, there is need of regionalized study of Indian subcontinent regions for better understanding of local distribution characteristics of rainfall. The main objective of this paper toidentify best performing scheme of RegCM-4.3 regarding inhomogeneity of Indian region to simulate regionalized ISMR.

The performance and validation of regional climate model (RegCM-4.3) simulation of Indian summer monsoon rainfall (ISMR) has been conducted with futuristic view of climate change study with best convective parameterization scheme over different homogeneous region of India. The dynamical downscaling of RegCM-4.3 has been done over South Asian CORDEX domain with the lateral boundary forcing provided by ERA interim at 50 km horizontal resolution. The seasonal and interannual variability of ISMR over India and its different homogeneous region has been done by comparing observational data of IMD the period of 25 years 1986-2010. The analysis includes the performance and validation of RegCM-4.3 in capturing regionalized rainfall of Indian subcontinent. The analysis is done over five homogeneous regions of India i.e. R1(NWI), R2(NCI), R3(WPI), R4(EPI) and R5(SPI) during 1986-2010. The CPS schemes Mix98 simulate reasonable good over North West and Western peninsular part of India i.e. R1 and R3. Over the North Central India predictability/simulation of Grell and Kuo is best among the six parameterize scheme of RegCM-4.3. The Western Ghat consisting region and Eastern peninsular shows Mix99 as the best simulated scheme of RegCM-4.3. The overall diversification of simulation depending upon the topological difference of Indian subcontinent cause the regionalize difference in simulating monsoon rainfall over Indian subcontinent.

Abstract ID – 491

Spatiotemporal Indian summer monsoon variability and NNRP1 downscaled Regional Climate Model sensitivity during ENSO and normal conditions

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Abstract

Indian summer monsoon season undergoes through four different phases i.e. Onset, active, break and withdrawal. Among of them first three phase heavily regulates the agriculture and livelihood of 1.7 billion people of India where the simulation/prediction of spatiotemporal Indian summer monsoon (ISM) variability is one of the most challenging issues over a subcontinent like South-Asia. After a lots of significant efforts, the Regional Climate Model by ICTP (RegCM) has shown the significant results in simulating ISM from the last few decades. After a group of up gradations in the directive way RegCM has shown excellent performance for the seasonal monsoon rainfallby overcoming the topographical issues over the Indian subcontinent. Still RegCM simulation is limited in the small scale. Very few works have been considered by the scientists on the phases of monsoon using RegCMtill the current time. Therefore, this work will show the precaution towards RegCMand behavior of the model for simulation the phases of ISM.

Keywords: Indian summer monsoon, phases of monsoon, Regional Climate Model.

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Abstract ID – 495

Impact of Assimilation of Microwave radiances on the simulation of cyclone Mekunu

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Abstract

Two parallel experiments have been done to notice the impact of assimilation of microwave radiances on the simulation of Mekunu cyclone occurs on 21 May - 27 May 2018, one of them is with microwave radiances and the other without microwave radiances. Microwave radiation refers to electromagnetic radiation generally in the frequency range between 300MHz and 300GHz. For microwave radiances, we used the microwave satellite instruments namely SAPHIR, AMSR-2, ATOVS and ATMS and to see the presence of these instruments affects the conventional observation (Aircraftsonde obstore, Satwind obstore, Scatwind obstore, AOD obstore, etc), and assimilation statistics for surface observation, aircraft observation, AIRS observation, SEVIRICLR observation, etc. These observations have been taken at the six-hour interval for 00, 06, 12, 18 UTC. Due to the effect of the microwave radiances, assimilated data gain is very low. There is no difference for varobservation with and without microwave radiances except SATWIND and SEVIRI observation. Mekunu cyclone was very intense tropical cyclone in the Arabian Sea. Its lifespan was 21 May - 27 May 2018. On the basis of the first-day analysis, we made five days forecasting of Mekunu cyclone. We analyze the difference in temperature, relative humidity, and wind for the above two experiments, at 850 hPa and 1000 hPa pressure level. The effect of microwave radiances is more effective on temperature after 25th May, But the impact on the relative humidity and wind is effective from the 1st-day forecasting. We noticed when the effect of microwave radiances is positive/negative.

Abstract Id – 3

Climate variability and its impact on wheat yield and acreage in Madhya Pradesh

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Abstract

Climate change and variability could significantly impact crop production sustainability in the coming decades. Increase and decrease in climatic parameters may have impact on livelihood of farmers and also the crop yield.To see short term (10 year) and long term (40 year) climate variability; an analysis of long term (1971-2010) climate and wheat yield data of five agroclimatic zones (six districts) of Madhya Pradesh was analyzed. Seasonal as well as decadal analyses were carried out. The rainfall was found to be decreasing at Tikamgarh, Chhindwara, Indore and increasing over decades at Jabalpur and Hoshangabad. No change in rainfall amount over the decades was observed at Rewa. The variability in rainfall was decreased over the decades and variability of maximum temperature was increased in recent decade at Rewa. There was remarkable decrease (1.2°C from decadal mean) in the value of minimum temperature observed at this district. A decreasing trend (-0.04°C/year)and (-0.06 /year) in minimum temperature during *rabi* was observed at Rewa and at Hoshangabad district respectively. The increase in minimum temperature during *rabi*season was found to be 0.05°C/year at Indore, but thesedecease and increase was found to be non-significant. It was found the maximum temperature slightly increased over the decades at Jabalpur, Rewa and Tikamgarh districts and also the wheat yield. The maximum temperature was found to be decreased over the decades and wheat yield has found to be increased at Hoshangabad. Results indicates that decrease in the minimum temperature at Jabalpur, Tikamgrah and Rewa has increased the wheat yields over these districts. In other districts there was no change was found in minimum temperature, but wheat yield has increased in all these districts. Wheat yield increased over decades and years at all the stations but was found to be more variable at districts like Chhindwara(58%) and Hoshangabad(55%).Increasing wheat yield trend was found of the order of 72kg/ha/year at Hoshangabad, 64kg/ha/year at Chhindwara and 44Kg/ha/year at Jabalpur and these increase was found to be significant.The wheat yield has increased over the decades irrespective of the slight increase or decrease in the minimum temperature over the decades in Madhya Pradesh.The area of wheat was found to be more variable at Tikamgarh(31.5%), Indore(28%) and Jabalpur(25.4%).The acreage of wheat was found to be increasing trend at Hoshangabad (2.2 thousand ha/year), Rewa (1.7 thousand ha/year) and in Tikamgarh (1 thousand ha/year) and this increase was found to be significant at Hoshangabad and Rewa. Though there was a sharp decrease in acreage of wheat at Jabalpur. The area of wheat at Jabalpur decrease of 62 per cent from 144.53 thousand ha (1991-200) and decreased to 89.21 thousand ha (2000-10).The above finding contradicts the earlier projection of the climate change as reported by other researchers. This may be due to adoption of improved technology by farmers of Indore district. Thus it may be inferred that climatevariability has not directly impacted to the wheat yield but influence its area in Madhya Pradesh.

Abstract ID – 23

Effect of climate change and study on yield gaps on wheat in Indo-Gangetic Plains

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Theme:Impact of climate variability/change on agriculture, water, energy and health sector.

Abstract

Indo-Gangetic Plain (IGP) is the food bowl of India. The region is affected by climate fluctuations. The study here focuses on the trends of climate variability of three locations of IGP viz. Allahabad, Gorakhpur and Varanasi for last 40-45 years and variability in the wheat yield both farmer's and simulated using CSM-CERES Wheat v 4.5 and yield gaps between them. The farmer's yield is affected by many other factors like management practices, cultivar choice, pests, weeds etc. besides climate. The difference between simulated and farmer's yields are the yield gaps. The yield gaps showed variations in trend over years depending on the climate conditions and farmer's yield of different regions. The trend of climate for Allahabad showed unfavorable conditions for wheat growth reducing the simulated yield. The yield gaps had decreased over years due to both declining trend of simulated yield and increasing farmer's yield in Allahabad. In Gorakhpur and Varanasi, the decline in yield gaps is mainly attributed by increased farmer's yield over years. The study on yield gaps using crop simulation model helps to find the difference between potential, attainable and farmer's yields of the region and provide farmers an opportunity to increase their agricultural production accordingly by improved management practices and better cultivars.

Keywords -Indo-Gangetic Plains, CSM-CERES Wheat v 4.5, Yield gap, Potential yield, Attainable yield.

Abstract ID – 26

A recent initiative, taken in India meteorological department towards climate services for health sector

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Abstract

As a WMO GFCS requirement, India Meteorological Department, the National Meteorological Service of India, has recently initiated (on experimental basis) preparation of climate information for health (CIH), for Vector borne diseases (VBD) like Dengue and Malaria, for the country using products of Extended Range Forecasting System. Through this initiative, regions which are likely to get Maximum / Minimum temperature within threshold Maximum / Minimum temperature of above VBD during succeeding two weeks are indicated. This initiative started since the second fortnight of 2017. Validation of usefulness of this information has been carried out usingClimate information for health based on ERPS products, issued on every Friday, since May 2nd week 2017 and monthly state wise disease data available from the Source:nvbdcp.gov.in,https://flutrackers.com/, disease data received from health department of some states, through the respective RMCs/MCs of those state, disease data available from municipal corporations of a couple of cities and also from NDTV/other medias.

The short term evaluation of usefulness of this service suggests that CIH appears to be grossly useful for most of the states in most of the months for Malaria, however for Dengue it is during winter only.

Abstract ID – 29

A Review of Hydro-meteorological Studies in Context to Climate Change in Beas Basin of North-Western India

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Abstract

Climate change has now become the most concerned global common and almost impossible is to find a place on earth left untouched by its impact. Glacier retreat, greater runoff, shifting of tree and snow line, temperature and precipitation anomalies are some impacts one can easily observe. The Himalayas literally the abode of snow has the largest concentration of glaciers outside the Polar Regions and therefore often cited as the third pole. According to the Intergovernmental Panel on Climate Change, the Himalayan region is highly sensitive to climate change. The rising temperatures in the glacier-bound terrains are affecting various life forms in a multitude of ways. Among others, the impacts of climate change on glaciers occupy a significant place owing to their contribution to the freshwater supply. With particular concern to India water resources are under heavy stress due to ever-increasing water demand. An evaluation of water resource status of a river basin is of primary importance for its overall development. This study is basically a systematic review of hydro-meteorological investigations in context to climate change for Beas basin of north-west India. A rise in temperature along with increasing precipitation anomalies have been observed in the study area. In addition, long-term negative impacts on the availability of water in Beas basin and downstream areas have also been predicted.

Abstract ID – 38

Climate Variability and its impacts on the weather of Damodar Valley area

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Abstract

Damodar Valley area covered Seventeen districts in Jharkhand and Gangetic West Bengal Out of 14 (fourteen) districts 09(nine) (Dhanbad,Hazaribagh,Koderma,Giridih Bokaro, Ramgarh,Chatra, Ranchi, Latehar) districts in Jharkhand and 5(five) districts in Gangetic West Bengal. Lower valley catchments contains five districts in Gangetic West Bengal (East Bardhraman, West Bardhraman,Bankura, Hooghly, Howrah). Lower valley region is highly flood prone area. In monsoon season due to very heavy rain fall in D.V. area flood occurred in this region.

Employing available 65 years data on dry bulb temperature, maximum temperature, minimum temperature, relative humidity, rain fall etc this study has been performed. In this paper climate variability on the basis of dry blub temperature, maximum temperature, minimum temperature and rain fall have been studied in two phases. First phase analysed data from 1955-1986 and in second phase analysed data from 1987-2017. Major findings are (i) Variability of dry blub temperature.(ii) Increase of maximum temperature in pre monsoon season,(iii) decrease of minimum temperature in winter season,(iv) thunder storm activities increased in pre monsoon season,(v)Variability of monsoon rain fall, monsoon rain fall decreased in June and August and monsoon rain fall increased in July, September and October and (vi) Winter become more dry.

The potential impacts of climate Variability and change of temperature,rainfall in Damodar catchments area especially in regions that face growing challenges meeting water demand for irrigation, flood control, soil conservation and forestation.

Abstract ID - 81

A systematic review of the effects of climate change on electricity consumption

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Theme: Impact of Climate Variability/Change on Agriculture, Water, Energy and Health sectors.

Abstract

The present study carries out a systematic review of literature on the impact of climate change on electricity consumption and demand covering a broader time horizon (1996-2017) and wider spatial scale of 12 countries. Along with the climate change, the paper also maps the literature on impact of non-climatic factors such as seasonality and socio-economic parameters such as electricity prices, income, GDP, household size as determinants of electricity consumption and demand. The results indicate that temperature is the main driving force behind electricity consumption, followed by humidity. The sector-wise decomposition of electricity consumption reveals that in majority of studies impact of climate change is assessed for residential electricity consumption only. On the direction and magnitude of the impact, though studies have clearly stated that increase in temperature will lead to enhancing of electricity demand, there is no conclusive result as to what magnitude of such impacts is. Review findings also suggest that scant attention is given to understand the dynamics of such impacts in Indian context.

Abstract ID – 95

Impact of Climate Change on Crop Production in Maharashtra

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Abstract

The study estimates the effect of changes in climatic factors on crop production in Maharashtra state. We have used 36 years of rice, sugarcane and cotton production data and climate data for this study. We first estimated the effect of climate variable using multiple regression models. These estimates are then used to find out the change in crop production in future projections of climate variable under the RCP 4.5 scenario. Results from the observed data showasignificant relationship between crop production and climate variables. With an increase in temperature, a decrease in riceproduction has been observed. For Sugarcane and cotton, an increase in production is observed with increasing rainfall. However,these results show the negative but insignificant relationship between temperature andproduction of sugarcane and cotton. Under RCP 4.5 projections of rainfall and temperature, the projections for crop production during two-time slices – the 2050s (2031-2060) and 2080s (2070-2099) - suggest a significant reduction in rice production with remarkable growth in sugarcane production relative to the base period of 1976-2005. The projections for cotton signifies an overall reduction in production in some districts.These findings imply a need to develop new varieties of seeds which are tolerant to thefuture changes in rainfall and temperature and at the same time, give high yield to combat the food security of increasing population.

Abstract ID - 110

Studies on impact of balanced fertilizer dose as compared to farmers' dose using DSSAT modelling in rice crop for Chhattisgarh state

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Abstract

Crop simulation models are essential tools to design management practices to mitigate such adverse conditions. Crop simulation models are useful to assess the yield gap of a crop in a set of given conditions. DSSAT is the most popular dynamic crop simulation model and CERES- rice model is used for assessing the yield gap of rice under a given set of conditions. One of the main advantages of crop model application is the possibility to use them under various weather and soil conditions and under irrigated and rainfed condition in different regions of the Chhattisgarh.To assess the impact of balanced fertilizer dose as compared to farmer’s doseand validating the simulated value using DSSAT model, experiment was conducted at Dept. of Agrometeorology, Raipur during *kharif* season of 2014 for different varieties namely Swarna, Mahamaya, MTU1010 and Karma Mahsuri. The DSSAT simulation model was validated for the different agroclimatic zones of Chhattisgarh. The effect of imbalanced fertilizer was studied on rice yields in three agroclimatic zones under irrigated and rainfed conditions. The results showed that there is considerable difference in the productivity of balanced and imbalanced fertilizer application in three zones. At Jagdalpur representing Bastar Plateau Agro-Climatic Zone, maximum yield was observed in balanced dose (100:60:40) in comparison to imbalanced fertilizer dose. The highest yield was obtained for Swarna variety in both cases that is 4.4 t/ ha. and 1.7 t/ha for balanced and imbalanced fertilizer respectively basically because of its yield potential. At Ambikapur representing the Northern Hill Region, the production with the dose of 40 kg/ha N was very low when compared to Jagdalpur and Raipur. Whereas, at Raipur representing the Chhattisgarh Plains region, rice productivity with balanced fertilizer dose 100:60:40 kg/ha was lower as compared to Ambikapur and Jagdalpur.It was also found that the yield gap varied from variety to variety with highest yield gap in Karma Mahsuri in both irrigated and rainfed conditions in all the three stations.

Key words -DSSAT Simulation model, Balance dose,Irrigated and Rainfed condition, Agroclimatic zones.

Abstract ID – 231

Retrieval of hourly values of air temperature from daily minima and maxima

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Theme : Observations in Climate Variability and Changes.

Abstract

The atmospheric planetary boundary layer is the lowest part of the atmosphere and its behavior is directly influenced by its contact with a planetary surface and responds to changes in surface radiative forcing in an hour. Surface characteristics are changing continuously affecting airflow and these changes may be gradual or sharp, and are due to the prevailing synoptic conditions. To understand the phenomena in detail, the variation of temperature near to the earth's surface is crucial. There's no simple and surely no analytic function describing the daily cycles of the temperature. An effort is made to study the variation of temperature for one year on very fine scale of information and making different sets of hourly and monthly variations. The data sets on meteorological observations were obtained from Mini Boundary Layer Mast (MBLM) of ISRO situated at Jnanabharathi campus (12°53′N, 77°30′E, 840 amsl) of Bangalore University, Bengaluru. It is well known that parameterized mathematical functions describe daily and hourly temperature for low latitude region. The mean daily temperature variation looks like a sine wave with a period of one year. Similarly, the hourly temperature also looks like a sine wave with a period of one day.

An effort is made to determine the hourly air temperatures from daily maxima and minima and validated with observations. Methods that have as inputs daily minimum and maximum temperature were selected from the past observations of MBLM. Daily maximum temperature did not appear to affect the accuracy of any of the methods used for retrieval. If accurate timing of temperature input to models is critical, the results indicate direct measurement of hourly temperature may be necessary. The observations and model outputs are discussed in detail.

Abstract ID – 233

Delineation and monitoring of the agricultural drought using remotely sensed drought indicesin the south western part of the West Bengal

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Abstract

Intergovernmental Panel on Climate Change (IPCC) on its Fourth and Fifth Assessment Reports (AR4 and AR5) with high and medium confidence level pointed out the fact that, extreme climatic events have increased in recent years and will likely toincrease in near and distant future. Hence, delineation and monitoring of climatic events with special reference to the climatic hazards is an important criteria for vulnerability assessment and thereafter policy making. West Bengal is the only state of India, connected with both the Himalaya and the Bay of Bengal. Henceforth, regional variability of different climatic elements is also high. South-western part of the West Bengal is one of the drought prone areas of the country and rain-fed agriculture is the dominated agricultural practice of the area.In this paper, agricultural drought has been monitoredby remote-sensing-based drought indices. For this purposes gridded precipitation and vegetation data has been collected from Tropical Rainfall Measurement Mission (TRMM) and The Moderate Resolution Imaging and Spectroradiometer (MODIS) website for the period of 2001-2015. Both the Standardized Precipitation Index (SPI) and Vegetation Health Index (VHI)very significantly identified the drought events in the study area during the time period. Positive relationship also found between crop anomaly and VHI.

Key words -TRMM, MODIS,SPI, VHI, Crop Anomaly.

Abstract ID – 244

Vector borne disease in relation to climate change

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Abstract

Recently, India reported an increase in the incidence of vector-borne diseases. Concentrations of air pollutants are on rise due to human activities. Increased air temperature under global warming and local urbanization can lead to earlier pollen season and altered distribution of allergen and thereby leading to asthma. Weather also affects vector population dynamics and disease transmission, with temperature and humidity considered as key variables. The impact of climate change on malaria reveals that the transmission windows (TWs) for malaria are predicted to increase with climate change. will assess some of the impacts of environmental changes on water and air borne diseases in IndiaAmong the entire major vector-borne diseases, malaria is still a major health problem in India. to assess the regions and months in which climate is responsible for a remarkable interannual variability in malaria vector distribution, larvae density, EIR and HBR values in Orissa. However, there is no adequate information on the abundance of malaria and the influence of climatic factors on malaria transmission dynamics, incidences and distributions in Odisha on a local scale (district wise distributions). An idealized VECTRI model is run for 1951-2013 for mapping and modeling the distribution intensity and seasonality of malaria transmission through the *Anopheles culicifacies*, which is the most potent malaria vector in Odisha. Results indicate that the predicted values of average temperature, mosquito population, and biting rate have been increased in the last 63 years. Analysis for the recent period (2000 to 2013) shows that the malaria vector abundance is higher during the summer monsoon season (June to September). The human biting rate (HBR) and entomological inoculation rate (EIR) is significantly higher over the northern and western parts of Odisha, which are of forest or mountainous ecotypes. Correlation coefficient analysis and seasonal analysis over these districts demonstrated significant relationships of temperature and rainfall with mosquito population, larvae density, HBR, and EIR. Such information will be useful for the government administrators or policymakers to formulate suitable adaptation strategies by enhancing the accessibility to health services.

Abstract ID – 281

Ordinal pattern dependence between rainfall time series in Tier 1 cities of India

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Theme:Weather and Climatic Extreme Events.

Abstract

Previous studies have shown the difference in rainfall pattern in and aroundthe specific urban area due to anthropogenic effect such as urbanization. In the present study, the focus is to study the dependencies between the rainfall time series from the Tier 1 cities of India using ordinal patterns. In contrast to many traditional studies, the ordinal pattern can measure the non-linear correlation even in the presence of non-stationarity. Time series of rainfallaround urban area show a greater variation on time and spatial scales, caused by anthropogenic (such as urbanization) and climatic impacts, both of which lead to a non-stationary behavior. The data considered in the present study was downloaded from the Tropical Rainfall Measuring Mission (TRMM)'s daily averaged near Real-Time data (3B42RT) during the South-West monsoon period (June, July, August and September, henceforth will be called as JJAS). The 3B42RT data is available from the Mirador website and is averaged within a spatial resolution of $0.25^{o} \times 0.25^{o}$ with a temporal coverage starting from March 2000 to date. The data covers the region between $\pm 60^{o}$ latitude and $\pm 180^{o}$ longitude. For the present study, data from the previous two monsoon years, 2016 and 2017 are considered. The daily averaged data is then interpolated within the city center identified by its latitude and longitude using Cressman weighing scheme. The radius of influence used in the interpolation scheme depends on the size of the city under consideration. Ordinal pattern analysis is performed for every Tier 1 cities between two successive years, and also between two Tier 1 city pairs for 2016 and 2017. The results will be presented at the meeting.

Abstract ID - 323

Strategic framework for integrated flood disaster management and modelling over Bangalore city

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Abstract

Most of the metropolitan cities are expecting unprecedented urbanization in recent times in order to meet demands of the growing population. Due to this impact there is subsequent pressure on infrastructure development, natural resources thus giving rise to many serious threats like climate change, global warming, greenhouse effect and natural loss of water bodies. The city planners are also under a pressure of discovering ways to sustainably manage the available resources and also handling serious issues like traffic congestion, habitat management and availability of basic amenities etc. In order to analyze the urbanization trend and pattern, spatio-temporal remote sensing data is subjected to supervised classification which is based on maximum likelihood estimation. This is done by acquiring Landsat data starting from the year 1991 up-to 2016. The vegetation pattern is studied by acquiring MODIS data and thus performing NDVI classification. Here we have considered extreme rainfall events (ERE) having 110-120 mm rainfall (24 hours accumulated) over Bangalore city causing urban flooding and the reason thereof during 2010-2014. We followed an objective methodology to identify the ERE in the context of Bangalore heavy rainfall events. Also we calculated the total runoff of some specific area of Bangalore city based on the intensity of ERE.In addition to that we are modeling the urban storm water due to ERE and the growth pattern and trend on the existing drainage system

Abstract ID – 489

Regional scale study of comfort / discomfort indices over six major citiesof Tamil nadu, India having distinct geographical features.

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Abstract

Discomfort indices are attracting considerable interest due to changed Climate Scenario to recent times. The aim of this research is to broaden current knowledge of Comfort /discomfort Indices on regional scale over Tamil Nadu, India. Four indices namely heat Index (HI), Wet Bulb Globe Temperature (WBGT), Temperature humidity Index (THI)& relative strain Index (RSI) have been studied for six major cities of Tamilnadu Viz., Chennai, Vellore, Coimbatore, Salem, Madurai and Trichy, having distinct geographical features. These indices are computed for climatological period of 30 years (1981 to 2010) to analyse their effects on comfort of human, changes & trend. This paper revisits role of above indices influence upon man/human activities.

The results reveal that climatologically the value of HI is observed to be more from mid-May to Mid-June in all 6 above mentioned cities; may be due to proximity of city to sea & moisture influx from Arabian Sea & Bay of Bengal. WBGT is seen to have maximum effect near mid-June to sometime up tomid-July when annual March of Sun is in northern 'hemisphere. Response of THI is significant from mid-May to mid-June& sometime in end of June & has considerable impact on human activities. RSI is max. For Vellore (Sept.) & minimum for Madurai (June), due to cloud cover, cooling degree days & consecutive days of extreme heat during these months.
(Add results of Trend analysis)

Keywords - Comfort/Discomfort, Heat stress; THI; WBGT; Relative strain index.

Abstract ID – 490

Effects of different sowing dates on the phenology and accumulated heat units in two wheat (Triticum Aestivum) varieties

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Abstract

Wheat is a winter season *Rabi* crop in India. It can be grown not only in the tropical and sub-tropical zones but also in the temperate zone and the cold tracts of the far north, beyond even the 60^0 north latitude. Wheat can tolerate sever cold and snow and resume growth with the setting in of warm weather in spring. Temperature is the most prime factor affecting the development rate of plant.Among the different management practices sowing date is one the important input which contribute significantly to wheat productivity. A large number of field experiments have been conducted in East Uttar Pradesh (North India) where the effect of different agro-ecological factors such as season, weather, soil, sowing dates and variety has been studied on growth and grain yield of wheat crop. This database included all relevant information (including the different management practices adopted and the date of sowing, specific soil and weather conditions) observed from experimental field as well as and farmer's field. A field experiment was carried out to study the effect of sowing dates on phenology and accumulated heat units of wheat crop were sown on factorial randomized block design (FRBD) with eight dates of sowing D_1 - 5 Dec .2016; D_2- 8 Dec.2016; D_3- 11 Dec.2016 D_4 -14 Dec. 2016; D_5-17 Dec. 2016; D_6 -20 Dec. 2016, D_7 -23 Dec. 2016; D_8 - 26 Dec. 2016 with two wheat variety *i.e.* HD-2967 and HUW-510 and three replications.The size of each plot was 4X4.5 m^2.Under North Indian condition, the maturity of wheat get hastened due to gradual rise in ambient temperature under delayed sowing. Keeping this in view, an attempt was made to know the phenology and heat unit requirement of promising variety under different sowing dates. From the results it was found that under late sowing condition. The growing degree days also decreased under late sown condition. The crop yield was found significantly higher for the early sowing crop in comparison to late sown condition in Varanasi region.

Key words- Phenology, Growing degree days, Heat use efficiency, Pheno-thermal index.

Abstract Id – 54

Extreme Weather & Upper Air Profiling

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Abstract

The GPS ascent is the usual conventional method to measure the upper air atmospheric profile. The ascent is taken as per the user requirement to get the upper air atmospheric profile. The atmospheric parameters measured by this method consists of Wind Direction, Wind velocity, Temperature, Humidity & Pressure. Depending upon the quality of the balloon used, the profile of the atmosphere upto 32-23 kms can be obtained.

During extreme weather events, when real time the upper air profile is badly needed, this method has got its inherent limitations because of signal failure of the transmitting GPS antenna. Besides this, the method is totally dependent upon the availability of balloons, hydrogen gas, GPS instrument & the observer. Hence, an alternative is must for the real time upper air profiling during extreme weather events.

With the advent of the remote sensing, 'Microwave Radiometer' has come into existence, which can provide the real time atmospheric humidity & temperature up to a height of 8-9 km using neural network technique. The only pre-requirement is availability of, "the upper air climatological profile of the 'place'/ 'place having similar climatology', where it is to be installed".

Troposphere Wind profilers, which also works on the principle of remote sensing, can measure the wind direction & wind velocity up to a height of 8-9 kms. It may be operated during any weather condition as per the user requirement.

A 'Microwave Radiometer' may be integrated with a 'Tropospheric Wind Profiler' to obtain the real time upper air Temperature, Humidity, Wind Direction & Wind velocity profile during extreme weather conditions. Using these data & 'Hydrostatic equation', the upper air 'Atmospheric Pressure' can also be obtained.

Hence, this can be an alternative technique for real time upper air profiling during extreme weather conditions.

Abstract ID – 101

Monitoring Weather and Climate Extremes from INSAT-3D satellite over the Indian region and future aspects

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Theme: Weather and Climatic Extreme Events.

Abstract

Any meteorological phenomena such as fog, thunderstorm, heavy rain which creates significant societal and economic problems especially as a major havoc to day to day routine life as well as entire communication as well as transportation system especially over the Indian subcontinent. Successful commissioning of indigenous satellite INSAT-3D on 26th July 2013 has provided a new opportunity to the Indian meteorologists. The INSAT-3D imager is to provide imaging capability of the earth disc from geostationary altitude in one visible (0.52 – 0.77 μm) and five infrared channels; 1.55 – 1.70 μm (SWIR), 3.80 - 4.00 μm (MIR), 6.50 – 7.10 μm (water vapour), 10.3 – 11.3 μm (TIR-1) and 11.5 – 12.5 μm (TIR-2) bands. The ground resolution at the sub-satellite point is nominally 1km x 1km for visible and SWIR bands, 4km x 4km for one MIR and both TIR bands and 8km x 8km for WV band. In the current study, some of the extreme events including fog, thunderstorm and south west monsoon feature of 2016-2017 will be presented in the conference. Apart from this a Real-time Analysis of Products & Information Dissemination (RAPID), a web-based quick visualization and analysis tool for INSAT satellite data on a real- time basis has been introduced and will be demonstrated for identification of pre-monsoon severe weather events.

Abstract ID – 133

A Brief Climatology of Significant Pre-monsoon Hailstorms in Punjab and Haryana in last Five year from 2014-2018

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Abstract

Among the recent extreme event hailstorm in recent past caused significant crop damage across the states of Punjab and Haryana. Hailstorm triggers traffic jams, snapping of power supply, uprooting of trees and blowing off roofs in parts of the Punjab and Haryana.Pre-monsoon hailstorm occurring in the months of March, April and May has caused significant damage and loss to rabi and horticulture crops in these two states. Though occurrences of hailstorm are unavoidable, need is felt now for its better prediction and preparedness to minimize its impact on crops and day to day life of people.Early Detection of hail producing thunderstorms is extremely important for better preparedness and mitigation. Here comes the role of weather radar. It is extremely useful tool to detect the presence of hail producing thunderstorm. However radar data has to be complimented by knowledge of current atmospheric conditions which can allow one to determine if the current atmosphere is conducive to further hail development. In view of this, five years Doppler weather radar data from the year 2014 to 2018 is analyzed to prepare the pre-monsoon hailstorm climatology as the Doppler weather Radar products help us to ascertain the hail causing thunderstorms Intensity, its vertical extent, movement, vertical integrated liquid and drop size distribution which enables the forecasters to early and accurate forecasting. Thisclimatology examines the temporal and spatial distribution of significant Pre-monsoon Hailstorm in the states of Punjab and Haryana and can help a forecaster to understand when a given event is most likely; and to quickly realizethe significance when a rare event occurs.

Keywords -hailstorm, hail producing thunderstorms, Doppler weather radar, weather Radar products.

Abstract ID - 182

A Study of Supercell storm in Bihar and its analysis of thermodynamic condition,evolution,structure and movement

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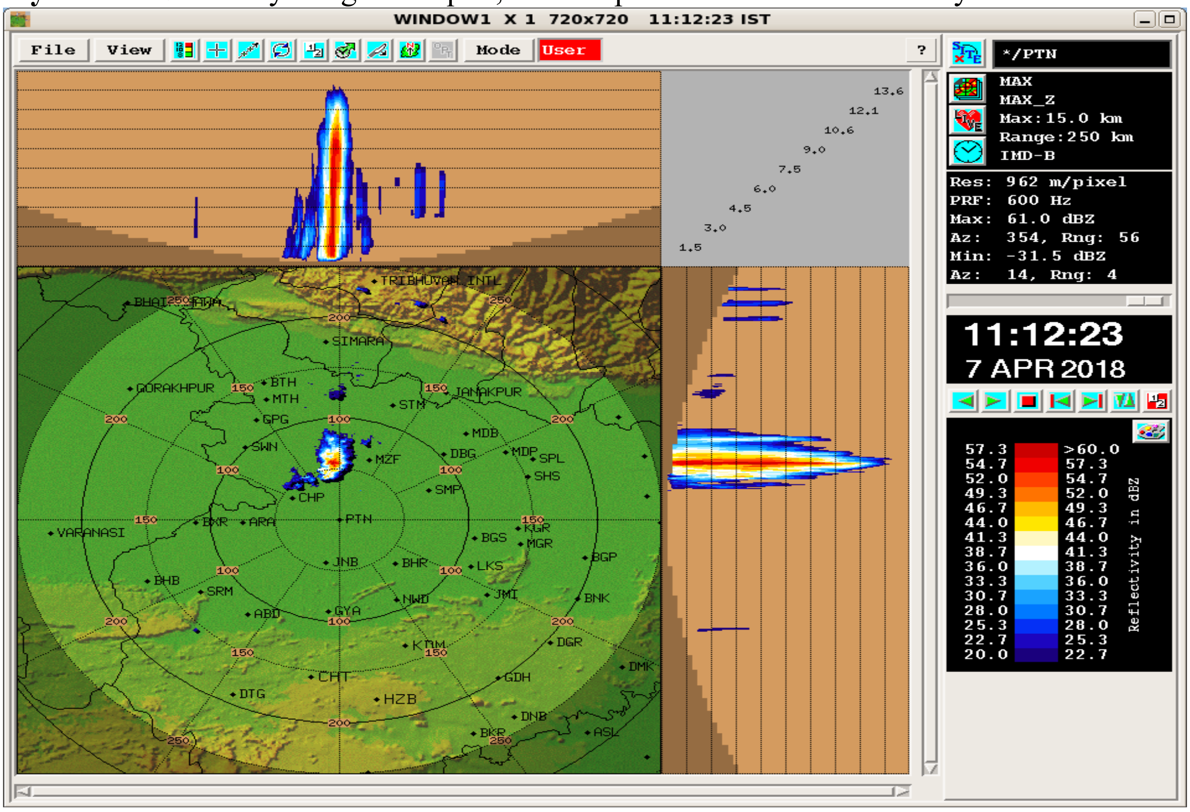
Abstract

On 7th April 2018 a very severe thunderstorm supercell passes across Bihar entering from Goplaganj and East-Champaran districts and while passing through Siwan and Gopalganj district it got intensified and Echo top reached upto 13.6 KM and subsequently while passing through Muzaffarpur and Vaishali districts Reflectivity reached to 61 dBz which is the highest reflectivity recorded at DWR(Doppler Weather Radar) Station, Patna.Documentation and analysis of the Satellite imagery, thermodynamic condition of the atmosphere and evolution, structure and movement of the storm as tracked by the Doppler weather Radar is presented in this paper. This Particular system lasted for around 10 hours. Based on the internal structure,reflectivity,duration and weather pattern on the ground,it has been concluded that the particular cell was asupercell.

Keywords - Vertically integratedliquid, vertical profiles of radar reflectivity.



A. MaxZ Product of DWR ,Patna Showing highest Reflectivity.

Abstract ID – 211

Diagnostic analysis of severe thunderstorm triggered by cyclone Roanu over Eastern India

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Abstract

Eastern parts of India are prone to severe convective activity during pre-monsoon season. Generally the presence of anticyclone over Bay of Bengal, surface heating, geographical location and lifting mechanism are responsible for severe convective activity. Presence of cyclone over Bay of Bengal during pre-monsoon season may enhance the instability over the region. This study investigates the role of cyclonic storm Roanu for severe thunderstorm activity over eastern parts of India.

Cyclone Roanu moved very closed to east coast and crossed North Bay of Bengal during 20-21 May, 2016 and gradually weakened into a deep depression over Mizoram at 1800 UTC of 21st, into a depression over Myanmar and adjoining Manipur at 0000 UTC of 22nd May over Bangladesh & adjoining NE India. Severe thunderstorm accompanied with squall was observed during 22-23 May 2016 over Jharkhand, West Bengal and Odisha. The thunder cells originated at the northern parts of Jharkhand and adjoining area, propagated southeastward and intensifying into squall lines were documented at Ranchi, Alipore&Bhubneswar on 23rd May. An attempt has been made to diagnostically analyse the synoptic features, satellite products and RS/RW observations for the study region. Thermal advection, wind shear and specific humidityanalysed by using NCEP reanalysis data of $2.5^0 \times 2.5^0$grid. This study reveals that, the presence of cyclone Roanu over Bay of Bengal and adjoining NE India one day prior to the occurance of event, incurred sufficient amount of moisture up to the mid tropospheric level and boosted significant amount of vertical wind shear over the region. The warm air advection of magnitude 3 $℃/day$ in 850hpa and cold air advection of magnitude -2 $℃/day$in 700hpa observed during 22-23 May over the study area enhanced the instability conditions of the atmosphere and results severe convective activity.

Keywords -Thunder squall, thermal advection, specific humidity, wind shear, instability.

Abstract ID – 218

Extreme rainfall events in Northeast India and their association with Indo-Pacific Ocean Sea Surface Temperatures

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Abstract

India's Economic status essentially judge by the agricultural crops success/failure which mostly depends on the distribution of southwest monsoon rainfall through June to September. The spatial distribution of summer monsoon rainfall is not uniform over India and it is found that, the extreme events like large scale floods and droughts are increasing over the country. The Northeast India (NEI) is one of the region which experiences more number of extreme rainfall events resulting frequent flash floods in the region and yet it is a grey area of research. In the present study we tried to explore associative relationship of extreme rainfall events over NEI during summer monsoon season (JJAS) with sea surface temperature (SST) over Indo-Pacific for the period of 1951-2007. Using APHRODITE (Asian precipitation highly resolved observational data integration towards evaluation of water resources) rainfall data, the extreme rainfall events categorized on the basis of rainfall intensity, such as low (less than 20th percentile), moderate (20-50th percentile), high (>90th percentile), very high (>95th percentile) and extremely high (>99th percentile). The Hadley centre sea ice and sea surface temperature data sets (HadISST) are used to find out connection of Indo-Pacific SST with extreme rainfall events over NEI. The observed trends in extreme rainfall events are computed to study its association with Indo-Pacific SST. There is a significant increasing trend in moderate range extreme rainfall events while decreasing trend in both high and very high extreme rainfall events. The correlation analysis revealed that the high extreme rainfall event category is negatively correlated with SST over central Indian Ocean and central Pacific Ocean. But correlation with low extreme rainfall event category remains positive over Indo-Pacific Ocean.

Abstract ID – 222

Composite structures of ocean parameters in the evolution of tropical cyclones over the Bay of Bengal

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Abstract

The motivation of the study is to understand the tropical cyclone (TC) induced response in the ocean and its spatial distribution patterns over the Bay of Bengal. The ocean parameters such as Tropical cyclone heat potential anomaly (TCHPA), barrier layer (BL) and sea surface temperature (SST) characteristics are evaluated to the TCevolution. About a total of 83 TCs during 2003-2016 with 1222 instantaneous samples were used. The ocean analyses data prepared at Indian National Centre for Ocean Information Services using Global Ocean Data Assimilation System (INCOIS-GODAS) 6-hourly data is analysed to understand these spatial distributions. The ocean parameters are studied as a function of TC intensity, season and movement. Composite structures of TCHPA revealed that the TC rear sector experiences the strong changes aswith the intensity progress. For ex., the TCHPA ranging from ~5-10 kJ cm^{-2}, ~10-15 kJ cm^{-2} and ~25-30 kJ $cm^{-2}$when TC is at CS, SCS and VSCS stages respectively. Overall structures revealed that the location of maximum TCHPA shifts from the rear-left to the rear-right sector as the intensity changes. During TC intensification, the relation between BLT and TCHP shows, contrary to each other in the eyewall region.The same relation shows a positive behaviour for various translation speeds. The magnitude of the SST anomaly (SSTA) shows largest cooling of ~1.2 °C for the strong and slow moving TCs. Probability density function (PDF) analyses of SSTA exhibited that the large cooling distribution is seen for the pre-monsoon rather than the post-monsoon season. The cooling rate decreases with an increase in the TC translation speed. The spatial distributions observed from the ocean parameters should help to understand the characteristic features of TC evolution over BoB.

Keywords -Bay of Bengal, Tropical cyclones, Tropical cyclone heat potential, Sea surface temperature, translation speed

Abstract ID – 223

Trends and variability of thunderstorm frequency during pre-warming and warming period over Andhra Pradesh and Telangana states

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Abstract

The climatology of thunderstorm (TS) frequency have been examined using monthly, seasonal and annual time series data of selected full time meteorological stations in Andhra Pradesh and Telangana states for a maximum period of 56 years (1955–2010). The results of the trend analysis showed that the average TS frequency exhibited significant trends for summer season(March, April and May) and during the month of May. The station-wise analysis for seasonal and monthly data showed increasing trends for the two states while decreasing trends was noticed for some stations of Telangana. The correlation coefficients of the time series of summer season TS frequency with rainfall and maximum temperature have been computed. Also, the composite climatology of geopotential height and temperature fields of the troposphere(850hPa, 700hPa and 200hPa) covering Andhra Pradesh and Telangana states and its surrounding areas for the month of May for the period 1955-1980(Pre-warming) and for the period 1981-2010(warming) have been investigated. The relative humidity, meridional/zonal component of wind fields havebeen also investigated. Additionally, the correspondence of TS frequency for this month with the low level vertical wind shear between 850 and 500 hpa levels for the u-component of the wind has also been studied using the data of 1955–2010, which shows that the TS frequency is positively correlated with vertical wind shear.

Keywords - thunderstorms, variability, trends, vertical wind shear, climatology, Andhra Pradesh, Telangana.

Abstract ID – 227

Influence of Natural Climate Variability Extreme Wave Climate in Indian Ocean

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Abstract

Extreme ocean waves are an essential segment of the climate system which is responsible for climate change and has significant impact on coastal as well as offshore human society and structures. In this study, impacts of various natural climate variability as El Niño Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), and Southern Annular Mode (SAM) over the seasonal extreme wave climate has been observed in Indian Ocean using ERA -20 Centaury reanalysis. The non-stationary Generalized Extreme Value (GEV) analysis has been used to determine the influence of natural climate variability over seasonal maxima of ocean wave height and wind velocity. The significant correlation is obtained between ENSO and IOD during the September to November (SON). The influence of ENSO, IOD and SAM over the extreme wind and wave height is analysed along with regions with 5% significance.

Keywords -Extreme Wave Climate, El Niño Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), and Southern Annular Mode (SAM), Generalized Extreme Value (GEV) distribution.

Abstract ID – 230

Extremely Heavy Rainfall Event over Nagpur during July 2018: A Case Study

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Abstract

The monsoon over Vidarbha region during July 2018 was featured by the extremely heavy rainfall that occurred over Nagpur on 06th July 2018 which caused flood like situation over the district due to water logging at many places causing disruptions in air, rail and road traffics. Rescue operations were started at schools and cities. This paper is an attempt to comprehend all the meteorological aspects that have contributed to such an unusually heavy rainfall event. In this particular event 30% of July rainfall over Nagpur region was received in one day. Relative study with past days observation and analysis, it has been seen that the monsoon circulation in westerly regime has triggered the convection to concentrate over a particular region with surface humidity reaching upto 100% and 90% and above in the upper levels resulting in high rain rate. Examining the thermodynamic aspects also substantiated the instability and likelihood of deep convection. Synoptic analysis shows that the active monsoon trough and the cyclonic circulation at upper levels alongwith the westerly flow leads to significant spatial and intensity distribution of rainfall over Nagpur region.

Abstract ID- 250

Severe Hailstorm of Spring-2018 over Madhya Pradesh – Tracking Impact of Western Disturbance using Doppler Weather RADAR (DWR)

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Theme: Weather and Climatic Extreme Events.

Abstract

During winter, western Himalayas and adjoining north India are affected by rainfall/snowfall associated with synoptic systems *viz.* Western Disturbances (WD). Favourable cyclogenesis conditions in upper atmosphere form an eastward-moving extratropical low/depression system, travelling through Indian subcontinent until the Himalayas inhibits, upon which it rapidly weakens. Western Disturbances (WD) brings precipitation pattern driven by westerlies due to moisture supply from Mediterranean Sea, Atlantic Ocean mainly and partially from Arabian Sea over the North-West Indian subcontinent till eastern plateau region.

Current study analyses the severe weather occurred over Madhya Pradesh during 11th-12th February 2018 due to WD with the help of Doppler Weather RADAR(DWR) - Bhopal and satellite imageries along with synoptic observations. As the event was strong enough and covered entire State of Madhya Pradesh, affecting State livelihood and agriculture, the same was chosen for study.

On 11th February 2018, WD as Upper Air Cyclonic Circulation (UAC) lied over Afghanistan and adjoining Pakistan, extending up-to 3.1 km AMSL with associated trough aloft in the form of westerlies up-to 5.8 km AMSL. Under its influence, induced UAC formed over South Pakistan and adjoining Rajasthan extending up-to 2.1 km AMSL that moved towards northeast. Westerly winds helped in moisture feeding from Arabian Sea. Further, night temperatures had marginally risen on 10th February 2018 mainly in stations of north and west MP due to increase in humidity. However, IMD-GFS model partially predicted rainfall over MP, but DWR/ satellite imageries particularly captured thunder/ hailstorms over entire MP on 11th and 12th February 2018 along with strong winds over Bhopal. The paper discussed thoroughly progress of clouds over Central India using DWR. Upper air observations too clearly indicated interaction of westerly (north MP) – easterly (south MP) winds. DWR helped in forecasting of severe hailstorms by predicting the track of clouds swiftly moving towards north-northeast (Fig.1). Moreover, INSAT-3D products (cloud top temperature-below 240 K) supported the occurrences of hailstorms.

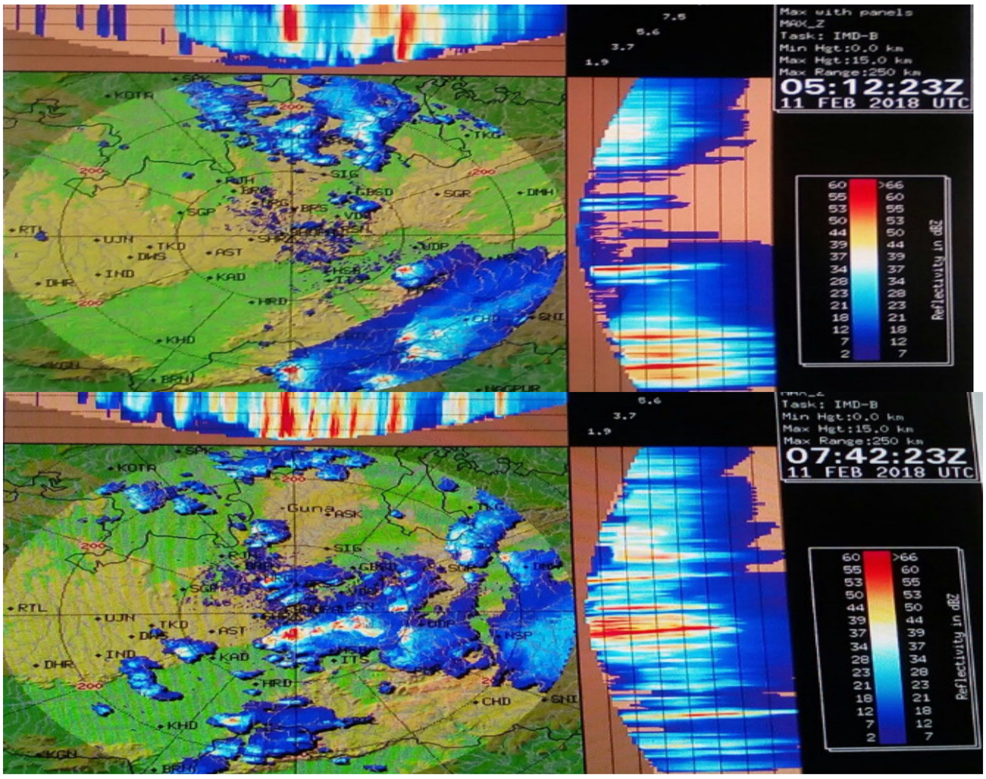

Fig. 1(A) & (B). DWR – Reflectivity product: At 05:12 UTC, hail-bearing storm clouds (red patches) entered through South MP and after 2.5 hours only, at 07:42 UTC, they crossed Central MP. This severe thunder/ hailstorm passed through Betul, Harda, Sehore, Bhopal, Raisen districts under influence of south-easterlies wind with speed of 80 kmph approx. However, another branch of hailstorm was effective over North MP under influence of westerlies in Bundelkhand region.

Key words -DWR, HailStorm, Western Disturbance (WD), UAC, Cyclogenesis, IMD-GFS.

Abstract ID – 254

Satellite based investigation of cloud microphysical properties for pre-monsoon thunderstorm events of 2018

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Theme: Weather and Climatic Extreme Events.

Abstract

Spatio-temporal observational analysis of INSAT-3D derived cloud microphysical parameters (CMPs)have been carried for the case of thunderstorms that struckthe state of West Bengal on 12th and 17th of April, 2018. The severe event of 12th April was reported to be around 15:35 IST whereas the thunderstorm event of 17th April was reported to be around 19:42 and 20:15 IST at two different locations respectively.The wind speed almost reached 98 km/h with atleast 15 casualties.Two important CMPs namely cloud optical thickness (COT) and cloud effective radius (CER) have been considered. However, the analysis study was limited to daytime hours as the satellite derived CMPs are based on visible and SWIR channel retrieval methods. Thus, due to the occurrence of the 17th April event during the late evening hours, the CMP structure could only beanalyzed for the period (14:30-15:30 IST)before the storm initiation. Here we observe the pre-storm conditions as the north-westerly air mass began to appear in the region. Observations show the presence of a system in the north-eastern India while the rest of the country was under warm conditions. It is hypothesized that the moisture influx from the north-eastern side served as an additional supply for the formation of the storm. The mixing of dry air from north-west with the deep moisture, resulted in instability and formation of large cloud particles. Similarly, COT and CER for 12th April event were examined as the storm traversed through Odisha and reached West Bengal. In contrast to 17th April, the 12th April event was advantageous as it affected the region during the afternoon hours owing to a better analysis of the CMP structure. It is observed that the CER lie in the range of around 30 microns during the time of the thunderstorm (15:30 IST). This represents the mature stage where the downdraft dominates resulting in heavy precipitation. The larger hydrometeors appear at the initiation of downdraft when cloud droplets collide withother droplets on its way down, and coalesce resulting in bigger precipitation sized particles. Moreover, clouds of high optical thickness can be found during the peak hour of the storm. This indicates deep convective growth possibly reaching tropopause as observed through thermal channel observations.Thus, analysis of the evolution of CMPs during severe weather events helps in identifying areas of potential precipitation. They also aid in better prediction of these events by their ingestion into weather and climate models.

Key words -thunderstorm, cloud microphysics, satellite, hydrometeors.

Abstract ID – 259

Variations in Accumulated Cyclone Energy over NIO during El Nina and La Nina episodes

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Abstract

Tropical cyclones are among the most destructive natural disasters around the world. The El Nino Southern Oscillation (ENSO) has a significant impact on the weather pattern over the Indian sub-continent. The influence of ENSO on tropical cyclones during the pre - monsoon and post - monsoon seasons over North Indian Ocean (NIO) comprising the basins of Arabian Sea (AS) and Bay of Bengal (BOB) has been examined in this study using accumulated cyclone energy (ACE) index. ACE is an important measure of tropical cyclone activity over a basin which combines storm intensity over the life time of each storm as well as over all the storms occurring during a season or year. The result reveals that during post-monsoon season tropical cyclone activity measured in terms of ACE is greater over AS during El Nino phase while ACE over BOB is more in the La Nina phase. However, in the pre-monsoon season the BOB has greater ACE during the El Nino years and AS has more ACE in the La Nina phase. The total ACE value over the NIO during the study period is observed to be greater during La Nina phase. The higher sea surface temperature (SST) during the post - monsoon season combined with positive sea surface height (SSHG) anomaly and low vertical wind shear during El Nino years leads to higher ACE over the AS. The SST, on the other hand, is not responsible for greater ACE over BOB during La Nina phase during the post-monsoon season but, high SSHG and low wind shear is observed to be significant during La Nina phase. However, the wind shear does not show any significant difference between La Nina and El Nino phases.

Key words - Tropical Cyclone, ENSO, SST, SSHG, ACE.

Abstract ID – 262

Study on frequency and intensity of Cyclonic Disturbances in the Bay of Bengal for retrospective assessment

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Theme: Observations in Climate Variability and Changes.

Abstract

Tropical Cyclones (TCs) are one of the deadliest phenomena in the nature bringing chaos in the coastal societies. These are rotational movements of wind i.e. counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere, and are often termed as depression, deep depression, tropical storm, cyclonic storm etc. on the basis of their size, intensity and strength. TCs alwaysbring heavy precipitation, strong and devastating wind movements, high waves and may also lead to storm surge in the area after the landfallwith subsequent impacts on water resources, environment, health, life and livelihood besides many. The Bay of Bengal is a sub basin of Indian Ocean, adjacent to the eastern coast of Indian subcontinent and more associated with the occurrences TCs impacting the Indian landmass in comparison to the Arabian Sea (adjacent to the western coastline of India). The present study is primarily aimed to assess the frequency and intensity of the TCs in the Reanalysis data for Pre-Monsoon months (March-April-May)in comparison to the Observations of India Meteorological Department (IMD) and Joint Typhoon Warning Centre (JTWC) over the Bay of Bengal. Also, it attempts to assess the variability in the sea surface temperature over the Bay of Bengal and understand its characteristics over the different regions of Bay of Bengal. For the study, reanalysis data (sea surface temperature, mean sea level pressure, u and v wind at 850hPa) from ERA-40 and ERA-Interim dataset has been obtained from European Centre for Medium Range Weather Forecast (ECMWF) at the spatial resolution 0.25˚X0.25˚ with temporal resolution 1979-2002 while the observation dataset (intensity, frequency and best track) has been collected from the IMD and JTWC for similar temporal scale.

In comparison to the annual occurrences of the TCs in the Observations (IMD and JTWC), Pre and Post Monsoon (October-November-December) months have more frequency of TCs in Bay of Bengal. In the Pre Monsoon season, month of May has more occurrences of TCs in comparison to March and April with one cyclonic disturbance every year. It is found that both the reanalysis dataset (ERA-40 and ERA-Interim) are able to capture the observed cyclones (about 60%) in comparison to IMD and JTWC for the pre monsoon months. Also most of the TCs have origins scattered around different regions of the Bay of Bengal with genesis central pressure 990mb. Further, the sea surface temperature has been assessed on the different regions of the Bay of Bengal (North East, North West, East Central, West Central, South West and South East) for long term trends using Mann-Kendall test statistics which shows rising trends with more intensified cyclones. Also, it is found that the Central Bay of Bengal (East Central and West Central) regions have relatively warmer temperature in comparison to other regions.

Keywords -Sea Surface Temperature, Pre-Monsoon Season, Reanalysis Data, ERA40, ERA-Interim.

Abstract ID – 271

Thunderstorm accompanied with squalls over northwest India on 02 and 14 May, 2018

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Abstract

Thunderstorm is a severe weather phenomena observed all over the world, it become sever when associated with squall and hail. Its impact is being felt by all the sectors of society including aviation services.In India, the hazard due to the thunderstorm is primarily concentrated over Northeastern states and East India. In present cases most parts of Northwest Indian plains observed severe thunderstorm activities on 02nd and 14th May, 2018. In present study, cases of thunderstorms accompanied with squall occurred over Delhi on 02nd May and 14th May, 2018 has been discussed in detail. In both squall events, Maximum wind speeds of 69 kmph and 107 kmph have been observed at Safdarjung station of Delhi with duration of about 2 minutes on 2 and 14 May 2018 respectively. Highest Maximum wind speed of 126 kmph was observed at Agra Air Force Station Observatory. During the first events of thunderstorm accompanied with squall, wind maxima at 100-250 hPa (wind speed), upper level divergence, low level convergence, penetration of low level easterlies upto Punjab and Rajasthan and Western Disturbance as a trough in mid-tropospheric level westerlies played the key parameters in formation and development of severe thunderstorms over parts of plains of Northwestern India. As per satellite imageries, the weak Convective cells on 0600 UTC of 02nd May developed over north Pakistan and under the impact of mid and upper level westerlies moved in southeast direction towards Delhi NCR on 2nd May. These cells organized into intense to very intense convection over south Haryana & neighborhood around 11 UTC and caused thunderstorms and squalls in the evening hours of 02nd May over Delhi. Convective cell formed over north Pakistan on 02nd May, has been seen in Satellite imageries as well as in radar imageries of Patiala and Delhi till squall happens by around 11 UTC of 02nd May over Delhi. The cloud top temperature (CTT) of convective cells over and around Delhi were observed -80^{0}C at 1100 UTC of 02nd May, 2018. The pre-thunderstorm environment has also been studied with the help of stability indices calculated from Delhi T-φ gram. Out of 13 indices, 11 (about 85%) were favourable at 0000UTC of 02nd May. Synoptic conditions and stability indices values have suggested the occurrence of severe thunderstorms over Delhi & neighborhood. (similar about 14 May case).

Abstract ID – 290

Study and Characterization of Tropical Cyclone Ockhi using Doppler Weather Radar

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Theme: Weather and Climatic Extreme Events.

Abstract

Doppler Weather Radar (DWR) is one of the integral components of weather monitoring and forecast system. DWR based algorithms have proven to be very useful for rain rate estimation, nowcasting and assimilation into the numerical weather prediction (NWP) models, especially during severe weather events like cyclones. This paper presents one such application of DWR for the study and characterization of cyclone Ockhi, a tropical cyclone falling into the very severe cyclonic storm category. Cyclone Ockhi was the third and the strongest cyclonic storm in the North Indian Ocean cyclone season in 2017. Although it had originated from a low-pressure area in the southwest part of Bay of Bengal on 28th November, 2017, it travelled almost over 2000 km (~2538 km) through the Indian ocean and Arabian sea and crossed south coast of Gujarat on 6th December, 2017. Cyclone Ockhi caused massive damages to life and property along its path, with recorded wind speeds over 160 km/hr. The measurements of Ockhi were carried out from the Thumba Equatorial Rocket Launching Station (TERLS) using the C-band dual-polarized ISRO-DWR. Radar observations considered in this study are in the Plan Position Indicator (PPI) mode, for the period of 29thNovember – 02nd December, 2018. The measured reflectivity was corrected for clutter using a combination of a texture-based filter and a fuzzy logic classification algorithm. Further, the velocity folded regions in the radial velocity data sets were corrected using an automated 2D multipass velocity dealiasing scheme. Post corrections, 3D volumetric grids of radar variables have been generated with a horizontal resolution of 1 km and vertical resolution of 250 m. The velocity profiles generated using the Velocity Azimuth Display (VAD) technique reveal the kinetic structure of the squall line and the overall kinematic evolution of the cyclone Ockhi. Contoured Frequency Altitude Diagrams (CFADs) have also been generated to observe the 3D structure and distribution of the hydrometeors in the rain bands of the cyclone. Finally, using the 3D volumetric gridded reflectivity, surface accumulated rainfall has been retrieved and validated against IMD rain gauge data.

Key Words: Ockhi, Doppler Weather Radar, Tropical Cyclone, reflectivity, radial velocity, VAD, CFAD.

Abstract ID – 336

Impact of extreme weather events in relation to hailstorms over Maharashtra in recent years

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Theme: Weather and climatic extreme events.

Abstract

The increased incidences of extreme weather events viz. floods, droughts, cyclones, heavy rainfall, hailstorms, thunderstorms, heat and cold waves havebeen causing widespread damage and loss to agricultural sectorespecially during the past decade. We cannot avoid natural hazards like hailstorms and disasters, but can minimize their impact on environment by preparedness & planning. Study of extreme weather events is essential for Agriculture planning because amongst extreme weather hazards, hailstorms cause a great damage to standing crops eventhough these occur for a very short duration.Therecent trails of the unusually widespread extreme weather events over India reporting an increase in the incidents of hailstorm. Studies in the past, mainly undertaken after the severe hailstorm incident in 2014 in Maharashtra when hailstorm was reported for 20 days between mid-February and mid-March, have revealed Maharashtra was becoming prone to hailstorm.From the studies it revealed that of the 35-years study period, hailstorms hit Maharashtra for 31 years, with a 91% to 95% probability of hailstorms striking the State, the highest episode of 11 days took place between February 24 to March 14, 2014. With thunderstorms and hailstorms occurring frequently during the pre-monsoon season of March, April and May, Maharashtra has witnessed this unseasonal weather pattern for four consecutive years – 2014, 2015, 2016 and 2017.Hailstorms can wreak havoc with the environment and cause harm to wildlife, plants, crops, and your home and personal property. A severe storm can have a domino effect and place challenges on the environment. The present study aimsthat,statistical analysis of these weather extremes of hailstorms over Maharashtra will be very helpful to understand the vulnerability potential and to minimize the adverse effects of hailstorms by issuing early warning. For this purpose,incidences of hailstorm reports prepared by India Meteorological Department, for the period 1981-2016(37 years) have been used in the study. Only those cases have been included for the study, which caused human fatalities and significant economic/agriculture losses. Frequency and trends have also been computed by using various statistical tools.

Key words :Extreme weather events, thunderstorms, floods, earthquakes etc.

Abstract ID – 342

Lightning evolution during severe tropical cyclones: Some case studies from the Indian sector

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Abstract

We investigate the dynamics of tropical cyclones with the help of World Wide Lightning Location Network data. For the present work, fourteen intense cyclones over the Bay of Bengal in the Indian sector are selected from the year 2013 to year 2017. Detailed analysis of lightning flash count shows that the initial phase of the intensification of cyclones over the Bay of Bengal is associated with high lightning activity within the eye as well as in the rain band regions. It is observed that the energetic lightning strokes mainly occur during the mature phase of the cyclones whereas the high peak current lightning strokes occur during the intensification and just before the weakening phase of the cyclones. Depending on the maximum sustained wind speed and intensification rate of the cyclones, the zone of the most energetic lightning activity changes position in between the eye and the rain-band region. Satellite microwave observation confirms that the high convective zones in the cyclonic grids are lightning populated. The lightning evolution during cyclonic activity is also found to be correlated with the sea surface temperature. The study indicates that the monitoring of real-time lightning activity could be used as a proxy to probe the temporal evolution of cyclonic activity over the ocean in addition to the existing ground and satellite based forecast methods.

Key Words: World Wide Lightning Location Network, Sea surface temperature, cyclonic eye, rain band.

Abstract ID – 348

Spatial variability of monsoon cloud bands during El Nino and negative IOD years

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Abstract

Indian summer monsoon rainfall exhibits spatial and temporal variability. The variability of Indian summer monsoon rainfall is important in view of the climate change scenario. Indian subcontinent experienced 3 major deficient monsoon years (seasonal rainfall is less than 90 % of long term mean) on all India basis due to El Nino during the last decade (2002 :19%, 2004: 14% and 2009 : 22% deficiency) and a deficient situation over the southwest peninsular India (2016 : 34 % deficiency, even though deficiency on all India basis was 3%). These deficient epochs are closely related to the global factors such as ENSO/IOD and subsequent shifting of the convection zone from the normal position. These four monsoon seasons were peculiar in the intraseasonalaspect,as the years 2002, 2004 and 2009 belong to El Nino and the year 2016 belongs to negative IOD year. Accordingly the behavior of evolution of the cloud bands in the equatorial region and their northward propagation are different from normal pattern. The abnormal behavior in the organized convection is reflected as long break in the Hovmoller diagram during the years 2002, 2004 and 2009. During these long breaks (breaks lasting for more than 7 days) in the 3 El Nino cases, we found that the convection is shifted to the West Pacific Ocean and highly suppressed over the Central and Northwest India. Further, an increase in convection over an area just south of the equator in the Indian Ocean is also noticed. Thus it is inferred that the long breaks lead to deficient monsoon rainfall and is attributed to shifting of convection zone due to El Nino. During the negative IOD year (2016), the cloud band kept away from the west peninsular India. This is due to the dipole nature of the SST with cold water in the Arabian Sea. It is found that the circulation pattern is also different during the El Nino and negative IOD year. The ascending limb of Hadley circulation in the Bay of Bengal region is feeble or absent during the El Nino. The ascending motion features are studied thoroughly over the monsoon core zone to understand the peculiar behavior during the El Nino years. During the negative IOD case, ascending motion is absent in the west peninsular India indicating inhibited convection over this region. This inference is supported during different years of El Nino and negative IOD years.A comparison is made with the convection features during 2013 to understand the peculiar behavior with normal monsoon.

Abstract ID – 355

Seasonal Prediction of Extreme Rainfall episodes over India

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Abstract

Vulnerability disaster due to extreme rainfall during south west monsoon over India has increased manifolds in the recent time. Like monsoon rainfall prediction it is also important and challenging task for the seasonal prediction of the extreme rainfall episodes over the continental India because this prediction can be used in the pro-active disaster management during the long monsoon season in India. In this study a variable resolution general circulation model (VARGCM) is configured and calibrated for the seasonal prediction of the extreme rainfall during monsoon for the period 1998-2013. The skill of model prediction in simulating monsoon extreme periods is evaluated by validating the same with the high resolution gridded rainfall data available from the India Meteorological Department (IMD). It is observed that the VRGCM has potential skill in the seasonal prediction of extreme rainfall episodes over India.

Abstract ID – 395

Study of Monsoon Circulations and its Impact on Monsoon Rainfall: Using 205 MHz ST Radar and Radiosonde Datasets

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Abstract

Southwest monsoon rainfall is important to India as it directly affects the country's economy and livelihood of its people. There is also a growing need for better monitoring, studying and understanding the regional scale processes for making better weather prediction and to understand the dynamics of these processes. Cochin, a city in Kerala is situated in southwest part of India and known as the gateway of monsoon. To study the 2017 monsoon characteristics we used data from the Stratosphere – Troposphere wind profiling radar which is situated in Cochin at 205 MHz and is the first radar to be operating at this frequency in the world. The 619 three element Yagi-Uda antennae provides wind profiles in the altitude range of 315 m to 20 km. In this paper we study the characteristics of the monsoon low level jet (MLLJ) and the tropical easterly jet (TEJ), which are two important components of monsoon circulation using ST radar and radiosonde datasets. The variability of MLLJ and TEJ and their association with monsoon rainfall observed over Cochin (10°2'31"N, 76°19'54"E) is studied for the monsoon season of 2017. Low level jet is observed to be greater during extreme rainfall days. During active monsoon period a strong coupling between LLJ and TEJ is observed.

Abstract ID – 400

Numerical simulation of Tropical cyclone "Ockhi" and comparative evaluation of the Symmetric vs Asymmetric features

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Abstract

In the present study numerical simulation of tropical cyclone "Ockhi" has been performed with two numerical models, one with an axisymmetric model and the other with the time tested WRF model. The initial soundings for the two models have been picked up from theNCEP/NCARwebsites. The time at which the minimum central surface pressure is achieved has been designated as the mature stage of the cyclone. The radius height cross sections of the three component winds, temperature and the humidity fields are analyzed and have been compared and discussed at the mature stage of the cyclone in both the experiments. The results revealed that the Asymmetrics are better represented in the WRF model and the intensification is reasonably good with axisymmetric model.

Abstract ID – 403

Recent heat conditions over Indian region during summer months

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Abstract

In recent years, the climatic change and its potential impacts especially caused due to extreme events have received a lot of attention. The increase in frequency and intensity of heat events that leads to increase in water demand, crop yield reduction, risk of health and heat wave casualties.

In the present work, heat conditions over Indian region (6-38^0 Lat., 60-100^0 Long.) have been analyzed using ECMWF analysis data of surface temperature (2 meter above surface) at 12 UTC at grid resolution of 0.5^0, considering pentads of temperature during April and May for 2017 and 2018. Two regions of North-West India (Lat.22-29, Long.70-74) and central India (Lat.19-23, Long.77-82) have been identified which are highly prone to heat conditions throughout summer season. Further, time series analysis of mean temperature over these two heat prone areas have been performed and temperature extremes, heat spells and their duration and frequency is discussed.

Abstract ID – 410

Regional scale study of comfort / discomfort indices over six major cities of Tamil Nadu, India having distinct geographical features.

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Abstract

Discomfort indices are attracting considerable interest due to changed Climate Scenario to recent times. The aim of this research is to broaden current knowledge of Comfort /discomfort Indices on regional scale over Tamil Nadu, India. Four indices namely heat Index (HI), Wet Bulb Globe Temperature (WBGT), Temperature humidity Index (THI)& relative strain Index (RSI) have been studied for six major cities of Tamilnadu Viz., Chennai, Vellore, Coimbatore, Salem, Madurai and Trichy, having distinct geographical features. These indices are computed for climatological period of 30 years (1981 to 2010) to analyse their effects on comfort of human, changes & trend. This paper revisits role of above indices influence upon man/human activities.

The results reveal that climatologically the value of HI is observed to be more from mid-May to Mid-June in all 6 above mentioned cities; may be due to proximity of city to sea & moisture influx from Arabian Sea & Bay of Bengal. WBGT is seen to have maximum effect near mid-June to sometime up tomid-July when annual March of Sun is in northern 'hemisphere. Response of THI is significant from mid-May to mid-June& sometime in end of June & has considerable impact on human activities. RSI is max. For Vellore (Sept.) & minimum for Madurai (June), due to cloud cover, cooling degree days & consecutive days of extreme heat during these months.
(Add results of Trend analysis)

Keywords: Comfort/Discomfort, Heat stress; THI; WBGT; Relative strain index.

Abstract – 415

Dynamics and Trends of Warm Days over India

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Abstract

Indian subcontinent is becoming highly vulnerable to warm days with adverse effects of temperature extremes on life and property increasing year by year. Hence the current study attempts to investigate the possible mechanisms leading to the formation of warm days over India. A gridded daily mean temperature dataset for the period 1951-2013 has been analyzed for the study. Warm days are identified using a threshold of 90^{th} percentile of daily mean temperature. An increasing trend in mean temperature and number of warm days of extreme is noticed in almost all parts of the country throughout the year during 1951-2013. Significant increasing trend in warm days (>5 days) and intensity (>0.1◦C) is noticed from the linear distribution of spatial trends over the southern states including Kerala, Tamilnadu, Karnataka and Andhra Pradesh throughout the year, especially during the winter season. Meanwhile, a significant increasing trend over north and central parts of India (Gujarat, Rajasthan, Punjab, Haryana and Himachal Pradesh) and a negative trend over northeast India is noticed during summer months of April, May and June. Time series of annually averaged warm days over 63 years has shown an increase of 0.3 days per decade. During the first half of the study period, the north and central Indian regions exhibited negative trend in warm days, while during the second half, increasing trend is notable for all months, a probable result of anthropogenic climatic changes.Over the north-west and central Indian regions, the formation and persistence of summer time warm days are observed to be associated with the presence of anomalous persistent high with anticyclonic flow at 500 and 200 hPa levels reinforced with subsidence and clear sky conditions. Interestingly, this anticyclone is present during the winter time warm days itself over the northern and central parts of India. Even though maximum warming is observed in the month of may, the maximum strength of this anticyclone is observed during the month of March. The formation of summertime warm days over southern India appears to be linked to the transport of moisture out of Indian landmass and associated reduction in specific humidity. The composite anomalies of specific humidity at 850 hPa and vertical velocity at 500 hPa suggests more evaporation and organised convection over equatorial Indian ocean resulting in subsidence of dry air over southern India, another possible reason for warming. During monsoon season, every part of India shows an increase in trend in warm days and there's an evident similarity in features of such warm days and the break days of monsoon. The number of warm days over India shows significant positive correlation with the equatorial Indian ocean SST with higher values more than 0.5 in every months over southern tip and more than 0.4 during summer months of April, May and June over the northwest. A significant negative correlation between warm days and soil moisture can be seen that indicates land surface processes have predominant role in modulating the warm days over India.

Abstract ID – 423

Upper Ocean Dynamics in the wake of intense cyclones in Bay of Bengal

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Abstract

The passage of two intense cyclones Phailin and Hudhud which crossed the Bay of Bengal (BoB) at the nearly identical time during 2013 and 2014 and also followed similar tracks provided a rare opportunity to study the upper ocean response of BoB to tropical cyclones. Though numerous studies have documented the upper ocean response to cyclones in BoB using ARGO floats, remote sensing, and modelling studies, this study utilised high-frequency surface and subsurface observations from moored buoys located in the vicinity of the cyclone tracks, to investigate the temporal evolution of upper ocean structure. Hudhud induced an extensive sea surface cooling (~ 3 °C) and enhanced chl-a about nine times along the track in the open ocean, which is normally oligotrophic and stratified, even though its intensity was less than that of Phailin. The physical mechanisms controlling the upper ocean response to cyclones were analysed. Our analysis shows that weaker stratification during the pre-cyclonic days of Hudhud, the longer time taken for the temperature restratification due to the strong winds after the cyclone passage and less translation speed could be the reason for the extensive surface cooling and enhanced chl-a concentration during Hudhud. This study highlights the importance of high frequency observations from moored buoys to get better insights of upper ocean response to cyclones especially in a stratified region like BoB.

Keywords: Phailin, Hudhud, entrainment, upper ocean response, translation speed.

Abstract ID – 439

Variability of cyclogenesis over Bay of Bengal striking eastern coastal states of India

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Abstract

The tropical cyclones are fatal ones among the most dangerous natural disasters throughout the globe. The major natural disaster that affects the coastal regions of India is cyclone since India has vast coastline on eastern and western parts.The Indian Ocean is one of the six major cyclone prone regions of the world. On an average, about 5 to 6 tropical cyclones are formed in the Bay of Bengal (BoB) and the Arabian Sea every year, out of which 2 or 3 may be very severe. More cyclones are formed in the Bay of Bengal than in the Arabian Sea. As such, the eastern coast is more prone to cyclones and about 80 per cent of the total cyclones generated in the Indian Ocean strike the East Coast of India. There are two definite seasons of tropical cyclones in the North Indian Ocean. One is from May to June and the other is from mid-September to mid-December. The months May, June, October and November are known for severe storms. Principal dangers from a cyclone are: (i) Gales and strong winds, (ii) Torrential rain, and (iii) High tidal waves (also known as 'Storm surges'). Most casualties are caused by coastal inundation by tidal waves and storm surges. The entire east coast stretching from Orissa to Tamil Nadu is vulnerable to cyclones with varying frequency and intensity.Most of the cyclones have their origin between 10°N and 15°N during the monsoon season. Andhra Pradesh has a long coast line of 1,030 km from Srikakulam in the north to Nellore in the south along the East Coast of India bordering the Bay of Bengal. Like Andhra Pradesh, its neighboring state Odisha is also vulnerable to tropical cyclones. The latest was the 'Super Cyclone of Odisha' which hit strongly the coast particularly the state of Odisha on 29th October 1999. The meteorologists consider it the most devastating cyclone that ever occurred in India. This cyclone left the state in a virtual paralysis with its communication system and infrastructure completely wrecked. It severely affected more than 13 million people in 97 blocks, 28 urban local bodies in 12 districts including the state capital Bhubaneshwar. Recently in the year 2013 the extremely severe cyclonic storm named 'Phailin' and in the year 2014 a similar cyclonic storm named 'Hudhud' hit the coastal region with relatively less intensity compared to the super cyclone,1999. Like Andhra Pradesh and Odisha the state of Tamil Nadu also witnessed many severe cyclones in recent time with very severe cyclone "Vardah" of 2016 causing large scale destruction in the state. As experienced, Indian coastal region particularly Andhra Pradesh and Odisha states are quite prone to cyclones and become worst victims. In view of this the variability of cyclone intensity and cyclone frequency hitting the four Andhra Pradesh, Odisha, Tamil Nadu and West Bengal) of eastern coastal states of India along with its percentage of intensification and the genesis location has been analysis by taking the cyclone data from 1971 to 2017. An interesting result is noticed about the variability of cyclone frequency hitting these states with West Bengal, Odisha, and Andhra Pradesh indicating less number of cyclones during recent two decades compared to earlier period, whereas the cyclones hitting Tamil Nadu coast is increasing in recent two decades compared to earlier period. The other results are discussed in details in the paper.

Abstract ID – 454

Multidecadal variability and trend in extremesprecipitation over India

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Abstract

India is one of the most vulnerable regions to severelyaffected by climate extreme events like floods, droughts and landslide etc. The robustmonsoon variability is magnify to decline the mean rainfall over Indiaand at the same time it is reported that climate extreme willbe increased inrecent decades. The fluctuation of climate extreme indices during monsoon season(JJAS)such as consecutive dry days (CDD) , consecutive wet days(CWD) , days of precipitation(>20 mm), Simple daily intensity (SDII) and maximum one day precipitation (RX1day) are most sensitive for understanding the uncertainty due to high variability and trends in climate system for regional assessments of the agricultural land , water availability , infrastructure and development of human society . This selective observational studyfor recent decades during 1951-2010 areto appraisal for spatial and temporal distribution of extreme precipitation indices for depicts the future uncertainties and climate change. The distribution of observed change in mean precipitation and consecutive wet days are significantly increasing mostly overcentral India and also over many subdivisionsof India and at the same time, consecutive dry days are decreasing, but in case of more dryer condition, maximum one day precipitation (RX1day in mm) is significantly increasing at most of regions, followed by more dryer and get more extreme precipitation. The high variability of climate extremesis foundmostly in central India and high altitude regions. The maximum one day precipitation (RX1day in mm) has shown high variability in central and adjoining regions. The trend of climate extremes has more uncertaintiesshowing greater increasing and decreasing over high altitude and coastal regions of India.Above mention information are most useful in reducing highrisk associated calamities with climate for human Society andwell planning for mitigation and adaptation.

Key words: Extreme precipitation, Extreme precipitation indices, Indian monsoon seasons, significant change and variability, trend.

Abstract ID – 464

Spatial and Temporal variations in Convective Available Potential Energy (CAPE) from INSAT-3D measurements

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Theme: Weather and Climatic Extreme Events.

Abstract

The extreme weather events such as thunderstorms and tropical cyclones cause severe damage to life and property, especially in the tropical regions. Convective available potential energy (CAPE) is a measure of the amount of energy available for convection in the atmosphere. So, CAPE can be used as a measure for the occurrence of these severe weather conditions. The Geo-stationary satellite measurements over the ocean and land can be used to better understand the atmospheric stability as these data sets are available at high spatial and temporal resolutions. In the present study, an attempt is made for the first time to estimate CAPE from the Indian National Satellite System (INSAT-3D) measurements. The estimated CAPE from the INSAT-3D measurements is comprehensively evaluated using radiosonde derived CAPE. For the evaluation, 20 stations are selected in different parts of India and these estimates are evaluated against the radiosonde measurements collected from the Wyoming University. The station wise comparison shows that the INSAT-3D estimates match well with higher correlation coefficient and lower bias with the radiosonde measurements. The categorical statistics shows that the INSAT-3D better represent the radiosonde measured CAPE.

The spatial distribution of CAPE is studied during different seasons over Indian sub-continent. In addition, the distribution of CAPE is studied for different instability conditions (different range of CAPE values) during different seasons over the Indian region. The diurnal and seasonal variability in CAPE is also investigated at different geographical locations to understand the spatial variability with respect to different terrains. The spatial and temporal distribution of CAPE reveals several interesting features. These results will be discussed during the conference/symposium.

The present study shows that the INSAT-3D measurements are in close agreement with the radiosondeobservations. As the INSAT-3D provides high temporal and spatial resolution data, it can be used for now-casting and severe weather warnings in the numerical models.

Abstract ID – 467

Heavy Rainfall Warning Over India: Issues & Challenges

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Abstract

National Weather Forecasting Centre of India Meteorological Department issues 5-day forecast of heavy rainfall on daily basis for 36 meteorological subdivisions of the country.The forecast is provided to Disaster Managers and general public to minimize the adverse impact of heavy rainfall. However, the utility of this Forecast depends to a large extent on the accuracy and uncertainty associated with it. Therefore, it is very essential to verify the Heavy rainfall forecast and inform the skill and uncertainty to the disaster managers and general public.To find out accuracy of the forecast done, Forecast Verification is carried out through different Forecast skill scores such as Critical Success Index (CSI), Heidke Skill Score (HSS), Probability of Detection (POD),Missing Rate (MR), False Alarm Rate (FAR) etc. A study has been undertaken to analyze these skill Scores for 5- day forecast based on data of the period 2011-2017.The Time Series of different Forecast Skill Scores for Heavy rainfallForecast during Monsoon months (JJAS) have been analyzed to for the period 2011-17 to find out the trends, if any. The results indicate that the POD is currently about 65-70% for Day-1 Forecast with gradual improvement over the years in terms of increase in POD and decrease in MR and FAR. The FAR and MR are still about 20-30% for the country as a whole.The results have been analyzed vis-à-vis the Numerical Weather Prediction (NWP) Models used for the purpose. The issues and challenges likei)observational network for detecting Heavy Rainfall, ii) Tools and technology used for analysis and decision making and iii) limitations of the NWP models; have been identified and discussed to further improve the heavy rainfall forecasting skill.

Abstract ID – 472

Trends in extreme rainfall eventsoverMadhayaPradesh : Intensity and duration wise study

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Abstract

Madhya Pradesh, the second largest state of the country is located in the central India, comprising 11 Agro – Climatic zones with diverse soil and climatic condition, which helps to support to cultivation of a wide range of crops with diversified cropping pattern. Madhya Pradesh mainly depends on agriculture and stands in the top most position for producing, garlic,coriander, pulses and oilseeds. The agricultural activities are totally dependable on water resources available in state in form of ground water, surface water and rainwater. The ground water development up to 2011is up to 57 percent. Ujjain, Indore divisions and some other parts of West M.P. over exploited ground water. In East M.P ,northern Gwalior, Sagar and Rewa divisions are in semi critical category of ground water exploitation. Past thirty years development in infrastructure facilities, technologies with increasing population and increasing demand for food putting lot of pressure on available water resources. The overall contribution of rainfall to country's annual ground water resources is 68 percent, so monsoon season rainfall plays a significant role for ground water recharge, agriculture and economy.

The annual rainfall received in the MP state varies from 800 mm in the northern and western regions to 1600 mm in the eastern districts. In some years rainfall goes much below to the normal. Most of rainfall is received in the Monsoon season from June to September and about 10 per cent of the rainfall is received in the remaining part of the year.

Trend~~s~~ in precipitation is critically important fortimely availability of rain water. An attempt has been made in this study to find out the seasonal trendsof extreme rainfall events based uponthedaily rainfall data of nine stations of MP during monsoon season (JJAS) for the period 1980-2016 and also to**correlate the rainfall event over the state with the NINO and ENSO index of corresponding of Indian Summer Monsoon.**Extreme rainfall events in terms of intensity areclassified as Moderate (15.6-64.4 mm), Heavy (64.5-115.5 mm),Very Heavy (115.6-204.4 mm)and extremely heavy(>204.5 mm).Trends in the rainfall events in terms of duration, continuousprecipitationwithintensity ≥2.5 mm/day for <(less than) or ≥ (more and equal) 4 consecutive days are defined as Short Wet Days (SWD) or Prolonged Wet Days (PWD). Similarly, continuous precipitation with intensity<2.5mm/day for<(lessthan) or≥(more and equal) 4 consecutive days are consideredas ShortDryDays(SDD)orProlongedDryDays(PDD).There are increasing trends in case of PDD in Bhopal, Guna, Gwalior and Sagar, this trend is significant in case of Gwalior and PDD trends are decreasing inIndore, Jabalpur, Hoshangabad, Satna and Khajuraho.

In case of SDD, increasing trends in Khajuraho, Guna, Indore, Jabalpur, Hoshangabad and Satna and decreasing trends in Bhopal, Gwalior and Sagar. These trends are not significant.

In case of PWD, increasing trends in Bhopal, Guna, Gwalior, Indore, Jabalpur, Hoshangabad and trends are decreasing for Satna, Sagar and significant decreasing for Khajuraho at **0.1 level** of significance of Mann Kendall test.In case of SWD increasing trends for Khajuraho, Indore , Satna, Sagar and trends are decreasing for Bhopal, Guna, Gwalior, Hoshangabad and Jabalpur. In terms of Intensity, extremely heavy event showed significant decreasing trend for Gwalior and Heavy rainfall event shown significant decreasing trend for Satna. The moderate rainfall events have increasing trends which are not significant for all stations except sagar and guna have neither increasing nor decreasing trend.Mann-Kendal test has been used for this study to test the significance of the trends.

Keywords: Events, Trends, Dry and Wet days, Mann-Kendall Test.

Abstract ID – 492

Study of cold and severe cold wave events over the Indo-Gangetic Plain (IGP) during 1951-2013

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Abstract

Extreme weather events such as thunderstorm, heavy rainfall, heat wave, cold wave, cyclone, flood and drought have large impact on environment and to the socio-economy of India. Cold wave is one of the climatic phenomena which prominently occurs during the winter season of India (November to February). These waves can be defined during the prolonged period of excessively cold weather. A sudden invasion of very cold air takes place over a very large area and leads to unusual and rapid reduction in temperature over that region. In the present study the trends of cold wave and severe cold wave frequency have been analyzed for the months November to March during the period of 1951- 2013 over Indo-Gangetic Plain (IGP) and its six different regions. In addition, the yearly and decadal variation of cold wave and severe cold wave event over IGP and the six different regions have been shown individually.

Keywords: Extreme events, Cold wave, Indo-Gangetic Plain (IGP).

Abstract ID – 507

Severe weather over major parts of Northwest India on 23rdMay 2016 - A case study

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Abstract

Unprecedented weather activity in the form of moderate to heavy rainfall, severe thunderstorm, hailstorm and duststormactivityoccurredover many stations of northwest India & neighborhoods on 23^{rd}May 2016.Therefore in the present study, an attempt is made to understand the various meteorological features -synoptic, dynamical & thermodynamical, associated with this unprecedented weather activity over northwest India. On 23^{rd} May 2016, there was aWestern Disturbance (WD) in middle & upper tropospheric levels with its southern end extending up to north Arabian Sea. At lower levels, there were three cyclonic circulations, one over the central Pakistan &neighborhoods, second overthe northeast Madhya Pradesh and third over the Gangetic West Bengal & adjoining northwest Bay of Bengal. In addition to above features it was also observed that there were wind confluence between westerlies and easterlies at lower levels, which enhance the weather activity over the region.

Abstract ID – 52

Potential predictability of Indian summer monsoon rainfall in NCEP CFSv2

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Abstract

The potential predictability of the Indian summer monsoon rainfall (ISMR), soil moisture, and sea surface temperature (SST) is explored in the latest version of the NCEP Climate Forecast System (CFSv2) retrospective forecast at five different lead times. The focus of this study is to find out the sensitivity of the potential predictability of the ISMR to the initial condition through analysis of variance technique (ANOVA),information-based measure, including relative entropy (RE), mutual information (MI), and classical perfect model correlation. In general, the all methods show an increase in potential predictability with a decrease in lead time. Predictability is large over the Pacific Ocean basin as compared to that of the Indian Ocean basin. However, over the Indian land region the potential predictability increases from lead-4 to lead-2 and then decreases at lead-1 followed by again increase at lead-0. While the actual ISMR prediction skill is highest at lead-3 forecast (second highest at lead-1), the potential predictability is highest at lead-2. It is found that highest and second highest actual prediction skill of the ISMR in CFSv2 is due to the combined effects of initial Eurasian snow and SST over Indian, west Pacific and eastern equatorial Pacific Ocean region. While the teleconnection between the ISMR and El Ni~no-Southern Oscillation is too strong, the ISMR and Indian Ocean dipole have completely out of phase relation in the model as compared to the observation. Furthermore,the actual prediction skill of the ISMR is now very close to the potential predictability limit. Therefore, in order to improve the ISMR prediction skill further, development of model physics as well as improvements in the initial conditions is required

Abstract ID - 58

Prediction of Cyclones & IoT based Automatic Weather Station

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Abstract

Cyclone is an extreme weather phenonmena which causes inordinate loss to masses & civilization. From climatology, the cyclone prone areas are usually pre-defined. But, its origin& generation, both are beyond the purview of forecasters. Once generated, only its 'Intensity & Path' can be tracked & predicted to minimize the loss to the civilization.

The prediction of 'Intensity & Path' of cyclones, requires real time availability of surface weather data. With the invent of the new technologies & induction of Automatic Weather Stations (AWSs) in the observational set-up of surface weather stations, now a days it has become possible to predict the 'Intensity & Path' of the cyclone with a certain modified accuracy. But, cyclone is such a complex phenonmena that it even affects & destroys the running instrumental set-up as well. Also, because of communication failure during cyclone period, the non-availability of these surface weather parameters, restricts the hands of the forecasters. Hence, the availability of the surface weather data during cyclone, requires involvement of the technology, which is having an edge over the existing AWS.

The recent development, **IoT(Internet of Things)** based AWS systems, can bridge the gap between instruments & destructive power of extreme to extreme weather events. The **Internet of Things (IoT)** is the network of physical devices, offices and other items embedded with electronics, software, sensors, and connectivity, which enables these things to connect and exchange data. Using cloud technology, as per the need of the user, any/all of these devices, offices & other embedded items, may be activated/deactivated.

The **IoP** based AWS requires installation of I.P based various sensors which can be energized remotely. These sensors are very low power consuming standalone devices, which can be installed anywhere (as per the need) for data acquisition. e.g I.P based pressure sensors can be installed in various safe & secured places to ensure the availability of the data during cyclone period.

Since, all these sensors are having different I.Ps, failure of any or some of these sensors, will also ensure availability of a good volume of the data for forecasting purpose, which will ensure a value addition to the cyclone prediction.

Abstract ID – 69

Rainfall prediction for the state of Gujarat using deep learning technique

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Abstract

Prediction of rainfall which varies both spatially and temporally is extremely challenging. Infrared and visible spectral data from satellites have been extensively used for rainfall prediction. In this study, two deep learning methods MLP and LSTM are discussed at length for predicting precipitation at a fine spatial (10km×10km) and temporal (hourly) resolution for the state of Gujarat. These methods are applied by using the multispectral (VIS, SWIR, MIR, WV, TIR1, TIR2) channel data such as cloud top temperature and radiance values of the INSAT-3D satellite (ISRO) as features for the model. Textural features of satellite images are incorporated by considering mean and standard deviation of each pixel's neighbourhood. Rainfall also heavily depends on the elevation and vegetation of earth's surface so we have used SRTM DEM and AWIFS NDVI respectively. Measurements of actual rainfall are obtained from AWS (point source stations) and TRMM (10km×10km resolution). First dataset contains only TIR1 band temperature and AWS rainfall data for training but the second dataset includes multispectral channel data and TRMM rainfall data which brought about great improvement in results. For each data-set, a comparison between MLP and LSTM models is discussed here. We were able to classify the rainfall into nil (0mm), low(<2mm), medium (>=2mm and <5mm) and high (>=5 mm) with a high accuracy. Metrics like accuracy, precision, recall and fscore have been computed to get better insights about the dataset and its corresponding outcome. Our results show that LSTM performs significantly better than MLP for any given balanced class data-sets.

Abstract ID – 127

Synoptic analogue model for Cauvery basin

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Abstract

Cauvery is a very important river in south India that drains an area of 81155 km2 of which 34273 km2 lies in Karnataka, 43856 km2 in Tamil Nadu, 2866 km2 in Kerala and 160 km2 in Union Territory of Puducherry. Flood Meteorological Office (FMO) at Bangalore started functioning in June 2016 as a joint venture between India Meteorological Department (IMD) and Central water Commission (CWC) for optimising operations of reservoirs and dams. IMD is providing quantitative precipitation forecasts (QPF) and heavy rainfall warning for three days and outlook for subsequent five days for 9 basins i.e. Harangi, Hemavathy, Kabini, Middle Cauvery, Upper Cauvery, Lower Cauvery, Periyar, Upper Vaigai, Lower Vaigai to CWC that in turn issues flood warning based on above inputs. This basin is receives rainfall during June to December that cover southwest and northeast monsoon seasons. An attempt has been made to develop synoptic-analogue model for issuing QPF in 9 basins of Cauvery during southwest and northeast monsoon seasons. This method involves searching for similar synoptic situations from meteorological archives as observed on a particular day and compiling them together. The rainfall observed during the current day is assumed to follow the same distribution as that of the composite. For this model, synoptic situation for 5 years from 2012-2016 is collected from IMD's publication called Indian Daily Weather Report (IDWR). Subbasin-wise rainfall (AAP) in 1-10, 11-25, 26-50, 51-100 and >= 100 mm categories is computed using daily rainfall data. AAP is 762 and 217 mm during southwest and northeast monsoon seasons with maxima is July and minima in September. A total of 5 synoptic situations namely, depression (D) and deep depression (DD), low (L) and well marked low (WML), upper air cyclonic circulation (UAC), offshore trough (OST) and east-west shear zone at 12oN (EW) identified are responsible for rainfall in these sub-basins during southwest monsoon. A total of 19 areas/sub-divisions are considered for rainfall and they are OST from Gujarat to Lakshadweep, Konkan Goa/Maharashtra to Lakshadweep, Karnataka to Lakshadweep, Gujarat to Kerala/Karnataka, Gujarat to Konkan Goa/Maharashtra, Konkan Goa/Maharashtra to Kerala, Konkan Goa/ Maharashtra to Karnataka, Karnataka to Kerala. L or WML, UAC and EW are considered over coastal Andhra Pradesh, Telangana, Rayalaseema, Tamilnadu & Pondicherry, SIK, NIK and CK. Frequency of synoptic situation on a previous day and AAP on the next day are compiled for each sub-basin. Results indicate that maximum frequency of AAP (69%) over the basin is due to OST, followed by UAC (19%), L or WML (7%) and EW is 5%. Amongst various categories of OST, %frequency of AAP is maximum (37%) when it extends over location 6 from Konkan Goa to Kerala & Karnataka coasts, is 31% and 17% when it is present from over location 4 (Gujarat to Kerala and Karnataka) and Karnataka to Kerala coasts (location 8). A total of 2808 occasions of AAP >= 1 mm was observed over 9 sub-basins of Cauvery during 5 monsoon seasons. Category 1-10 mm has highest frequency (1920/68%) amongst all the categories followed by 594 (21%), 215 (8%), 68 (2%) and 11 (0.004%) in 11-25, 26-50, 51-100 and >=100 mm respectively. Each sub-basin has 100 to 465 instances in all the five rainfall categories due to all synoptic situations. Upper Cauvery sub-basin comprising of Kodagu, Hassan, Mysore and Mandya districts received rainfall on maximum number of days (465) and Upper Vaigai sub-basin lying in rain shadow region of TamilNadu has received rainfall on minimum number of days (100) due to all synoptic situations in 5 years. Amongst all the sub-basins, only Harangi, Kabini, Hemavathi and Periyaar receive heavy rainfall in the categories of 51-100 and >100 mm. The results have been verified for the year 2017 and where percentage correct (PC) is up to 70%.

Abstract ID – 172

Assessment of WRF Rainfall Simulations Over the North-Eastern Region of India with respect to Satellite and Gauge Rainfall.

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Theme: Weather Forecasting Services at Different Time Scales.

Abstract

The North Eastern Region (NER) of India has been a hot spot for extreme weather events and related disasters like thunderstorms and floods. Thus, a skillful weather forecast model would be a much-needed boon for this region. In trying to investigate the skill of such a weather forecast model, a study was initiated tovalidated the 1-day rainfall forecasts of the Weather Research and Forecasting (WRF) model for the monsoon season (June-July-August-September: JJAS) with the daily estimates of rainfall from the Global Precipitation Measurement (GPM) and rainfall from five *in-situ* stations over the NER. This is achievedby using classic performance metrics namely, Root Mean Square Error (RMSE) and Correlation Coefficient (CC), and a new performance metric namely, modified index of agreement.This modified index of agreement has been developed based on Mean Absolute Error (MAE) and has the characteristics of both RMSE and CC. The analysis of the model performance showed that WRF performed good,with respect to GPM, in most pixels of the region. More than 50% pixels had RMSE around 20mm per day. However, some parts of Meghalaya and Tripura showed high RMSE values, ~60 – 70 mm per day. WRF showed no significant correlation with GPM is most pixels of the region. However, it showed very good correlation, ~0.8 in the eastern parts of Arunachal Pradesh.With respect to *in-situ* AWS stations, the performance of WRF was not found very promising which can be associated with the coarser resolution of WRF (9 km). Some stations showed relatively good performance, e.g., Jowai in Meghalaya and some stations showed relatively poor performance, e.g., Tawang in Arunachal Pradesh. This study helped in understanding the skill of WRF over NER and would help map a course for future endeavors to make these WRF simulations better.

Abstract ID – 224

Observational Analyses of Composite Rainfall Structures of Tropical Cyclones over North Indian Ocean

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Abstract

The main motivation of the study is to understand the average rainfall structures of tropical cyclones (TCs) over North Indian Ocean (NIO) using TRMM rainfall observations. For this purpose, 2376 individual samples are considered from 109 TCs during 1999-2017. The rainfall structures are analysed as a function of region of formation, season, intensity evolution and direction of movement and translation speed. Results indicate that the azimuthal mean rain rate of NIO TCs is about 5 mm h^{-1} within the eyewall region (30-40 km) and decreases to <1 mm h^{-1} in the TC environment (~400 km).The azimuthally averaged rain rates are almost doubled when a TC intensify to cyclonic storm and very severe cyclonic storm as compared to its earlier intensity stages. Radial extension for any rainfall amount is more in intensification phase of TC than weakening phase. Comparing rain intensity, heavy to very heavy rainfall (10-11 mm h^{-1}) is observed in the intensifying phase, while, the rain intensity is reduced during weakening phase due to interaction with land. Left-forward sectors experience heavy rainfall in case of northward and northwestward moving TCs, while, northeastward TCs show maximum rainfall in the right forward sector. The translation speed not only influence the rainfall intensity, but also spatial distributions and symmetricity. Higher the translation speed lesser the rainfall symmetricity. Slow and normal moving TCs produce intense rainfall in left forward sector, unlike fast movers. This study highlights the need for understanding TC rainfall structures for its use in early warning system and provide platform to validate and improve state-of-the-art TC forecasting models over the NIO region.

Keywords: Northern Indian Ocean, Tropical cyclone, TRMM, Rainfall**.**

Abstract ID – 413

Performance of numerical weather prediction models in prediction of dust storm and thunderstorm over northwest India during May 2018

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Abstract

Dust storm is an ensemble of particles of dust or sand energetically lifted to great heights by a fierce and turbulent wind.They are basic meteorological perils in dry and semi-dry regionsincluding northwest India. These are typically caused by convective process or due to strong horizontal pressure gradient over northwest India during pre-monsoon season. The thunderstorms over theseregions are associated with lightning and squall leading to structural damages and loss of lives. Understanding their severityand making a precise forecast becomes highly crucial inminimizing the damage to lifeand property. During the month of May 2018, there were severe dust storms and thunderstorms leading to loss of more than 200 lives and major destruction to property. In this paper, an attempt has been made to investigate the dust storm/thunderstorm events during May 2018 over the northern plains of India. Dust storms/thunderstorms events on 2nd May and 14th May are considered for this study. The maximum wind of 116 Kmph and 107 Kmph were recorded during these storm events. These events generally originated from the dry regions of northwest India and affected states of Rajasthan, Punjab, Haryana, Uttar Pradesh and National Capital region. The events have been analyzed using the high resolution NWP model outputs.The major large scale feature that was attributed to these severe weather events was the presence of a Western Disturbance in the middle and upper tropospheric levels and lower level cyclonic circulation over the region in addition to interaction of an easterly wave resulting in sufficient moisture feed into the region. The large scale features were significantly captured with the high resolution GFS and WRF model to identify the potential region and day of occurrence. Model generated thermodynamic indices along with convergence and divergence charts depicted favorable conditions for development of intense convection over northwest India. However, the models couldn't predict well, the severity of the event, in terms of wind and lightning.Forward and Backward trajectories from The Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT) were utilized to understand the movement of the dust laden winds and its subsequent direction. The study analyses the gap areas in modeling and prediction of such mesoscale dust storm/ thunderstorm events.

Keywords: Dust storm, Pre-Monsoon, Synoptic Conditions, North India, Squall.

Abstract ID – 416

Seasonal prediction skill of Indian summer monsoon rainfall in monsoon mission CFSv2 and NMME models

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Abstract

The present study compares the Indian summer monsoon rainfall (ISMR) prediction skill (Feb IC) of monsoon mission climate forecast system version 2 (CFSv2-T382) with that of the seasonal prediction models participating in US National Multi-Model Ensemble (NMME) project. In general, the present-day coupled models simulate cooler than observed sea surface temperature (SST) in majority of the Tropics and extratropics. The model rainfall has strong dry bias over major continental regions and wet bias over tropical oceans. Meanwhile, prediction of the boundary forcing such as SST is essential for driving the atmospheric response through teleconnections. It is noted that even though the prediction skill for SST boundary forcings like El Niño-Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) is not at the best in CFSv2-T382 compared to a few of the NMME models, it shows better skill for ISMR hindcasts initialized at 3-month lead time (February IC). This may be attributed to the better teleconnection pattern of ENSO and IOD in CFSv2-T382, which has minimum biases in equatorial Indo-Pacific region. It also has a better ISMR–SST teleconnections in the Tropics with a pattern correlation of around 0.6. In many of the NMME models, the better prediction skill of the inter-annual variability of SST indices is not transformed into the improvement of ISMR skill through teleconnections. The CFSv2 T382 model has simulated regional rainfall over different homogenous rainfall except south peninsular Indian region and also captured extreme events reasonably well compared to T126. It is therefore concluded that having good prediction skill for major SST boundary forcings is not sufficient, but capturing the appropriate teleconnections of these SST boundary forcingsinthemodeliscriticalforthebetterpredictionofISMR.Thestudypointsouttha the present – dayseasonalpredictionsystems needtobeimprovedintheir simulationoftropicalSST-monsoonteleconnections,whichcanimprovetheseasonalprediction skill of Indian summer monsoon further.

Abstract ID – 468

Fog Warning and its Skill over Different Sub-divisions of India in recent past

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Theme:Weather forecasting Services at Different Time Scales.

Abstract

India experiences Fog mainly during winter months (December, January & February) leading to loss of life and properties. All the mode of Transportation (Road, Rail & Aviation) affected by fog cover leading to loss of revenue. Hence the early warning of the occurrence of fog can minimize these losses. India Meteorological Department (IMD) is the nodal agency to provide fog warnings to National Disaster Management Authority (NDMA), transportation sector, health sector & general public. It provided sub-division/district level Fog warning for next 5-days during winter months. Based on this warning concerned authorities like NDMA, State Disaster Management Authority (SDMA) & Airport Authority of India (AAI) etc., take remedial measure. To find out accuracy of the Fog warning, Forecast Verification is carried out by using different Forecast skill scores such as Critical Success Index (CSI), Heidke Skill Score (HSS), Probability of Detection (POD), Missing Rate (MR), False Alarm Rate (FAR) etc. Thus a study has been undertaken to analyze these skill Scores for 3- day Fog warning based on data of 36 subdivisions of India the period winter of 2011-12 to winter of 2017-18. Results indicate that there is significant improvement in the accuracy of skill score in the recent years. In the year 2017-18, forecasting skill score accuracy of Day 3 is better than the skill score of Day 1 of previous year. The high improvement in the fog skill score in recent year are mainly attributed to Multi-Institutional Forecasting Demonstration Project on Winter Weather System including Fog, which is activity participated by different division of IMD, NCMRWF, IITM, IAF, SAC etc.

Index Terms: Fog Warning, Winter Season & Forecast Skill Score.

Abstract ID – 475

Weather and Climate Services for the Farmers of East Vindhyan Agro-climatic zone of Uttar Pradesh

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Abstract

Under present situation of climatic change due to global warming, management of weather and climate related risks in agriculture has become an important issue. To manage the climatic risks associated with farming in East VindhyanAgro-climatic zone of U.P., Integrated Agrometeorological Advisory Services (IAAS) was started from Agrometeorological Field Unit (AMFU) established at Deptt. of Geophysics, Institute of Science, BHU since June 2008. Agromet Advisory bulletins (AAB) were prepared twice in a week on every Tuesday and Friday and disseminated to farmers through personal contact, DD and daily newspaper at district level and uploaded regularly on AGRIMET website of India Meteorological Department (IMD), New Delhi.Now agromet advisory services has started at block level on experimental basis w.e.f. June 2018. This activity is being carried out at BHU, Varanasi in collaboration with IMD, Ministry of Earth Sciences (MoES), Govt. of India, New Delhi. The AAB were issued two times in a week regularly for different seasonsby the AMFU, BHU, Varanasi based on medium range weather forecast w.r.t.six parameters (viz. rainfall, cloud cover, wind velocity including speed and direction, and maximum-minimum temperature trends), received from IMD, New Delhi. The AMFU which is now renamed as Gramin Krishi Mausam Sewa (GKMS) located at BHU, Varanasi used to organize farmers awareness program at different villages of the Agro – climatic Zone of Eastern U.P. to provide knowledge about climate, weather and utility of medium range weather forecast in day to day operational works in the field crops to help ourpoor farmers. GKMS, BHU, Varanasi has distributed several rainguages at different locations during various Farmers Awareness Program (FAP) conducted in the region sponsored by the IMD, (MoES), New Delhi. The rainfall recorded at KVK, Barkachchha, Mirzapur andatShahanshahpur villageof Varanasi were 1234.2 & 1078.5 mm respectively during the rainy season, of 2016. Total 365 days of weather forecasts on above weather parameters were received though internate/e-mail/fax/telephone/ valid for 24, 48, 72, 96 and 120 hours in advance for East VindhyanAgro-climatic zone comprising nine districts (viz Azamgarh, Chandauli, Varanasi, Mirzapur, Ghazipur, Jaunpur, Mau, Sonbhadra& Sant ravidas Nagar Bhadohi) of Uttar Pradesh. These forecasts being quantitative in nature have been verified season wise with the observed values of various meteorological parameters, by applying different statistical procedures using the skill scores and critical values used for error structure as suggested by IMD, New Delhi. Mean percentage of rainfall forecast on annual &seasonal(monsoon) basis were 82.2%&64.6%respectively over Varanasi district of Uttar Pradesh for the period of (2008 - 2017). The study also revealed that increase in forecast accuracy and period of validity up to one week would be of immense value to the resource poor farmers of East VindhyanAgro-climatic zone of the Uttar Pradesh state.

Keywords: India Meteorological Department, Agromet Advisory Services, GKMS, Varanasi, Verification, Success percentage.

Abstract ID – 479

A pilot study on Mountain waves over Khasi Jayantia hills

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Theme: Short, Medium and Long Range Weather Forecasting

Abstract

Orographic barrier at any place play very important role in modulating airflow and rainfall there. Khasi Jayantia hills (KJH) in India plays very important role by modulating those in north east India. KJH modulates the airflow by obstructing southerly airflow during southwest monsoon season(SWMS), causing forced ascend of moist airflow, leading to windward rainfall enhancement and also causes updraft-downdraft associated with mountain waves on the lee side of it, produced due to airflow across and around KJH. It is known that mountain lee wave, associated with mesoscale airflow across a meso-scale barrier is a significant aviation hazerd, hence need to be modeled for diagnosis. In this pilot study, an attempt has been made to develop a model, following Dutta (2005), for diagnosing the linear effect of lee wave associated with airflow across the KJH. Digital Elevation Model (DEM) data for KJH has been taken from GTOP30. The basic flow has been obtained from a far upwind station which in this case is Dhaka. Only normal wind component to the barrier was considered for the calculations. In this study, realistic vertical variation of basic flow and static stability has been considered. The perturbation vertical velocity (w') and stream line displacement (η') are expressed as a double integral. These two integrals have been evaluated numerically. Result of the study may be briefly summarized as following: For both the parameters ,w' and η', the numerical solutions show the upwind tilting. Both transverse and divergent component of lee waves were observed. There is lateral spreading of the waves with height. The region of updraft is approximately crescent shaped. Damping of waves away from the barrier was observed.

Abstract ID – 521

Verification of value added medium range weather forecast with inter-comparison of Vidarbha and Marathwada regions of Maharashtra state during Indian summer monsoon

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Abstract

In India rainfed area occupies 80 million ha out of 143 million ha net cultivated area and contribute 44% of total food grain production. Amount, distribution and intensity of rainfall mainly determine the quality and quantity ofcrop yield in the rainfed agriculture.The quantitative probabilistic forecasts of the Global Spectral Model, running at the National Center for Medium Range Weather Forecasting (NCMRWF), Noida, India and value added by India Meteorological Department is compared with actual rainfall data of District-wise Rainfall Monitoring Stations (DRMS)received from India Meteorological Department, Pune.This comparative study is done by using rainfall data of all 11 districts of Vidarbha region and all 8 districts of Marathwada region of Maharashtra. As rainfall concern both regions are diverse, in Vidarbha normal annual rainfall is 954.6 mm while in Marathwada it is only 682.8 mm. During this study different verification measure-oriented methods are include and their results are compared. Accuracy of forecast (0.73, 0.67), Bias score (1.03, 0.85), Probability of detection/hit rate (0.84, 0.74), Probability of false detection or false alarm rate (0.64, 0.52), Success ratio (0.82, 0.78), Threat score or critical success index (0.70, 0.62), Equitable threat score/Gilbert skill score(0.11, 0.14), Hanssen and Kuipers discriminant/true skill statistic Peirce's skill score (0.20, 0.24) was more for Vidarbha compare to Marathwada, but Heidke skill score/Cohen's k (0.20, 0.24), False alarm ratio (0.19, 0.23) and Odds ratio (2.80, 3.01) was more for Marathwada compare to Vidarbha while Odds ratio skill score/Yule's Q (0.48, 0.48) was found equal in both region respectively.

Similarly, accuracy of forecast over different lead time is also compared. In Vidarbhahighest accuracy found on day-1 (0.79) followed by day-4 (0.75), day-2 (0.71) and day-3 (0.71) while lowest accuracy was recorded during day-5 (0.67) but in case of Marathwada region highest accuracy found on day-1 (0.70) followed by day-2 (0.67), day-4 (0.67) and day-3 (0.66) while lowest accuracy was recorded during day-5 (0.65). Heidke skill score (Cohen's k) was highest during day 1 for both in Vidarbha (0.35) and Marathwada (0.32) which was gradually decreasing for day-2, day-3 and for day-4 while lowest as found during day-5 for both in Vidarbha (0.08) and Marathwada (0.20) regions. From the above study it is found that the performance of the Value added forecast based on NCMRWF model is better in Vidarbha compare to Marathwada, similarly accuracy of forecast was good for

day-1 and it was gradually decreasing for lead times. This study can help to improve forecast and to determine usability of forecastfor different regions.

Key words – NWP model, Value added forecast, Medium range weather forecast, Probabilistic forecast.

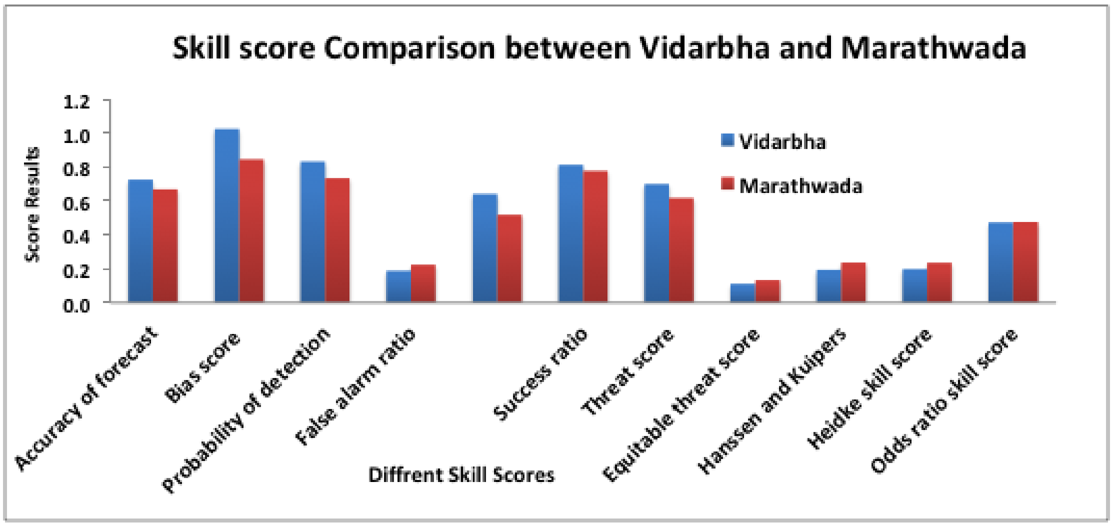

Figure 1: Comparison Skill score between Vidarbha and Marathwada regions of Maharashtra

Abstract ID – 24

Particle formation during splashing of raindrops on the ground surface

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Abstract

The mobility distribution of atmospheric air ions generated by splashing of rain drops is investigated in the ion-mobility spectra measured with a Neutral Cluster and Air Ion Spectrometer in the mobility range of 3.16-0.00133 cm^{-2} V^{-1} s^{-1} at a tropical site Pune. Ion concentration of all categories increases as the rain intensity increases to ~ 50-60 mm h^{-1} and then tends to level-off for higher rain intensities. Negative ion concentration is always more than that of positive ions. However, positive small ions of mobility ≥ 2-3 cm^2 V^{-1} s^{-1}which are also generated during splashing are more numerous than negative ions. Our observations show that the mechanism responsible for the generation of intermediate ions is more efficient than that for the generation of heavy large ions during periods of high rain intensity. Relative roles of Lenard and Blanchard effects are suggested in generating excess of negative intermediate ions in the initial stages and excess of positive cluster ions, in the later stages of a rain shower, respectively

Abstract ID – 32

Spatial variation of Single scattering albedo and asymmetric parameter over the Eastern Himalayan region

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Theme: Aerosols, Atmospheric Chemistry and Weather / Climate.

Abstract

Collective measurements of black carbon concentration (BC) and scattering properties near to ground were conducted out along with the spectral aerosol optical depth (AODs) over the Eastern Himalayan stations, Tawang (27.57^{o}N, 91.87^{o}E), New Palin (27.69^{o}N, 93.63^{o}E) and Yinkion (28.40^{o}N, 95.06^{o}E). From the diurnal variation of BC over the stations found that BC deposition at Geku was very low compared to other stations during the day hours. But during the evening hours due to the higher rate of biomass burning, BC emission rate was higher than the other stations. Geku has the lowest SSA (0.81) compared to other two stations. Asymmetric parameter (g) indicates the dominance of forward scattering in all stations. The smaller value of g (0.55±0.035) at the wavelength of 550nm at Geku specifies the particle sizesweresmaller than the particle sizes at the other two stations. Due to the smaller g at Geku SSA also smaller, which indicates the forward scattering is lesser than the other two stations.

Abstract ID – 33

Transport of trace gases via eddy shedding from the Asian summer monsoon anticyclone and associated impacts on ozone heating rates

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Theme: Aerosols, Atmospheric Chemistry and Weather/Climate.

Abstract

The highly vibrant Asian Summer Monsoon (ASM) anticyclone plays an important role in efficient transport of Asian tropospheric air masses to the extratropical upper troposphere and lower stratosphere (UTLS). In this paper, we demonstrate long-range transport of Asian trace gases via eddy shedding events using MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) satellite observations, ERA-Interim re-analysis data and the ECHAM5–HAMMOZ global chemistry–climate model. Model simulations and observations consistently show that Asian boundary layer trace gases are lifted to UTLS altitudes in the monsoon anticyclone and are further transported horizontally eastward and westward by eddies detached from the anticyclone. We present an event of eddy shedding during 1-8 July 2003 and discuss a 1995-2016 climatology of eddy shedding events. Our analysis indicates that eddies detached from the anticyclone contribute to the transport of Asian trace gases away from the Asian region to the West-Pacific (20°-30° N; 120°-150° E) and West-Africa (20°-30° N, 0°-30° E). Over the last two decades, the estimated frequency of occurrence of eddy shedding events is ~68 % towards West-Africa and ~25 % towards the West-Pacific. Model sensitivity experiments considering a 10 % reduction in Asian emissions of non-methane volatile organic compounds (NMVOCs) and nitrogen oxides (NO_x) were performed with ECHAM5–HAMMOZ to understand the impact of Asian emissions on the UTLS. The model simulations show that transport of Asian emissions due to eddy shedding significantly affects the chemical composition of the upper troposphere (~100-400 hPa) and lower stratosphere (~100-80 hPa) over West-Africa and the West-Pacific. The 10 % reduction of NMVOCs and NO_x Asian emissions leads to decreases in peroxyacetyl nitrate (PAN) (2-10 % near 200-80 hPa), ozone (1-4.5 % near ~150 hPa) and ozone heating rates (0.001-0.004 $K \cdot day^{-1}$ near 300-150 hPa) in the upper troposphere over West-Africa and the West-Pacific.

Abstract ID – 73

Study of particle loading over the three major biomass burning regions across the globe

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Abstract

Smoke due to natural and anthropogenic activities may have prominent impact on the environment and the human health. In this paper, we have studied the smoke levels as seen from CALIOP (Cloud Aerosol LIdar with Orthogonal Polarization) sensor on-board the CALIPSO satellite. Along with this, the absorbing aerosol levels were studied from the OMI (Ozone Monitoring Instrument) sensor aboard the AURA satellite. This study was conducted over the Brazilian, Central African and Siberian regions during their respective biomass burning periods. For that purpose, we have utilized level 3 AOD data due to smoke from CALIOP at 2°x5° while the Level 3 AAOD data of OMI at 1°x1° spatial resolution. Further, for quantitative comparisons, we have resampled the OMI Level 3 data at the spatial resolution of CALIOP AOD data. The correlation and trends of the aerosol parameters from the two sensors have been discussed over the three major biomass burning regions.The time frame for the study was 2005 to 2016.

Keywords: OMI, CALIOP, AOD, AAOD, Brazil, Siberia, Central Africa.

Abstract ID – 121

Seasonal and Inter-annualvariation of CO2 at high altitude mountain sites of Asia: Observed vs Model

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Abstract

Atmospheric carbon dioxide (CO_2) records different source signals due to anthropogenic and natural biospheric activities and provides useful information on the changes occurring on the Earth's surface. A high regional air quality model Weather Research Forecast coupled with Chemistry (WRF-Chem) is used for CO_2 simulation (WRF-CO_2) and investigate the seasonal and inter-annualvariations of atmospheric CO_2 at two high altitude sites (Acronym: LLN: Lulin (23.47°N, 120.87°E and 2867m amsl), NTL: Nainital (29.36° N, 79.45°E, 1958 m amsl)) situated at inland mountain of China and India respectively. The WRF-CO_2 is run with 27 × 27 km horizontal resolution and 31 vertical levels centered at Myanmar (24°N, 96°E). Three major CO_2 flux components due to the terrestrial biosphere (obtain from Carnegie-Ames-Stanford-Approach (referred as CASA)), fossil fuel combustion (Emission Database for Global Atmospheric Research verson2 (referred as FT)) and ocean CO_2 (Lamont-Doherty Earth Observatory (referred as OC)) at different spatial and temporal resolutions are simulated by WRF-CO_2 model continuously for three years 2010-2012. Model simulations are sampled horizontally at the nearest grid point of sitesand vertically at two points, one at lowest model level (k_1)and another at actual model level (k_a) [k_1,k_a= (1895 and 2878m) and (813.6 and 2027.9 m) for LLN and NTL respectively]. Adding three different components of CO_2 (FT+CASA+OC), total model CO_2 is obtained.To assess the WRF-CO_2 model performance, result is compared along with observed and global Atmospheric Chemistry Transport Model's (ACTM) de-trended data, obtain using Nakazawa digital filtering technique. Based on the models and observed data we have studied mean seasonal variation of CO_2 obtained from three years average inter-annual variation, contribution of different component of CO_2 in the total CO_2 variation, inter-annual variation of CO_2 seasonal cycle. Analysis reveals that the observed CO_2 seasonal cycles differ significantly for both stations (amplitude is 10.6 ppmv and 21.5ppmv at LLN and NTL respectively).Comparison of the model results with observation indicates that the model reproduces the spatial and temporal variation of CO_2mixing ratio reasonably well. Statistical analysis using de-trend data shows normalised standard deviation (NSD) is higher (1.12) than ideal (1) at LLN for both the models.However, at NTL, NSD is 0.63and 0.38 for WRF-CO_2 and ACTM.It is reduced further for both the stations at actual level WRF-CO_2 data. However, correlation coefficient(CC) improved significantly at LLN (CC at k_1 =0.32 and k_a =0.53), when using actual level model data. Analysis of the individual components of CO_2 from WRF-CO_2 shows that ocean flux has least contribution to both the stations but dominance of biospheric flux over fossil. Maximum uptake of CO_2occurs at LLN and NTL during early autumn period (September and October respectively) and higher values in spring (April and May respectively).However, models show some limitation in showing timing of maximum and minimum and year to year variation of seasonal cycle amplitudeat LLN but it is captured well by WRF-CO_2 at NTL. In general, WRF-CO_2 produces better results than ACTM over regions of complex topography and able to resolve fine scale structures of CO_2.

Abstract ID – 123

Vertical distribution of dust, polluted dust and smoke over different parts of Indian region

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Abstract

The Indian region experiences the atmospheric loadings of various types of aerosol particles affecting the regional climate as well as the human health. Both the natural as well as anthropogenic emissions, emitted locally as well as affected by long range processes affect the aerosol loading over the Indian region.Whereas, the knowledge of columnar aerosol properties as global and regional scales have greatly improved both due to continuous ground based and satellite based observations; there are still comprehensive studies needed focussing on vertical distribution of aerosol types prevalent over different parts of Indian region. The understanding of columnar as well as vertical distribution of aerosol loadings can improve our knowledge on the aerosol-climate interaction processes. This paper presents the vertical distribution of major aerosol components, i.e., dust, polluted dust and smoke distributed over different parts of Indian region over a decadal period. The data is taken from the space-borne lidar, i.e., Cloud Aerosol Lidar with Orthogonal Polarisation (CALIOP) onboard Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO). The time period of study spans over 2007 to 2016.

Keywords: CALIOP, dust, polluted dust, smoke, India.

Abstract ID – 158

Emission inventory preparation at different sectors in Madurai

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Abstract

The preparation of emission inventory from two different transport sectors (road and air) and domestic sector was estimated in Madurai for the year 2016. Emission inventory estimates the emission of various pollutants from two different transport sectors (road and air) including CO_2, CO, HC and NOx by using the bottom-up approach.The total emissions of CO_2, CO, HC, and NOx from different vehicles (road transport) were found to be approximately 4099.95, 18.93, 20.63, 13.698 kilotons/year respectively. Similarly, the total annual pollutant emissions were estimated both domestic and international aircraftwere about 33889.3 kiloton/yr (CO_2), 40.32 kiloton/yr (CO), 3.38 kiloton/yr (HC) and 149.68 kiloton/yr (NOx) for the year 2016. For road transport sector, LPG driven vehicles emit fewer emissions compared to petrol and diesel driven vehicles. The carbon dioxide emission was high followed by hydrocarbons, carbon monoxide and NOx emissions in all vehicle categories. In air transport sector, B737-800 (Jet engine) emits a large amount of NOx and CO_2 more than that of other engine flight in operation. Domestic aircrafts emit more HC emissions, whereas more CO_2, CO, NOx emissions emits by international aircrafts. Hydrocarbon (86%) was the largest contributor in road sector and oxides of nitrogen (92%) was the largest contributor in air sector. Emission inventory of carbon dioxide was also estimated from domestic sector, such as household electricity consumption, and household cooking purpose for the year 2016. The total emissions of carbon dioxide from household electricity consumption (2.1 kilotons/year) and household cooking purpose (0.18kilotons/year). The emissions varied depending upon the durability, kilometer travelled by the vehicle, amount of fuel used, the LTO cycle of aircrafts, engine type and also by meteorological conditions plays nearby the airport in this city. This paper highlights the air quality levels in the study area and the present study will help to improve the regional scale modeling over the study area.

Keywords: Airquality; Transportsector; Domesticsector; Emissioninventory; Bottomupapproach.

Abstract ID – 176

Changes in Chemical composition of the Stratosphere during Sudden Stratospheric Warming Events over Western region of India

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Abstract

The Earth's atmospheric regions are coupled to each other with the dynamical, electrical, radiative as well as chemical processes. A large scale thermodynamical phenomenon in winter polar regions which affects the middle atmosphere vigorously is Sudden Stratospheric Warming (SSW). Two major SSW events have been considered in this study. One occurred in 2009 winter which is associated with polar vortex splitting. Another event considered was there in 2008 winter, which is one of the strongest events recorded till now and being associated with polar vortex displacement towards the equator. Thermal structure over Ahmedabad (23.1^0 N, 72.58^0 E) obtained by the data from SABER (Sounding of the Atmosphere using Broadband Emission Radiometry) on board TIMED (Thermosphere Ionosphere Mesosphere Energetics Dynamics) satellite has showed that though SSW mostly occurs over high latitudes, its effect can also be seen over this region. The temperature peak has been observed over Ahmedabad after few days of the central date of SSW in case of the event of the year 2008; while it is found almost immediately for the stronger SSW event which occurred during 2009. Further to investigate about the chemical composition of stratosphere over this region, we have taken Ozone (O3) and Water Vapor (H2O) mixing ratios from both SABER onboard TIMED and Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) instruments onboard EOS-Aura and ENVISAT satellites. The primary results show an enhancement of Ozone mixing ratio while a decrease in water vapor have been seen during Splitting as well the Displacement event. The effects have been found to be more prominent in case of the Splitting event of 2009 winter.

Abstract ID – 187

Atmospheric aerosols variation and its correlation with meteorological and optical parameters

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Abstract

Real-time measurements of the mass concentration of particulate matters (PM_{10}, $PM_{2.5}$) ozone (O_3) and meteorological parameters were carried outin CSIR-CRRI campus, New Delhi for year 2016. Daily data of aerosol optical depth (AOD), angstrom exponent (AE) and single scattering albedo (SSA) were taken from the space-borne satellite MODIS-terra at level-2, for the year 2016. The mass concentration of PM_{10}, $PM_{2.5}$ and O_3were ranges 93µg/m^3 (in July) to 495µg/m^3 (in November), 44µg/m^3 (in August) to 258 µg/m^3 (in Novemebr) and 14.30 ppb (in January) to 39.45 ppb (in December), respectively. The annual mean concentration of PM_{10} was 261.19 ± 105.04 µg/m^3, $PM_{2.5}$ was 118.86 ± 53.38 µg/m^3 and O3 was 23.17± 8.28 ppb. All three pollutants have higher concentration in winter and minimum in monsoon season. The relationship between meteorological parameters and PM_{10}, $PM_{2.5}$ and O_3 were also analyzed and found that pollutants has inverse relationship (r=-0.54) with wind speed and visibility (strong invers correlation in winter). Back trajectory and optical parameters were also evaluated to understand the temporal variability of PM_{10}, $PM_{2.5}$ and O_3. Findingindicates significant correlation of rapidly growing anthropogenic emissions in winter and post-monsoon season with ambient meteorological and optical parameters over the station.

Key words: Particulate matters, Ozone, visibility, optical parameter.

Abstract ID – 194

Characteristics and Emission Sources of Atmospheric Aerosols over Varanasi

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Abstract

Air quality is deteriorating with alarming atmospheric aerosols level over Varanasi. *Highly increasing* Aerosol Optical Depth(AOD) *reduces visibility andphotosynthetic radiation and which in turn alters the Earth's radiation balance.* Space-borne passive MODIS-Aqua data based observations were used with ground based aerosol mass measurement for the winter (November 2016-February 2017) and summer (March-May 2017)months. The aerosol optical properties such as AOD and Angstrom Exponent(AE) were found the significance seasonal variations. Average AOD (~1.00) and AE >1were observedin the winter season. Whereas, in the summer season average AOD (~0.50) and AE <1were observed. High aerosol mass loading was recorded for both $PM_{2.5}$ (130.2 ± 41.42 µg m-3) and PM_{10} (205.64 ± 65.28 µg m-3) in winter season. Whereas concentrations of $PM_{2.5}$ (36.48 ± 24.12 µg m^{-3}) and PM_{10} (145.22 ± 40.38 µg m^{-3}) were found in summer season, typically exceeding national standard. The correlation coefficient (R^2 = 0.50) was found between $PM_{2.5}$ and PM_{10} in the winter season however R^2 = 0.54 was found in the summer season. The mean $PM_{2.5}/PM_{10}$ ratio was ~61% in the winter season, is the indicative of a higher loading of the fine aerosol particles compared to the coarser aerosols in Varanasi.The major sectors of aerosol sources based on the seven days air mass back-trajectory analysis using NOAA HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectories) model were plotted to identify possible regions contributing particulate loading through regional/ transboundary movement. The trajectory model was run at 500 m, 1000 m and 1500 m to establish a possible link between synoptic air movement and aerosol loading. Varying statistical association of columnar AOD and surface aerosol loading both in terms of fine ($PM_{2.5}$: MODIS-AOD: R^2= 0.40) and coarse particulates (PM_{10}: MODIS-AOD:R^2= 0.31) in the winter season. However, these results were found poorly correlatedin the summer season. Results observed in the present study were found to be quite considerable with aerosol optical characteristics measured by several scientific groups throughout the world and will be useful for the environmental and climate modeler.

Keywords: MODIS, PM, AOD, AE, HYSPLIT.

Abstract ID – 255

Case Study Of A Dust Storm Episode Over North India During May 2018

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Abstract

Dust storm is an ensemble of particles of dust or sand energetically lifted to great heights by a fierce and turbulent wind.They are basic meteorological perils in dry and semi-dry regions and are typically caused by thunderstorms which results in significant wind speed over a wide region. These turbulent winds lift a lot of sand and residue from exposed, dry soils into the environment, transporting them hundreds to thousands of kilometers away.As per the Earth Observatory, dust episodes are considered as characteristic dangers, which influence the biological communities and human life. Contingent upon climate and atmosphere, dust can stay suspended in air for a considerable length of time, causing sensitivity episodes a long way from their source. During pre-monsoon period, dust storms are highly catastrophic in nature. Understanding their severityand making a precise forecast becomes highly crucial inminimizing the damage to livestock and property. A severe dust storm event was observed over the northern plains of the Indian Sub-Continent between 2nd and 3rd May 2018. The dust storm episode extended from the western province of Rajasthan upto the eastern territory of Uttar Pradesh and also impacted the national capital region.The event resulted due to conducive environmental conditions like intense heating over land, availability of moisture, unstable atmosphere resulting in the formation of a cyclonic circulation. The details of the event, the prevailing synoptic conditions along with high resolution numerical weather prediction model and satellite products verifying the episode are presented in this study.

Keywords: Dust storm, Pre-Monsoon, Synoptic Conditions, North India, Model Output.

Abstract ID – 303

Investigation of optical properties and sources of aerosols in the subtropical humid region of northern India

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Theme:Aerosols, Atmospheric Chemistry and Weather/Climate

Abstract

Two years, May 2015- April 2017, of the columnar aerosol optical properties derived from a Multi-wavelength solar radiometer (MWR) over the Gorakhpur (26.75˚N, 83.38˚E, 85 m amsl) region, in the eastern part of the central Indo-Gangetic Plain (IGP) are presented. The aerosol optical parameters i.e. columnar spectral aerosol optical depth (AOD), Ångström exponent (α), and atmospheric turbidity (β) are analyzed to examine their temporal and seasonal heterogeneities, spectral characteristics of AOD, and identification of aerosol types in the atmospheric column with their seasonal contribution. The average AOD at 500 nm ($AOD_{500\ nm}$) was 0.68 ± 0.28 with highest seasonal mean (0.74±0.30) during the Pre Monsoon (Pre M) and lowest seasonal mean (0.62±0.20) in Monsoon (M) season. During Pre M season, more than 50% of $AOD_{500\ nm}$ values were greater than 0.7 indicating high aerosol loading over the study region. Using the seasonal variation in spectral AOD at shorter and longer wavelengths the dominance of fine or coarse mode aerosols were studied. Large variability in α and β ranged from 0.16 to 2.06 and 0.11 to 0.75 with mean value of 0.85±0.34 and 0.38±0.16, respectively. Higher α (>1) indicates dominance of fine mode aerosols during Post monsoon (Post M) and winter (W) season, whether lower α (<0.7) indicates coarser mode aerosols during Pre M season. Diverse aerosol types were observed depending upon the strength of different emission sources over the study region. The urban/industrial and biomass-burning (UB) aerosols has maximum contribution during Post M (60%) and W (54.5%) season, while more than 35% of mixed type (MT) aerosols were observed throughout the study period with maximum contribution was observed during M (63.6%) season. Comparison of AOD retrieved from MWR with MODerate-resolution Imaging Spectroradiometer (MODIS) indicated a good comparison between ground-based and satellite based measurements, with correlation of 0.59.

Keywords: Multi-wavelength solar radiometer, Indo-Gangetic Plain, Aerosol optical depth, Ångström exponent, Aerosol type.

Abstract ID – 310

Characteristics of near-surface air pollutants at an urban location in the Indo-Gangetic Basin

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Abstract

An urban air quality will have regulated by the local and distant emission sources. Measurements of near-surface air pollutants at an urban station, Lucknow (Industrial and residential site), have been studied during three year period from 2015 to 2017 to understand their variability on different temporal scales. The annual mean mass concentrations of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), nitric oxide (NO) and particulate matter of size less than 2.5 µm ($PM_{2.5}$) at an industrial (residential) site were about 10±5 (8±5), 28±17 (30±21), 10±11(9±7) and 128±99 (102±81) µg m^{-3}. The annual mean mass concentration of $PM_{2.5}$ was about 3 times higher than its annual National Ambient Air Quality Standards (NAAQS) level. However, SO_2 and NO_2 were about 5 and 1.5 times lower to its annual NAAQS levels, respectively. The seasonal mean mass concentrations of all the pollutants were found to be highest during the winter/post-monsoon season at both sites (SO_2=12±3, NO_2=31±12,NO=19±12 and $PM_{2.5}$=209±31 µg m^{-3} at the industrial site and SO_2=6±0.4, NO_2=45±25,NO=10±3 and $PM_{2.5}$=185±16 µg m^{-3} at the residential site). At industrial site, the mass concentration of SO_2, NO and $PM_{2.5}$ was ~112%, 94% and 38%, respectively higher than that of residential site. However, NO_2 was ~31% lower at the industrial site as compared to the residential site. The frequency distribution of each air pollutant shows the dominance of relatively higher concentrations at the industrial site and lower concentrations at the residential site. Further, the air mass back-trajectory analyses have been done to identify the probable source regions for these pollutants.

Abstract ID – 320

Characterization of the 'Aerosol Humidograph Instrument' for aerosol optical growth studies

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Theme: Aerosols, Atmospheric Chemistry and Weather/Climate.

Abstract

Knowledge of the hygroscopic properties of aerosols is critical in order to understand the aerosol-radiation interaction and reduce the uncertainties in quantification of associated forcing. A hand full of studies are available globally. Over the Indian region the physical and optical properties of aerosols are studied extensively under the Aerosol Radiative Forcing over India (ARFI) project of ISRO-GBP using a network of observatories. But the information on the aerosol hygroscopic properties is non-existent due to lack of suitable experimental facilities. Studies using such setup offer a unique opportunity to explore and couple aerosol radiative properties with aerosol chemistry and meteorology, and hence, will advance our understanding of the complex climate system. In this regard, a state-of-the-art instrument in under development in-house and named as the Aerosol Humidograph Instrument (AHI). AHI simultaneously conditions the incoming aerosol flow to a desired RH level, RH_{wet} and RH_{dry}. This enables measurement of aerosol physical and optical properties at two different RH levels using aerosol physical and optical measurement instruments. AHI consist of a Nafion based dryer unit, responsible for preconditioning the incoming aerosol flow to a desired low *RH* state, RH_{dry}, and a membrane based humidifier unit for conditioning the aerosols to a *RH* between 40% and 90%, also termed as RH_{wet}. *RH* is ramped up from 40% to 90% in steps of 5% *RH*. The overall flow in the system is controlled by two mass flow controller working on equal flow rates in the range 5 - 8 LPM each. These flow rates are selected after careful consideration of the drying and humidifying efficiencies, laminar flow requirements for minimal particle loss and adequate residence time for *RH* conditioning of the flow. Aerosol losses in the AHI, due to sedimentation, impaction, and diffusion, are estimated to be < 5% in the submicron size range and ~ 30% for aerosols larger than 4 µm. Dryer and humidifier units have been characterized for a range of flow rates and ambient conditions. The dryer unit is capable of reducing the incoming flow RH by ~ 40% and the humidifier unit scans up the RH from 50% to 90% in ~ 5 minutes in a direct scan and ~ 1 hour in step mode scan with minimum overshoot and lag time.

Results are presented for the AHI characterization with laboratory generated standard salt (NaCl and $(NH_4)_2SO_4$) and Aquadag aerosols.

Keywords: Aerosols, Hygroscopicity, Relative humidity, Instrumentation.

Abstract ID – 328

Effects of solar high energy protonson ozone layer during super Storms

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Theme: Weather and Climatic Extreme Events.

Abstract

We are very much known to the importance of ozone without which life on the Earth would not have evolved in the way it has. Strong solar storms carried energetic protons into the Earth's upper atmosphere, where they boosted production of nitrogen oxides which are known as ozone killers. In the present study, we have estimated the effects of solar energetic protons over the total ozone column since last 30 years. To that end, we have selected total seven solar storm events having Dst index < -300 nT and occurred duringsolar cycle 22nd, 23rd and 24th (for 32 years). We have statistically analyzed the significance of the solar proton events on the quantitativevariation of total ozone column during super storm events. Further, we have applied the superposed epoch analysis to verify theimpact of storm events on solar protons and ultimately on total ozone content. During our analysis, we have established that the ozone column gets depleted significantly (15 - 20%) as proton density increased with the result of solar storm.

Keywords: Super storms, Solar energetic protons, Total ozone column, Superposed epoch analysis (SEA).

Abstract ID – 333

Study Fog life cycle observed using 20m micrometeorological tower over IGI, Airport New Delhi during WIFEX

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Abstract

To develop better now-casting and forecasting of winter fog on various time and spatial scales the Winter Fog Experiment (WIFEX) over the Indo-Gangetic Plains of India has been initiated in December, 2015. Extensive sets of ground based instrumentation were deployed at the Indira Gandhi International Airport (28.56°N, 77.09°E), New Delhi. Major in situ sensors were deployed to measure surface micrometeorological conditions, radiation balance, turbulence, thermodynamical structure of the surface layer. Approximately, 119fog events data has been collected for moderate &dense events (visibility < 500m& Vis < 200m) during the 3 phase of WIFEX campaign 2015-16, 2016-17, and 2017-18. A 20 meter tower which is equipped with multi sensor to measure various meteorological parameter been installed at IGIA, New Delhi. Results show there is a sharp decrease in temperature and increase in humidity values prior to fog events. Development of well-mixed boundary layer is observed during the fog hours which depict low values of visibility & temperature with 100% humidity.Gradually, humidity starts decreasing analogous to temperature values starts rising which disturbs the well mixed boundary layer which improves the visibility. Observed life cycle of short lived and long lived fog events follow the same criteria prior to fog events and during the fog events. Initial results can be present during the presentation.

Abstract ID – 337

Seasonal variation of Tropospheric Aerosols observed using ground based and space-borne Lidars over south-east India

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Theme: Aerosols, Atmospheric Chemistry and Weather/Climate.

Abstract

The nocturnal, seasonal and inter-annual variation of vertical distribution of tropospheric aerosols over two nearby stations Gadanki (13.5^{o}N, 79.2^{o}E) and Tirupati (13.6^{o}N, 79.4^{o}E) is investigated using ground based Micro Pulse Lidar (MPL) and space-borne Lidar (CALIPSO) and MODIS measurements obtained during 2010 to 2017. The nocturnal variation of aerosol extinction (AE) coefficient reveal high AE below ~2km in midnight hours and slowly decrease during early morning hours. Further, the slow deposition of aerosols towards the lower troposphere is noticed after 02:30h (LT). From the seasonal variation, AE values are found to be higher at lower altitudes during winter and post-monsoon seasons, a sharp decrease with increasing altitude is found in tandem with boundary layer and low windspeeds. Interestingly, during monsoon season, significant aerosol loading is found in the altitude range of ~2 to ~5.5km mainly due to the influence of strong Low Level Jetwhereasbelow ~2km very clean environmentis observed and is attributed to the wet scavenging, downward vertical winds and existance of no strong local source. The seasonal mean AE profilederived from CALIPSO matches well with the MPL in all the seasons except in monsoon season where a large bias is noticed below 2 km.This indicates the need to consider at least season dependent Lidar Ratio values while deriving extinction from MPL. The inter-annual variation revealed the aerosols existing above the boundary layer during monsoon months and below during winter and post-monsoon months. More than 80% aerosols located below (above) the boundary layer contribute to the total AOD during winter (monsoon) season. This reveals that the free tropospheric contribution is enhanced through long-range transport over this location. Back trajectories reveals that potential sources are changing from season to season at different altitudes and confirms that the aerosols observed at higher altitudes are advected from other land and oceanic regions. Thus, aerosol vertical distribution is mainly controlled by meteorology and dynamics over this region. Further, the reasonably good correlation found between MPL and MODIS suggests that MODIS could provide reliable AOD over land region also.

Keywords*:*Aerosol, vertical distribution, Lidar, Extinction Coefficient, CALIPSO.

Abstract ID – 338

Elucidating Severe Air Pollution Episode of November 2016 in New Delhi

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Abstract

In recent years, Northern India is experiencing recurrent and severe air pollution events, particularly during post-monsoon and winter seasons, which are often associated with anthropogenic local and long-range transported emissions in conjunction with topography and/or meteorology.This study examines a severe air pollution episode observed during the year 2016 (1–7 November) in New Delhi. The spatio-temporal patterns of aerosols and trace gases, and chemical transformation of trace gases are studied using satellite and ground-based observations, respectively. A large number of MODIS fire countsover Punjab were associated with high aerosol loading (MODIS AOD>1.0), enhanced OMI UV-aerosol index (>2.0) andtropospheric NO_2column ($>4\times10^{15}$ molecules/cm^2), and high MOPITT surface CO (>400 ppbv) over northwestern and central-southeast IGP.The ground-based measurement of aerosols and trace gases at New Delhi showed significant enhancements in their concentrations. PM_{10}, $PM_{2.5}$, BC, CO, NO, NO_x, and O_3 concentrations during the smog were higher by about 64% (47%), 77% (58%), 43% (31%), 59% (43%), 54% (39%), 38% (27%) and 6% (23%), respectively, as compared to before (after) the severe air pollution episode. Meteorological conditions, characterized by low air temperature, calm wind speed, low boundary layer height, and high relative humidity were all favourable for accumulation of pollutants close to the surface and could have played an important role in occurrence of severe air pollution episode in New Delhi. The enhancement of O_3 abundance relative to CO (i.e. O_3/CO enhancement ratio) was very low (0.006 ppbv/ppbv), suggesting the biomass burning smoke plume of photochemical age less than 2 days. Analysis of ozone production efficiency further revealed suppression of O_3 production in fresh polluted plumes.Thus, it is crucial to develop strategies for alternative and sustainable solutions to mitigate not only crop residue burning but also other anthropogenic emissions in Indo-Gangetic Plain which is one of densely populated regions of the world and has a peculiar topography and meteorology.

Abstract ID – 367

Study of aerosolproperties and PM concentration during a severe dust storm in Indo-Gangetic Plain

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Abstract

Dust aerosols are produced during the erosion of soils by wind and are a common source of aerosols in arid and semiarid regions. The size of these particles varies widely from less than 2μm to larger particles that can exceed 50μm in diameter. Usually, Indo-Gangetic Plain (IGP) experiences several dust storms during the pre-monsoon season and that affects the air quality of region for 2-3 days. But in the pre-monsoon of 2018 during 12-17 June an unusual dust storm occurred which lasts more than a week and affect the air quality of IGP and Himalayan foothills very severely and due to this, the Delhi NCR region plunged into an environmental emergency. The air pollution level in NCR region had reached to an alarming "severe plus" category on 12-14th June 2018 due to heavy and surface elevated dust storm originating from neighboring areas of the Thar Desert and adjoining areas of Pakistan resulting in a thick cover of haze and dust. This storm increased coarser particles (PM10 and above) rapidly in the air and finer particles slowly.To study aerosol optical and physical properties we have used ground and satellite-based measurements. We have used data from ground-based AERONET and satellite-based MODIS and CALIPSO for the Aerosol optical depth (AOD), Single scattering albedo (SSA), Angstrom exponent (AE), vertical profile and types of the aerosols. We have also used particulate matter (PM) data from the ground-based air quality monitoring system SAFAR for Delhi region. We found an elevated level of AOD, 2-3 times higher than the usual distribution in both ground and satellite observation. Kanpur AERONET data shows the AOD values more than the 2.5 and AE values near to zero during dust event which is a clear indication of the dominance of coarser particles. The SSA shows a high value near to 1 during the storm days. MODIS AOD shows AOD more than the 1.5 during peak storm days. CALIPSO observation shows that the aerosol is spread up to a height of 5 km from the surface and the type of aerosol is mainly the dust and polluted dust type. Surface observation of PM also shows the unusual increase in the bigger size of particles mainly PM 10 and higher. The 24 h average of PM10 over Delhi touch a peak of 1200 $\mu g/m^3$ (~3 times the severe limit on 13th June) and PM2.5 level peak touched 240 $\mu g/m^3$ (very poor). The high abundance of bigger particles of dust (> PM10) and meteorological conditions opposes the flush out of dust which made dust to hang 5-6 days. These types of severe dust storms are important to study of air quality in this region. We are also estimating the satellite-based surface PM using model over IGP during this massive dust storm.

Key Words: Severe Dust Storm; Particulate Matter (PM); Air Quality.

Abstract ID – 402

Study of PM2.5 concentrations in Delhi NCR and its validation using satellite products

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Abstract

A study of $PM_{2.5}$ concentrations, monitored at eight locations in Delhi National Capital Region (NCR) during last five years, has been done for the period 2013 - 2018. Surface observed data have been validated using NASA's satellite products (MERRA-2 Model Dust Surface mass concentration of $PM_{2.5}$) and Aerosol Optical Thickness (AOT) products from OMI's sensor at the wavelength 550 nm onboard Aura satellite. The study has shown that the highest $PM_{2.5}$ concentration has been observed during winter season due to stable atmospheric conditions and low mixing height and the levels of $PM_{2.5}$ have been found highest during winter season of the year 2016. Highest $PM_{2.5}$ concentration has been observed as 1624 $\mu g/m^3$ near inter- state road in Dheerpur area which is having very heavy traffic load as well as high commercial activities along with dust from the road construction activity in the surrounding areas. In Delhi region, unplanned urbanization, very high vehicular emissions and inadequate infrastructure development are supplementary factors for the deterioration of air quality. Satellite data confirms that the agricultural residue burning in neighboring Indian states during post-monsoon seasons as well as dust storms in Arabian region are responsible for air pollution episodes in Delhi NCR. PM_1 concentration in Delhi has been found higher during pre-monsson season. Diurnal variation of $PM_{2.5}$ concentrations shows that the minimum concentrations of $PM_{2.5}$ are found in afternoon hours during the day. A correlation of 0.75 has been observed between satellite observed AOT and $PM_{2.5}$ concentrations in Delhi.

Keywords: $PM_{2.5}$ concentration, Agricultural residue burning, Dust storms, Aerosol Optical Thickness and vehicular emissions.

Abstract ID – 471

Do aerosols suppress the Gross and Primary Production over the north-eastern region India: a decadal study (2001-2010)

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Abstract

In this work, we have presented what is the effects of aerosols on the photosynthetically active radiation (PAR; 400-700 nm), thereby influencing the Gross Primary Production (GPP: total amount of energy utilized by Autotrophs) and Net Primary Production (NPP: GPP - Rate of respiration by plants) in North-Earth India Region for the period 2001-2010. Since PAR (amount energy available for photosynthesis) is essential for the primary production, change in PAR results in increase/decrease of crop production and plant biomass. Since the plants also serve as CO_2 sink, decreasing in plant biomass can decrease the carbon sink and accelerate the global warming. In this context, we have utilized satellite (MODIS) retrieved aerosol data to understand the role of aerosols in incoming and diffuse PAR.

The study reveals that the association of diffuse PAR and AOD are higher during pre-monsoson and monsoon (approx ~ 220Wm^2) than post-monsoon & winter (approx~ 100 Wm^2). GPP is relatively lower during pre-monsoon and monsoon (approx ~ 0.023 kgCm^2) than post-monsoon and winter (approx ~0.035 kgCm^2). Even though the aerosol loading in atmosphere can increase the diffuse PAR and promote the photosynthesis by strenghtening canopy Light Use Efficiency (LUE) of plants, we found the increase in AOD (550nm) by ~8.7% suppress the total PAR, GPP & NPP by ~4.6%, ~7.8% and 9.6% respectively from 2001 to 2010.

In summary, the high aerosol load can affect the agriculture by suppressing crop production and Earth's climate by reducing carbon sink. The work of this kind shall help mitigating the global warming and climate change. However, detailed investigation on various other parameters, viz., soil moisture, temperature and precipitation are also required to understand the influence of aerosol loading (through various feedback processes) on GPP & NPP.

Abstract ID – 477

The trace elements associated with ambient respirable particulate matter and related cancer risk: a case study of Dehradun city, India

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Abstract

Exposure to toxic trace elements associated with ambient aerosols can have a significant adverse effect on the human health including respiratory and other life threatening diseases. While there is convincing evidence that exposure of air pollutants is linked to human health disorders, little evidence is available on population outside of developed countries. Taking this into account, Respirable suspended particulate matter (RSPM) was measured using a High volume sampler at different locations within the Dehradun city (latitude and longitude 30.00 N to 30.50 N and 78.30 E and 78.60 E, mean sea level 700 meters), an urban location in the foothills of the Himalayas, during the period October, 2015 to June, 2016. To estimate 14 trace elements associated with RSPM, standard protocols for acid digestion of filter paper was adopted, further the filtered solution was analyzed in an Inductively coupled plasma-Optical emission spectroscopy. Health risk was estimated by making use of indicators such as excess cancer risk (ECR). A strong seasonality was observed in the RSPM mass concentration with higher concentration during the winter season followed by summer. Source apportionment study by principal component analysis revealed vehicular and crustal origin as the dominant sources of trace elements in the ambient atmosphere. ECR was calculated using the mass concentration of Cr (VI), Cd and Ni. The ECR revealed that ~14 excess cancer cases in each population of one lakh people in Dehradun district. This study will be helpful for the policy makers to frame effective environmental rules and regulation.

Abstract ID – 512

Climate and Air Pollution impact on wheat crop over Indo Gangetic Plains of India

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Abstract

Indo Gangetic Plain (IGP) has the highest population density in India and is characterized by its unique topography, regional meteorology and large aerosol emission sources. This region is also highly agriculturally fertile with the prominent rice-wheat cropping system. In the present study the influence of aerosol pollution on wheat crop yield is assessed. The assessment is based on the variability of weather parameters viz, temperature maximum and minimum (Tmax and Tmin), solar radiation (Srad), rainfall (Rain) and aerosols optical depth (AOD) over Varanasi region which lies in the north eastern part of IGB from the year 1986 to 2015 during the Rabi (wheat) season. The regression approach has been applied to examine the effect of aerosols on weather variables and in turn the effect of weather variables on wheat yields using the partial derivates. The result showed that over the region, the trend of Tmax and Tmin are decreasing at the rate of -0.04˚C and -0.02˚C per year, respectively. The trend of AOD is increasing at the rate of 0.01 per year whereas; Srad is decreasing at the rate of -0.01MJ/m2/year in the wheat growing season. Using the partial derivatives of the log yield with respect to weather parameters and the partial derivatives of the weather parameters with respect to aerosols, it was found that for every unit increase in AOD an increase in Tmax and Tmin with 1.7˚C and 0.2˚C is recorded whereas, the decrease in solar radiation of -0.91MJ/m2. The net impact of aerosols on wheat yield showed that it reduces the yield by 8% in the growing season. The overall study brings out this region to be sensitive in terms of adverse impact of weather and aerosol. The mitigation approach and development of pollution resistant crop varieties along with better management practices are needed which may benefit the crop production.

Keywords: Indo-Gangetic Plain, Wheat, Aerosols, Regression Analysis.

Abstract ID – 62

Mitigating Earthquake Hazard: Future perspectives

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Abstract

We feel frightened from the very name of earthquake as it is the most dreaded natural disaster unleashing devastation and inconvenience in our day to day life instantaneously in large area without giving much scope for prevention. India is also a earthquake prone country and about 59% of India's land mass in under threat of moderate to severe seismic hazard, i.e. prone to shaking of MSK Intensity VII and above. Whereas, about 8% of land is vulnerable to cyclones and about 5% of land vulnerable to flood. As on date, it is not possible to predict/forewarn precisely about the occurrence of an earthquake with respect to its time, place, and magnitude. A typical earthquake cycle has six elements covering basically two phases of disaster management viz. Post-Disaster which includes Rescue, Relief & Rehabilitation (3R) and Pre-Disaster, which includes Prevention, Mitigation and Preparedness (PMP). In present time, emphasis is more on pre-disaster management i.e, strengthen the emergency response to a mitigation and preparedness-centric. The emphasis is laid on (i) upgrading network for seismic monitoring for creating comprehensive database for regional risk evaluation and (ii) focusing studies for mitigation planning for urban agglomerations falling in seismic zones IV & V. For regional risk appraisal and primary structural designing, the codal guidelines provided in IS: 1893 (Part I)-2016 are followed based on seismic zone map. However, the seismic risk at a given location is result of interaction of seismic hazard, vulnerability of built environment and factor of cultural and demographic exposure at the site. Hence, in respect to detailed pre-disaster mitigation planning for urban agglomerations, further parametric inputs are called for and concept of Seismic Hazard and Risk Microzonation (SHRM) evolved. In Indian context the seismic hazard microzonation has been done for several cities. The first experiment was made for Jabalpur city in 2004 and it was deterministic one. Since then much advancement has been made with recent state-of-art work on probabilistic seismic hazard microzaontion of NCT Delhi on 1: 10K scale. Based on experience and confidence gained, we may better plan earthquake mitigation for future big earthquakes and this fulfills the Sendai Framework for preparedness to "Build Back Better".

Abstract ID – 226

Composite environmental vulnerability analysis in the c.d. blocks of the Sundarban region, west Bengal

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Abstract

Vulnerability describes the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of hazards. A natural resource dependent community affected by climatic, geomorphic and social vulnerability has higher perilous impact. With the emerging need of exclusive emphasis on capacity building and development of marginalised population, the hazards and resource potentials of the area must be critically analysed. A vulnerability approach study on the Indian part of the world's largest single mangrove forests of the Sundarban region has been carried out in this research to identify the intensity of the natural and socio-economic stressors on the environment of this region. The Community Development Blocks under the Sundarban region within North and South 24 Parganas Districts of West Bengal are plagued with frequent physical exposuresin varying sensitivity rates as well as inequalities in distribution of capabilities and opportunities of the rapidly growing inhabitants.The negligible access to life supporting resources and amenities renders the peopleincapable of risk management leading to recurring disasters. Developmental proposals are too threatened by the vulnerability status of the population in the region. Thus, the present paper also aims to highlight the vulnerability issues with respect to environmental hazards through qualitative and quantitative methodologies. Vulnerability indices have been devised to identify the extent of the impacts, both physical and psychological with data from India Meteorological Department, United States Geological Survey imagery, Census of India, District Statistical Handbook and other authentic reports. The analysis has been verified on ground by case study methods through target group discussions and personal interviews in the mouzas, prone to recurring disasters of the Sagar Island through snowball sampling. The study highlights the distribution and diverse degree of environmental vulnerability status from coast line northwards and from the international border shared with Bangladesh westwards.

Keywords: Natural hazards, Socio-economic Vulnerability, Sagar Island, Development Potentials.

Abstract ID – 232

Influence of solar radiation on the atmosphere of earth and mars – comparative study

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Theme :Weather/Climate Modelling at Regional & Global Scales.

Abstract

The ground and space based observations for Earth and Mars have been in use since long time and given a relatively fair understanding of the dynamics of the atmosphere of both planets. Solar activity is the manifestation of sunspots, solar flares that are driven by solar magnetic fields. The activity plays a major role and has an influence on weather/climate of Earth and Mars. It has direct impact on the Earth's magnetosphere and atmosphere, while the weather on Mars depends only on solar radiation. The reason for the deviation is mainly due to absence of magnetosphere on Mars. The solar activity data is obtained from the SILSO and WDC, where as the data on mars is from MOM-MENCA of ISRO mission. Upper air observations for the earth's atmosphere are obtained from NASA/NOAA and standard atmosphere. The necessary algorithm and computer coding techniques are being developed for processing voluminous data to determine the variations of the atmospheric total/partial pressure and the influence of solar activity, in terms of meteorological influence.

Prediction of weather such as dust storms on Mars are relatively simpler compared to that on Earth, and is due to the fact that less internal factors influence the atmosphere. Martian year lasts for 687 earth-days and hence the effect of solar activity on Martian atmosphere will be much higher and remains for quite long period. There will be a larger variability of temperature in exosphere and thermosphere of mars compared to Earth. However, the diurnal variations of temperatures are more in the lower atmosphere on Earth. The low surface pressure about 4-9 mb in Mars responds quickly to the changes due to solar activity compared to lower atmosphere of earth. Also put an effort to compare the influence of solar activity on atmosphere of Earth and Mars, which differs much in their composition and seasonal response to the solar activity.

Abstract ID – 265

Flood risk assessment using multi-temporal SAR data

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Abstract

Floods are unexpectedly and transient natural events, affecting areas that are not ordinarily covered by water. These are most damaging natural hazards that is characterized as climatic extreme events. The impact of floods plays a significant role in a society and the surroundings; thus, flood mapping is crucial. Remote sensing data was accustomed develop flood map in an efficient and operative method. In this study, the Katihar and East Champarandistrict (Bihar)has been chosen owing to its vast extent of flood prone area in the northern India. We have discussedtwo ways i.e. one is histogram thresholdingand other is Random forest classification(RFC). Three images of Sentinel-1 based synthetic aperture radar(SAR) of June(pre-flood), August(post flood), and October (post-flood) of 2017 were acquired for multi-temporal flood analysis. Thresholding approach was carried out to determine flooding from these images and contains the utilization of image subtraction and application of thresholding values. The flooded area determined from two periods for Katihar were 627 sq.km.and 366 sq.km and for East Champaran was 284 sq.km. and 42 sq.km.respectively. The RFC methods was also used to extract flooded area from two periods were 635 sq.km.and 399 sq.km for Katihar and 261 sq.km. and 22 sq.km for East Champaranrespectively. In addition, several pre-processing methods were integrated before extracting flooded maps. Thus,thesatellite-based flood inundation mapping was used to get a vital information for authorities to rearrange, relief work and safeguard activities.

Abstract ID – 319

Rainfall Trend over North East Region (NER) of India and its Implications on Climate Change and Water Availability

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Abstract

Climate change is likely to affect all aspects of life and decreasing rainfall will result in decreased water availability (Gosain *et al.*, 2006) in future. An understanding of the spatial & temporal distribution in rainfall is one of the basic and important requirements for the planning and management of water resources. This paper examines the monthly, seasonal, and annual rainfall trends on different scales *viz*; the subdivision and regional scale for the NER. It has been revealed that there exists large variability in the rainfall trend data from one subdivision to another. Further, due to rise in Green House Gas emissions in future, variabilities in temperature and rainfall will be observed more and consequently effects on climate change including agriculture will be more pronounced for India.

Abstract ID – 345

Objective Analysis of Wind Data of Automatic Weather Station over Tamilnadu

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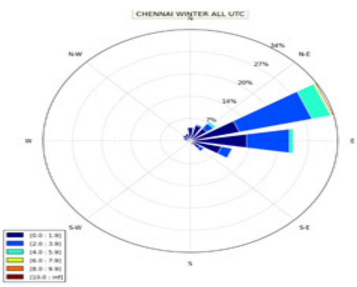
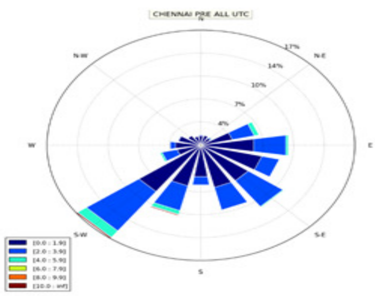
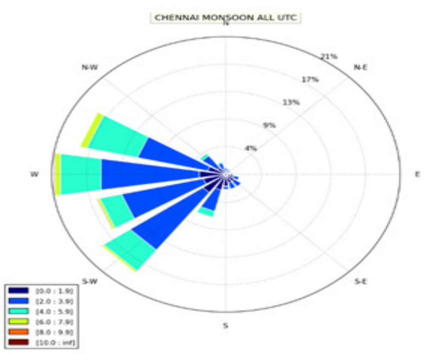
Abstract

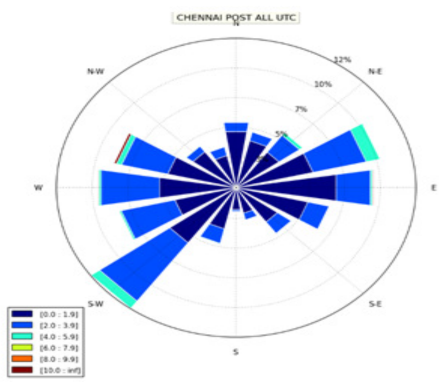
India meteorological Department has a network of 701 Automatic Weather Station all over India. The more accurate data and better transmission status for AWS is available for Tamlnadu region, where wind energy more popular in almost all districts. Stake holders and manufacturers of wind energy systems always demands for the wind rose diagrams in each district. But IMD has very few departmental round the clock synoptic observatories in Tamilnadu out of its 32 districts and many occasions it become difficult to provide the exact wind rose diagrams. At present AWS network of Tamilnadu is expanded to almost all districts and state of the art technology is utilised for the wind measurement. Out of 40 AWS systems in Tamilnadu, 20 systems are equipped with GPRS technology having every 10 minutes data transmission. In this paper fiveyearsWinds data(2013-17) of all AWS systems of Tamilnadu are taken and compare with the wind data of co-located observatory wherever available.Since the data is comparable with deviations in the accuracy limits, AWS data can beconsidered as a useful tool for deriving wind rose diagramsof districts having no representative synoptic observatories.

Sample diagrams: Wind rose diagrams derived from AWS system at Nungambakkam, Chennai for all the seasons is shown below for reference









Abstract ID – 419

Understanding the thermodynamic variability in relation to pre-monsoon thunderstorms over a tropical coastal station Bhubaneswar

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Abstract

The pre-monsoon thunderstorms are the main source of rainfall and catastrophic destruction over the Eastern India. These pre-monsoon thunderstorms are also known as Nor'westers or Kal-Baishakhi by the local people. It has been found that the Nor'westers are having signatory values of thermodynamic indices over the places, which changes with evolution of thunderstorms and can be a good indicator for predicting/understanding them. In the present study, we have analysed the radiosonde data over a tropical coastal station of Eastern India, Bhubaneswar, for past thirty years (1987-2006). Various thermodynamic indices have been calculated and together with the thunderstorm occurrence information, threshold values of these indices have been decided. The work shows the variation with time in the values of these thermodynamic indices with a marked shift in some of the indices, whereas some other indices show no clear change in pattern over the period of study.

Keywords: Thunderstorms; Radiosonde; Thermodynamic Indices.

Abstract ID – 424

Lightning observation and relation with vertical temperature profiles over Andhra Pradesh during – 2017 & 2018

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Abstract

Lightning and lightning induced effects have significant influence on many aspects affecting the public, which makes the studies on lightning and lightning protection very important. Thunderstorm/Lightning is hazardous and causes risk to life and property. Thunderstorm has important characteristics such as the formation of towering cumulonimbus associated with turbulence, In-cloud electrification with associated lightning and strong rain, it causes to loss of lives as well. State Emergency Operation Centre, Andhra Pradesh State Disaster Management Authority has a unique set up to identify the lightning area using Earth Networks data.

Air density decreases with increasing temperature. Severe thunderstorms are resultant of vigorous localized convective activity leading to Thunder, Lightning and heavy rain, etc.., The greater the heating is during the day, the greater the instability of the atmosphere. Instability increased by warming the low levels and/or cooling the mid and upper levels (700 to 300 mb), dry air in the mid-levels combined with warm and moist air in the Planetary Boundary Layer will produce convective instability. In the present study authors are attempted to verify the relationship between temperature gradients to the Lightning activity during 2017 and 2018.

Abstract ID – 425

Unprecedented thunderstorm/ squall activities over north eastern India during Premonsoon season 2018: A synoptic cum diagnostic study

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Abstract

North Eastern region of the Indian republic may be classified as laboratory for the meteorology specially pertaining to the extreme events as far as Indian subcontinent is concern. During the premonsoon season (MAM), this region witnesses large scale thunderstorm/ squall and hailstorm events every year. Northeastern Indian region comprises of three meteorological subdivisions viz. AP, A&M and NMMT covering 07 states viz. Arunachal Pradesh, Assam, Meghalaya, Nagaland, Manipur, Mizoram& Tripura. Climatological average frequency of thunderstorms is maximum over this region in the country and is more than 40 in some pockets during this season.

Unprecedented intense to very intense thunderstorm/ squall events occurred in isolated pockets of North-Eastern India (area of study) during the pre-monsoon season in the year 2018. An attempt has been made to examine & understand the underlying causes of the same by carrying out a synoptic cum diagnostic study with valuable inputs from thermodynamic parameters. The atmosphere was convectively unstable over the study area due to warm and moist air incursion from Bay of Bengal overlaid by cold and dry mid-latitude westerlies caused due to western disturbances passing over the region. At the surface and lower levels, anti-cyclonic outflow from Bay of Bengal provided southerly/ southwesterly moisture laden winds over this region and cyclonic circulation over and in the neighborhood of the region caused convergence of this moist air in lower levels supported and stimulated by the divergence field produced by the sub-tropical westerly jet (STWJ) in association with the troughs in mid-tropospheric westerlies in the upper levels making atmosphere very much conducive for intense convective activities. As a result of this synoptic & thermodynamic setup and dynamical structure of convergence/ divergence field pattern, large scale rising motion occurred over this region which caused such unprecedented convective activity in isolated pockets of this region. This atmospheric setup which lasted for months together resulted due to combined effect of large scale synoptic forcing, regional meso-scale thermodynamic forcing and local physiographic characteristics.

Key words – Pre-monsoon season, Thunderstorm, Squall, Hailstorm, Western Disturbance, Sub Tropical Westerly Jet (STWJ), Convergence, Divergence, Synoptic, Thermodynamic, Dynamic.

Abstract ID – 429

Very Severe Cyclonic Storm OCKHI over Bay of Bengal, 29 November–05 December 2017: A case Study

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Abstract

Ockhi, Very Severe Cyclonic Storm (VSCS), originated from a low pressure area over southwest Bay of Bengal (BoB) and adjoining areas of south Sri Lanka & equatorial Indian Ocean in the forenoon (0830 IST) of 28th November and intensified into a Cyclonic Storm (CS) in the forenoon (0830 IST) of 30th November over the Comorin area. The uniqueness of this cyclonic storm was its rapid intensification during genesis stage. It intensified into a depression at 0830 hrs on 29^{th} November and CS within 24 hrs at 0830 IST of 30^{th} November. It further intensified into a Severe Cyclonic Storm (SCS) over Lakshadweep area at 0530 IST of 01st Dec. and Very Severe Cyclonic Storm (VSCS) over southeast (SE) Arabian Sea to the west of Lakshadweep at 1430 IST of 01st Dec. It moved northwards and attained its peak intensity of 150-160 kmph at 0830 of 4^{th} Dec. Further Ockhi followed clockwise recurving track and moved north-northeastward and weakened gradually into CS at 0830 IST on 5^{th} Dec and then further weakened and crossed South Gujarat coast as a well marked low around 0530 IST of 6^{th} Dec. This study examines the performance of ocean coupled HWRF model in prediction of Bay of Bengal cyclone "Ockhi" and its comparison with uncoupled HWRF forecast.

Abstract ID – 461

Uniqueness of Indian Storm Season 2018(Thunderstorm and Dust Strom) in Scale, movement, Severity, Damages and Sectorial impact, their Meso-Characteristics and Progress in Early Warning Systems

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Abstract

In summer 2018, a total of nearly 500 number of lives were lost from severe Thunderstorm/Dust storm(TS/DS) events those occurred during 11 April-13 June covering various northern states across great Indo-Gangetic Plains(IGP) region(Ref-Media search in Google April-June 2018 for India from such events), which may be highest in historical record of lives lost in any single season from local meso-scale storms. It is also unusual when one analyze this summer, and consider their pan-India occurrences, movement, their frequencies and longer spatial scale-they covered during their movement or re-intensification stage, life period-they last, intensity and severity-they reached and their impact in other sectors and. The damages from their severity in terms of impact on Aviation, Power sector, etc. also could be highest in Indian weather History from such severe events. The impact and damages were very unique as it was more wide spread occurrences covering sometime a number of states across Punjab-Haryana-Rajasthan-Delhi-Uttar Pradesh–Bihar-Jharkhand-West Bengal-Odisha, having of simultaneous occurrences across such vast IGP region. The season was so favourable for local storms that, by mid-May 2018, it had triggered four severe spells of severe TS, all triggered and preceded by Dust storms occurred in squall lines mode, like on 11 April, 2, 9 and 13 May, where to believe their severity, it is very much need to see cloud pictures of INSAT 3D and Max-Zs of DWR of Patiala(PTL), Delhi, Lucknow(LKN), Patna(PTN), Kolkota(KOL) for scaling in together with surface data e.g. all enrooted airport Met report data and airport AWS/RVR data and routine AWS for estimating, their intensity in terms of pressure fall/wind squalls and Vis lowest they caused. One also need to critically analsyze all these data to find how uniquely these severe TS/DS were formed say at Punjab or west UP areas, by 0600-0900 UTC in early afternoon and moved upto 800-1200km far to Bihar- Bengal areas(e.g. 2 May 2018 and 11 April) or simultaneously they formed all across IGP plain at 1200km long zone with highly favourable moistures, instability conditions where lower convergence zone were persistently available from large-scale IGP easterlies. If one looks all those DWR animation and INSAT 3D/Rapid, then one could see how such violent formation with roaring CBs were all with severe DS and gusty/squally winds sweeping across these states in a row and were moved across various states/areas across west and central IGP reducing visibility to 200-800m and winds upto 70-130kmph which have made all lives across these states really miserable. UP, Delhi and Raj was the worst hit by these four DS with Delhi-Agra-Bharatpur division affected worst, where a total of around 270 lives lost. The DS of 11 April caused severe damages across same Agra-Bharatpur sector and killing 42 People respectively with Taj Mahal, Agra Fort partly damaged. There were 5 lakh residents of 300 Agra villages without electricity for 10-20 days in May and 24,000 transmission towers, electric poles uprooted in these four dust storms when High-speed winds accompanied by rain on April 11, May 2, 9 and May 13 had

crippled power supply infrastructure across west UP, especially Agra district. In aviation sector, the season was so unusually active and TS/DS were so severe that even IGIA Delhi has recorded a highest number of DS in last 10-years, with total 5 events when a total of 177 flight diversions were made–A highest in IGI history for any season. Also, on 13 May 2018 at IGI Airport, due to severe TS/DS, there was around 78 flights were diverted-a highest by any single day of severe weather in the history of aviation operation at IGIA(if all days of diversion by any bad weather whether it was by a severe fog date or severe TS/DS dates.
In the present study, we have studied all the 2018 summer's major spells e.g. 6-11 April, 2, 7-9 and 13 May, 28 May, 1, and 9 and 13 June using GFS wind analysis, DWR/UA data of Patiala, Delhi, Lucknow, Patna, Kolkota and INSAT 3D(IR 1 and Vis band) at each 30-minute for evolving of pan India CB cloud features. At meso-scale, the high resolution network of 13 number of RVR and five Airport AWS of IGA were used to study their meso-features. The VVP of DWR of 13 May was used to compute wind shear in view of 76 flights were diverted on a single day evening-a highest in aviation history of India for any airport, to find if wind shear can be a factors besides CB height in DWR. The result shows such unique storm season was manifested mainly due to monsoon like east-west trough lines formed in 4-5 occasion during 10 April to 15 May across IGP region at lower levels with well established stronger easterly winds persisting for 3-5 days period in a spell. The latter was observed as early as 10 April due to unusual heating occurred at Pakistan areas in March-April 2018. The 2nd May day when a series of severe TS/DS events formed and hit IGP plains, the result shows they were very uniquely forming, intensifying and moving east with occurrences as more evolving with CB Zones moving as squall lines in form of SW-NE orientation across Punjab-HP as early as 0400UTC triggering by active WD and then moved to east wards with the time and scale upto 2400UTC and upto 1200km resepctively to far east i.e. corresponding to 20 hours with 70km per hours moved to to Bihar- WB areas as was confirmed from INSAT 3D- Cloud monitoring and DWR monitoring of PTL, Delhi and LKN-PTN-KOL. The events of 11 April had similar features but started from Delhi side and terminated at central UP near LKN areas while 13 May and 9 June were of simultaneous formation all across the E-W or northwest-southeast trough lines across great IGP through central India. We have compared CAPE and other instability convective indices as computed using RS/RW data for all stations for all these dates for which data are available to find their roles. Besides all these diagnostic studies, we have analyzed their impacts at various sectors and how IMD have improved its monitoring and early warning system of local storms of summer 2018 including dissemination of nowcast to minimize the damages in various sectors.

Abstract ID – 463

Capturing Role of Meso-Scale and Large-scale Met Features on Dense/no dense Fog spells/days for WIFEX 2015-18: Why Fog forecast Systems of Met Office Palam have Success and Failure on some Evenings?

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Abstract

Winter fog experiment (WIFEX) has been conducted at IGI Airport Delhi jointly by IITM-IMD for last two winters of 2015-16 and 2016-17 and it had successfully completed, its 3rd phase for current fog season 2017-18. The main objective is to understand fog micro-Physics and role of various type of gaseous and other pollutants those trigger fog formation, intensification and its further life period including sampling of fog droplets to understand its chemistry. The other objective is to use those precious data at real time in development and validation of an effective fog forecast model that provide fog early warning 18-24 hours in advance for airport use. In all three phase of WIFEX 2015-2018, at IGI Airport, various different equipments have been installed and made operational for measurement of various fog related parameters at second to hours time gap. Some of the major equipments installed at IGI Airport during three phases of WIFEX are as follows:

1. RVR instruments
2. Fog droplet microphysics
3. Radiometer
4. SODAR
5. Flux tower
6. Aerosol, gases and fog water analysis
7. Aerosol Microphysics
8. Radiation
9. MARGA (Chemical analysis of PM1, PM2.5 and gases) online first time in India on high temporal resolution(newly added and functional in 2017-18)
10. Ceilometer -(newly added and functional in 2017-18)
11. Fog dispersal set up (experimental mode Ion generator)- (newly added and functional in 2017-18)
12. *Tethered balloons data at Pusha upto 1000m collected during 10-23 Jan of 2016.*

Summary of our study

- **Yes/no dense fog forecast at 4-12 hours lead time in 2015-18**
  - **IITM Fog model has huge improvement (skill in 2017-18 winter is 75%)**
  - **while IMD has saturation of 95% for Dec and 85% for Jan for 2015-18**
- **Both have problem of capturing timing of onset/lifting of dense fog of <200m though IMD has better capacity by using INSAT 3D RAPID analysis and nowcast System anddata of WIFEX(MRM, MARGA) which have helped in improving the lowest Visibility forecast and onset-lifting timings skill from 78% to 88% in 2013-2018.**

Abstract ID – 473

Machine learning to evaluate impact of weather variability on rainfed upland kharif rice yields of West Bengal

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Abstract

The variations in total monsoon rainfall, its varied/uneven distributions and dry spells within the season affect kharif rice yield inrainfed upland areas considerably. Therainfed upland areas of the adjacent Purulia and Bankuradistricts of West Bengal in the western most part Chhotanagpur plateau and in the intermediate tract between the plateau and eastern alluvial plains respectively show a block-level variation in kharif rice yield from929 to 4009 kg/ha during 1992-2014.Besides, the weather variables, the non-weather variables like seed variety, fertilizer, soil type, pesticides and mechanization impact the yield significantly. The statistical and crop simulation models are conventionally developed for yield predictions and evaluate the impact of the weather and non-weather variables. These models have their inherent merits and demerits. The present study attempts to use the data-driven machine learning techniques which derives robust models with predicting capabilities from big, heterogeneous data sets of multiple-predictor variables non-linearly related to the target variable. Though non-weather variables positively impact the crop yield, to evaluate the impact of weather variables on it, in the present study these are exclusively considered for developing the machine learning models. The variations in weather within the districts of Purulia and Bankura being appreciable, block level crop yield prediction models using machine learning technique have been developed with the data of 20 and 16 upland block areas of these districts respectively. The effect of weather variations on kharif rice yield was investigated using 23 years' (1992-2014) daily data of rainfall, minimum & maximum temperature, solar radiation and relative humidity. The different combinations of time granularities such as weekly, monthly and crop-growth phases were considered to understand the temporal aspect of the data. The 23 years' block level kharif rice yields for 36 blocks were the output variables.The supervised machine learning methods of Artificial Neural Network, Random Forest Regression and Support Vector Regression were used to evaluate their performances in developing crop yield-weather models. The models were run using R language.Since a high level of multi-collinearity is observed among the input variables,Factor Analysis was done at initial stage to extract the important features, AKA factors. The extraction was done using principal component analysis. Further, this helped reducing the dimension of predictor variables and generating mutually exclusive Factors, required to improve ANN model accuracy.For the different combinations of inputs, the correlation between test and predicted data ranged from 0.6 to 0.8 for Bankura and Purulia districts respectively. Performance analysis was done through cross validation. Connection weight method was used to rank the importance of predictor weather variables. The results of neural network models for manifold combinations of multiple input variables have given an insight into differing impacts of various weather factors on kharif rice yield from the rainfed upland areas of these two districts. It also indicates that the impact of weather variability is more pronounced in Purulia district as compared to Bankura revealing the significant effect of non-weather variables in the latter. Besides, this study reveals the necessity of predictive model generation at finer space scale.

Abstract ID – 496

Investigating the Effect of ENSO Events on the Malaria Transmission over India

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Abstract

The malaria is one of the important disease occuring over the Indian subcontinent whose impact is far reaching and fatal in many cases. The malaria transmission rate and its distribution over India sensitively depends on the climate factors such as rainfall and temperature of the region. The El Nino and La Nina events are known to strongly affect the rainfall (and temperature) over the Indian subcontinent. An effort is made to investigate the role of El Nino and La Nina events in changing the malaria transmission rate over the India. The El Nino, La Nina, and Neutral years have been selected out of a period of 45 years from 1961-2005. The VECTRI model simulations carried out seperately for these three types of years suggest that the Malaria transmission frequency decreases (increases) during the El Nino (La Nina) years as compared to the Neutral year. This may be due to decreased rainfall and increased temperature during the El Nino event (and *vice versa* for La Nina event). The malaria transmission rate (for El Nino, La Nina, and Neutral years) using the VECTRI model has also been calculated for the future climate data (years 2006-2050) of RCP 8.5 climate change projection scenario.

Keywords: ENSO, ISMR, Variability.

Abstract ID – 504

Modeling to Assess Possible Impacts on Environment due to Tsunamigenic Sources (Makran subduction zone) along Gujarat Coast of India

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Abstract

West coast of India is affected by tsunami generated along Makran subduction zone. Modeling of tsunami amplitude, travel time and run-up have been made for some of the Gujarat coast from the source using Tsunami N2. For tsunami run-up the land topography data was collected using SRTM data. The bathymetry data was taken from ETOPO-2 and near shore data from C-MAP. Makran, Fault strike 270°: The fault parameters of the earthquakes for the generation of tsunami are: fault length and width (200km length and 100km width), Fault strike (270°), dip and slip (15° and 90°), focal-depth (10 km), and magnitude (8.0). From the source in central part of Makran the amplitude of tsunami near the source is 6m and Gujarat coast is 4.5m or less (Jakhau- 4.5m, Porbandar- 4.0m and Dwarka- 3.0m). In Gulf of Kutch tsunami reaches in 3hr with 1m run up. The simulation of model results show that the tsunami wave propagated initially very fast in Arabian Sea and it slowed down when it reaches shallow region of Gujarat coast. At Dwarka, positive tsunami waves arrive within approximately 2 hours and 10 minutes and to Mandvi after 3 hours 10 minutes. If the tsunami strikes during high tide, we may expect more serious hazards which can impact local coastal communities and mangroves. It can be devastating causing property damage, loss of biodiversity and loss of life. In addition to this, tsunami can also impact environment in many ways such as sea water intrusion causing salinization problems for soil and ground water in coastal areas, and sediment deposition and it can also induce salt injuries in crops. Makran, Fault strike 250° and other parameters as above: Directivity is found to be directed towards India. If the source is considered along the western part of Makran the travel time increases.

Keywords: Gujarat coasts, Tsunami N2, Makran Subduction Zone, modeling (tsunami amplitude, travel time and run-up), Environmental impacts.

Abstract ID – 506

Machine Learning Internet Of Things Applications In Meterology

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Abstract

WSN(wireless sensor network) – IoT Geophysical Monitoring:WSN- IoT to monitor Meteorological Monitoring ,Automatic Weather Station- Agro-Meteorology,Temperature , Humidity , Deformation Systems , volcanic Gases Monitoring, Seismic Monitoring , geosciences natural disaster monitoring-earthquake,landslide, volcanology, etc. Central Nervous System for the Earth (CeNSE) wireless sensors wireless microseismic hydrocarbon reservoir monitoring, monitoring system microseismic, hydropower dams, bridges-railways, highways, etc. Implementation in real time early warning systems to send alerts to government institutions (NDMA Nationaal Disater Management Authority, India) of prevention and mitigation of natural disasters. Benefits of IoT geophysical monitoring- Improve our monitoring systems with high resolution of coverage areas in different fields Deformation , Seismic and Volcanic events,etc. Underwater networks of sensors(UW-ASNs): Environmental Monitoring. UW-ASNs can perform pollution monitoring (chemical, biological, and nuclear), ocean current and wind monitoring,and biological monitoring such as tracking of fish or micro-organisms. Also,UW-ASNs can improve weather forecasting, detect climate change, and understand and predict the effect of human activities on marine ecosystems.Disaster Prevention. Sensor networks that measure seismic activity from remote locations can provide tsunamiwarnings to coastal areas, or study the effects of submarine earthquakes (seaquakes),submarine landslide. Ubiquitous Knowledge Processing,Real Time Signal Processing(PRISM filter for IOT signal)IoT connets surrounding smart devices to Internet- Smart Device: A device that can take intelligent decisions on its own. It consists sensors and actuators., Sensors: Sense the surrounding activities, Actuators: Response to the sensed activities.Major Components of IoT-Sensor technology; Communication technology; Machine Learning; Human-machine interface .The Internet of Things further introduces a need for data routing and event processing, provisioning and management of the software on the sensors, identity access controls for securing data transmissions in the middle tier, and an appropriate communications network from the sensors and devices to the corporate intranet infrastructure.Machine learning /Deep Learning/ Statistical Learning: A computer program is said to learn from Experience E with respect to some Task T and some Performance measure P, if its performance on T, as measured by P, improves with experience E.. Learning means Improving with Experience at some Task Machine learning investigates how computers can learn (or improve their performance)based on data. A main research area is for computer programs to automatically learn to recognize complex patterns and make intelligent decisions based on data.machine learning evolved as a subfield of artificial intelligencethat involved the development of self-learning algorithms to gain knowledge from that data in order to make predictions .The three different types of machine learning: supervised learning, unsupervised learning, and reinforcement learning. Semantic Web for Earth and Environmental Terminology (SWEET) -An ontology is expressed using a language that is typically a specialization of XML(eXtensible Markup Language). XML is receiving a lot of

attention and the question for geoscientists is what does it bring new to the problems of data exchange. XML is widely supported by existing software tools and is rich enough to express the hierarchical structures inherent in knowledge representation. Resource Description Framework (RDF) is the simplest such ontology language. RDF specializes XML by standardizing meanings for: class, subclass, property, subproperty, domain, range, etc. The DARPA Markup Language (DAML) and DAML+Ontology Inference Layer (DAML+OIL) are further specializations of RDF. These languages add standard meaning for: cardinality, inverse properties, synonyms, and many more concepts. DAML is the most widely used ontology language and is being adopted by W3C as its standard Ontology Web Language (OWL). CUAHSI Consortium of Universities for the Advancement of Hydrologic Sciences Hydrologic Information System(HIS) **WaterML** for meterological data World Meteorological Organization's Commission for Hydrology.

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CUAHSI Hydrologic Information System(HIS) (http://his.cuahsi.org), conducted under the aegis of the Consortium of Universities for the Advancement of Hydrologic Sciences, Inc.
(CUAHSI: www.cuahsi.org). **WaterML (http://his.cuahsi.org/mastercvreg.html)**

Abstract ID – 511

Long Term Spatio-Temporal Analysis of Heat Waves and Severe Heat Waves Over India

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Abstract

Heat waves (HWs) and Severe heat waves (SHWs) are more pronounced during pre-monsoon (March – May) and early summer monsoon (June-July) season in India. Studies have confirmed increased occurrence and severity of HW and SHW events since last few decades. The rise in frequency and intensity of HWs have detrimental impact on health in form of heat stress and heat related mortality. The present study aims at analysing monthly, decadal, seasonal variations, and long-term climatological trends of HWs and SHWs over India.
The study period extends over pre-monsoon season and early summer monsoon season from March to July for 1951-2016. The daily gridded maximum temperature data was obtained from India Meteorological Department (IMD; 0.5 ˚ latitude x 0.5 ˚longitude). To obtain high resolution homogenous temperature dataset for the entire study period (1951-2016) temperature data available at 1˚ x 1˚ resolution for the period 1951-1979 was regridded (0.5 ˚ x 0.5 ˚) by using bilinear interpolation method. The criteria for defining HWs and SHWs was employed from the revised criteria of IMD, New Delhi.
An increasing trend of HWs and SHWs was observed in the decadal and seasonal variations over the country. The results obtained showed a significant long-term increase in frequency of HWs with rising occurrence of SHWs particularly in recent decades. Densely populated Northern region of the country experienced a significant rise in HWs proposing serious implications on the health of its inhabitants. Potential heat stress condition is expected to rise in future as coastal regions of the country have also observed rise in HWs. A continuous trend of increasing HWs and SHWs pose grave risk on human health, predominantly on the vulnerable sections of the society. Frequent episodes of HWs and rise in heat related mortality observed in recent decades questions the lacunae in adaptation and mitigation measures for climate change in India.

Keywords: Heat waves, Severe Heat Waves, India, Long term trends, Climatology.

Abstract ID – 514

Assessment of Climate change for Water Resources over the Varuna River, Varanasi, India

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Abstract

Management and development of water resources isessential for present as well as future constancy for a region or state. Climate change influenced the basin's hydrology as per topographical characteristics. The annual rainfall pattern and its percentage departure have shown high frequency of drought conditions while the seasonality index (SI) depicts that most of the rain occurs in less than three month period. Annual rainfall over the *Varuna* Basin is heterogeneous with large variation in temporal distribution with annual average of 863.9mm. The departure is calculated by subtracting the annual rainfall for an individual year (rf_i) with an average mean ($\overline{rf}$) of annual rainfall (1960 to 2013).The departure ($Departure_i$) of rainfall for an individual year is expressed as $Departure_i$=$rf_i - \overline{rf}$. The maximum rainfall found in the study period was 1,222 mm (1971) while minimum rainfall was just 397.8 mm (1997). Percentage deficit in rainfall indicated to drier periods in year 1988, while high intensity in rainfall departures was observed more than 30% departure in the annual rainfall.The rainfall peaked in the month of July and August (an average of <250 mm month^{-1}), and started to decline in September. The summer monsoon months June-July-August-September (JJAS), shows a large variability of rainfall from very low to high with respect to all India averageIndian Summer Monsoon Rainfall (ISMR). Seasonality of climate over the *Varuna* River is carried out using SI which helps in determining the monthly rainfall distribution on temporal scale calculated by Equation;

$\mathrm{SI} = \frac{1}{\mathrm{R}}\sum_{\mathrm{n}=1}^{12} |\overline{\mathrm{X}_\mathrm{n}} - \frac{\overline{\mathrm{R}}}{12}|$ Here, $\bar{X}_n$= mean rainfall of month n, $\bar{R}$ = mean annual rainfall.

SI of *Varuna* River which depicts that rainfall generally occurs in in the duration of three or less months indicating towards the ISMR in months of JJAS. The rainfall regime of *Varuna* shows minimum SI (0.93 in the year 2007) reflecting markedly longest drier periods for 2007 while maximum SI (1.36) was found in the year 1976. Most of the year's showSI greater than 1.0. This further elucidates that *Varuna*Basin is more prone to drier periods rather than surplus water conditions leading to high frequency of drought that was also found in the study. The rainfall pattern over the *Varuna* River basin shows temporal heterogeneity and the frequency of percentage deficit in rainfall occurs very frequently, which might lead to the diminishing of the channel width of river basins andreflects more proneness to drought conditions. It indicates drier periods with the decrease in annual rainfall pattern illustrating*Varuna* basin may consequently turn into a drain.

Keywords:Climate Change; Rainfall Departure;Drought;Seasonality Index (SI); Varuna River (India)**.**

Abstract ID – 516

Application of DSSAT model to study the impact of climate change on Evapotranspiration in sub humid climate region of Eastern Uttar Pradesh

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Abstract

The components of hydrological cycle are sensitive to climate variability. One such component is Evapotranspiration (ET), that is highly dependent on climate variablesand significantly determines the water availability of an agriculture system. It is thusessential to study the impact of climate change on ET of any region. The present study is an attempt to analyzethe trend in observed ET (1978-2003) and to compare measured ET with simulated ET (FAO Penman-Monteith and Priestly-Taylor method)using NCEP, NASA Power, RegCM4.0 and agriculture field data. Susceptibility of ET to climate variables (relative humidity (RH), solar radiation (SLR), minimum and maximum temperature and wind speed (WS)) was studied using CERES-rice and CERES wheat crop model. The influence of climate change on EThas also been analyzed using projected climate (RegCM4.0, RCP 4.5 scenario during 2041-2060) in DSSAT model. Further, attempt has been made to study the significance of ET in determining agriculture drought using StandardizedReconnaissance Drought Index(RDIst). The result shows declining trend of ET during 1978-2003, but an increase during 2040s (2040-2061) for both wheat and rice. In case of simulated ET,FAO Penman-Monteith gives more accurate result in comparison to Priestley-Taylor method if reliable weather data is available. Also, ET simulated using weather data input from agriculture field shows highest concordance with observed ET, followed by NASA/RegCM4 and NCEP. Overall, Sensitivity study of ET reveals that RH is most significant parameter followed by temperature, SLR and WS.RDIst result suggests that ET along with rainfall efficiently estimate the drought condition of any region.

Keywords :CERES- Wheat, Evapotranspiration, FAO Penman-Monteith, Priestley Taylor, Reconnaissance Drought Index.

Abstract ID – 13

The unusual long track and sudden intensification of very severe Cyclone Ockhi

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Abstract

Cyclone Ockhi formed on 29th November 2017 over the Lakshadweep Sea, south of Cape Comorin, is the first very severe cyclone to form in this region since 1925. It maintained cyclone strength for five consecutive days and touched a maximum wind speed of 85 knots (160 kmph) during its lifetime. The cyclone travelled from south Bay of Bengal to northeast Arabian Sea, covering a distance of more than 2500 km. It underwent rapid intensification from depression to cyclonic storm in a span of just 9 hours (against an average of 24-36 hours). Our analysis shows that the sudden intensification was a response to conducive thermodynamic conditions due to anomalous warm sea surface temperatures (SSTs) and a favorable phase of the Madden Julian Oscillation (MJO). This system had its genesis from westward moving remnants of a tropical storm in the South China Sea. Further, a strong MJO in favorable phase provided the necessary background conditions for the cyclonic circulation to evolve into a deep depression. Along with MJO, anomalous warm SSTs of about 0.8 °C led to conducive thermodynamic and dynamic conditions such as anomalously high specific humidity, equivalent potential temperature and convective available potential energy (CAPE) caused the sudden intensification. The unusual long track of this cyclone, from the Bay of Bengal to the northeast Arabian Sea, was mainly steered by the upper level winds leading to its movement in northwestward direction in its initial stage than northward in its peak stage and later northeastwards during its dissipation stage.

Abstract ID – 31

Temporal variation of surface-layer parameters and turbulent kinetic energy budget in a topographically complex terrain over Umiam, India

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Theme: Observations in Climate Variability and Changes.

Abstract

In this study, we present the temporal variation of surface-layer parameters and turbulent kinetic energy budget over complex terrain. Data from a fast response 3D sonic anemometer at 18 and 30 m above ground level have been used for the analysis. The prevailing low and moderate wind plays a crucial role in the evolution of surface-layer parameters. Sensible heat fluxshows apeak value during January (202 ± 62 W m^{-2}) to February (295 ± 103 W m^{-2}) at the station. Mountainous topography induced heterogeneity in the wind direction throughout the day, which significantly influences the diurnal evolution of turbulent kinetic energyand momentum flux . During the daytime, different production and loss factors play an imperative role in the rise and decay of turbulent kinetic energybudget. Buoyancy dominates in the morning whereas in the late afternoon both buoyancy and wind shear contributed more to the turbulent kinetic energybudget. The maximum flux transportation has been observed in the morning and late afternoon hours. However, dissipation becamegreatest in the afternoon hours when wind shear increased. Wind direction variability significantly affects the production of turbulence at the station.

Abstract ID – 39

Importance of Ice-Microphysics on Simulation of Indian Summer Monsoon Intraseasonal Oscillation

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Abstract

The Indian summer monsoon (ISM) is a coupled climate system. A coupled forecast system involving a Coupled General Circulation Model (CGCM) has a vital role for the seasonal forecast of ISM rainfall as well as for the forecast of the active-break cycles of monsoon. It is well established that the seasonal mean rainfall is the sum of contributions from vigorous sub-seasonal oscillations i.e. active-break spells. The coupled climate models have biases and low prediction skill in the simulation of seasonal monsoon which might be coming from limited success in the representation of MISO. The ice-microphysics in CGCM significantly alters radiation feedback, which may lead to improvement in monsoon simulation. Satellite observation also indicates that over the ISM region, about 40–50% of rainfall events originate from the melting of ice which indicates the greater role of ice processes. In the present study we have performed Convective Parameterization (CP) experiments which do not consider ice-microphysics; and Convective Microphysics Parameterization (CMP) which incorporates ice-microphysics in CP scheme. We know that the meridional scale and northward propagation over the ISM region are the unique features of the dominant MISO. The results connote that models using only CP fail to comply with observations for capturing the MISO and northward propagations of clouds during Monsoon (June-September) whereas CMP experiments, comply much better with observation in this particular aspect. Our results of outgoing longwave radiation (OLR) and Hadley Circulation also indicate the linkages between convection and dynamics through the distribution of heat source. The CP experiments could not capture the convergence zone over central India and oceanic regions properly during the active and break phase of monsoon but the CMP experiments show a significant improvement in this connection. In order to examine the role of ice-phase microphysics, the aspect of wave number and frequency structure, finite domain space-time spectra are examined. There is a significant difference in the power spectrum of filtered daily rainfall anomaly (Lanczos filter of 20-100 days) over Extended Indian Summer Monsoon region-EIMR (averaged over 60°E–110°E), Arabian Sea averaged over 50°E–78°E), Bay of Bengal(averaged over 77°E–99°E), Indian Land Region(averaged over 68°E–98°E) Equatorial Indian Ocean(averaged over 40°E–105°E) and South Indian Ocean(averaged over 50°E–110°E) for these experiments (CP and CMP) as compared to observation. For EIMR, it is seen that the observed maximum intensity of MISO occurs at wave number one with a period of 40 days. The convective parameterization (CP) experiments simulate MISO with 40 days period with a higher meridional wave number (wave number 2) with very low intensity, whereas the CMP experiments simulate it with a slightly larger period with nearly same meridional wave number and intensity. For the rest of the regions, the CMP experiments were able to capture the intensity and oscillation period better than that of CP experiments. We have also looked into probability density function (PDF) of ISM rainfall from these experiments. There we have noticed that PDF significantly varies in the two sets of experiments. The CP and CMP experiments also differ significantly in capturing the EOF (mode 1 and mode 2) and in comparing with observation CMP comply much better.All these results pinpoint that proper microphysics may be essential for the realistic simulation of Indian Summer Monsoon rainfall and Intraseasonal Oscillation.

Keywords: MISO, Convective Parameterization, Convective Microphysics Parameterization, PDF, Space-Time Spectra, EOF.

Abstract ID – 40

A one year source apportionment study of black carbon aerosols over Agartala

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Abstract

Atmospheric black carbon (BC) aerosol is an important constituent of particulate matter that is formed during combustion of fossil fuels (FF) and biomass burning (BB). Black carbon is a graphitic form of carbon particles with unique physical properties. It consists of pure carbon in several linked forms. It is formed through the incomplete combustion of fossil fuels, biofuels and biomass. BC aerosol emitted directly at the source from incomplete combustion processes such as FF and BBand therefore much atmospheric BC is of anthropogenic origin.
The contributions of FF and BB emissions to BC have been investigated in the recent past by analysis of multi-wavelength Aethalometer data.Aethalometer is one of the popular instrumentsworldwide for measuring black carbon particles. A 7-wavelength Aethalometer (Model: AE-31, Make: Magee Scientific, USA) is used to measure the BC mass concentrations at 370, 470, 520, 590, 660, 880, and 950 nm. This approach utilizes the stronger light absorption of BB aerosols in the near ultraviolet compared to the light absorption of aerosols from FF combustion. Here we present one year of seven-wavelength Aethalometer data from one rural background site in Tripura state measured during 2011. The contribution of BB and FF to BC was directly determined from the aerosol absorption coefficients of FF and BB aerosols which were calculated by using confirmed Angstrom exponents and aerosol light absorption cross-sections that were determined for the given site. Reasonable separation of total BC into contributions from FF and BB was achieved for the site for all the seasons.
The diurnal and daily mean values of BC mass concentration during year 2011 have been determined. BC mass concentrations are found to show different peaks at morning, afternoon and evening hours. Diurnal variation in BC is marked with two peaks, one in the morning hours and other in the late evening hours. The contribution of fossil fuel and biomass burning in absorption coefficient have been determined by assuming exponent value 1.5-2.6 for BB and 1.0 for FF. We tested an algorithm for year 2011 over Agartala and our results are encouraging. BC concentrations are higher during winter months and lower during monsoon months. Maximum BC concentrations were recorded during month of January were 28.6±5.4 μgm^{-3} and minimum during the month of July were 4.07±2.31 μgm^{-3}. The annual average contribution of FF combustion sources to BCconcentrations was 79%, with the remaining 21% corresponding to local and regional BB.

Keywords: Aerosols. Black Carbon.Apportionment.Fossil Fuels.Biomass Burning.

Abstract ID – 45

The Influence of ENSO on Bay of Bengal Tropical Cyclone Activity

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Abstract

A well-documented literature is available on the influences of El Nino-southern Oscillation (ENSO) on the tropical cyclone (TC) activity of global oceans. However, the influence of ENSO on Bay of Bengal TC activity has received little attention than other basin. Therefore, the present study seeks to examine the impact of ENSO on the BoB TC activity. The analysis reveals that out of the total 144 TCs (mean 3.27 per year; standard deviation = 1.56), 92 (mean 2.09 per year, standard deviation = 1.38) occurred during the post-monsoon season (October-December). The mean annual and peak TCs season accumulated cyclone energy (ACE) is 12.84 (standard deviation of 9.42) and 8.71 (standard deviation of 9.33), respectively. The mean annual and peak TCs season power dissipation index (PDI) is 9.35 (standard deviation of 8.77) and 6.39 (standard deviation of 8.68), respectively. Interestingly, the peak season TC activity, ACE and PDI are negatively correlated with the Nino 3.4 sea surface temperature anomalies (SSTAs), significant at the 95% confidence level. La-Nina regime is characterized by more frequent and more intense cyclonic events compared to El-Nina regime. A significant shift in genesis locations, tracks and landfalling locations of TCs has been observed under different ENSO phases. The presence of negative outgoing long wave radiation (OLR) anomalies, less vertical wind shear (VWS), high SST (≥28°C), more mid-tropospheric humidity and low level cyclonic circulation pattern have provided favourable conditions for cyclogenesis during La-Nina and vice-versa in El-Nino conditions. It is further observed that in conjunction with high SSTs the El-Nino and La-Nina with above (below) normal TCs frequency is associated with high (low) convective activity, high (low) RH, cyclonic (anticyclonic) circulation and low (high) VWS over the BoB.

Abstract ID – 55

Overview of fog chemistry during Wifex-2015-18

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Abstract

By considering the national interests and key research issues it is important to consider how future research on fog modeling and forecasting will be organized so that it will most effectively address the issues that are important for public services in India. Therefore, the winter fog Experiment (WIFEX) was carried out in the winter season of 2015-18 at IGIA, New Delhi through an initiative taken by MoES, GoI. The main aim of WIFEX was to characterize the fog events occurring in Delhi and monitor simultaneously associated dynamics, thermodynamics, microphysics and chemical composition of the gases, aerosols and fog water phases to understand factors responsible for their genesis, intensity and duration. This study provides results on fog microphysical and Chemical analysis. We found that the fog particles grew larger and number concentration increased uniformly with time along entire diameter ranges (not shown here) when condition changes from the non-foggy to the foggy condition. Hence it is most likely that the particles grew larger by vapor deposition/collection processes. Data from the aerosol and fog water chemistry collected so far from MARGA and PM analyzer indicate a highly polluted environment in which fog developed and dominance of combustion and vehicular exhaust sources have been noted in the aerosol samples. Secondary inorganic aerosols (NH4, Cl, So4 and NO3) were the dominant ions (60%) in the chemical constituents of the fine particles and were higher during the fog events. The chemical partitioning of fog water samples suggest that Cl (29%), NH4+ (28%), NO3 (24%) and SO42- (17%) dominates the chemical composition. The pH of fog water indicates the alkaline (6.91). These results are important for considering role of chemistry and Microphysics in Fog life cycle and very much important for forecasting purpose because we can tune model simulation schemes accordingly to get accurate forecast.

Abstract ID – 129

Sensitivity of the 4DVar assimilation system to the control variables: A case study on Uttarakhand cloudburst event (2013)

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Abstract

Various data assimilation (DA) techniques use different choices of analysis control variables and most of the DA systems employ stream function (ψ) and velocity potential (χ) as momentum variables in modelling the background error covariance (BEC) matrix. Another popular choice for momentum variables is the horizontal wind components (u and v wind). The present study investigates the sensitivity of the 4DVar system to the control variables using the Weather Research and Forecasting (WRF) model on the simulation of a cloudburst event that occurred over the Himalayan region of India in June 2013. The study uses three sets of BECs: (i) ψ,χ based BEC with univariate humidity variable ($\psi\chi$-BE), (ii) ψ,χ based BEC with multivariate humidity variable ($\psi\chi$-MBE), and u,v based BEC (uv-BE). Five cyclic assimilations were performed with conventional observations in combination with satellite derived wind information. The analysis fields of the uv-BE experiment were found to be more closer to the radiosonde observations. However, the 24-h accumulated rainfall verification against the TRMM observations suggests that the $\psi\chi$-MBE run could capture the maximum rainfall location realistically with improved quantitative skill scores among the three experiments. Despite the uv-BE experiment having a more accurate representation of the initial fields, the above experiment failed to yield the best forecast. The results indicate that the introduction of multivariate humidity variable, as in the $\psi\chi$-MBE, is found to have a considerable impact on the 24-h accumulated rainfall forecast.

Abstract ID – 147

Patterns of climate-induced migrations and the methodologies: a review of literature

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Abstract

The controversial definitions of such words like, 'environmental refugees' in mid-1980s, several rounds of reports of Intergovernmental Panel on Climate Change since 1990 and the several influential papers of famous environmentalist of Oxford University, Myers in 1990s had started a debate around how the growing climate change related problems can influence human migration since the last three decades. After that many papers have tried to address the issue. But still conclusive answers are yet to find out. The current literature review was designed to identify mainly the following two questions: (1) whether environmental factors can change the existing migration patterns at all if yes then the dimensions of such changes like quantitative, qualitative, spatial and temporal? And (2) how the existing literatures assess that such changes in migratory patterns as introduced by the climatic factors i.e. methodologies? Peer reviewed research articles from around the world were found out from several online repositories. And a comprehensive literature review was undertaken with a standardized questionnaire to systematically store the information.To answer the first question, two particular climate hazards, one fast onset (cyclone) and the other one slow onset hazards were chosen by observing the popularity of these two particular climatic hazards among scholars. Where literatures related to cyclone induced migration on a large scale concludes that cyclone displaces a huge population from their native places temporarily but the most marginalized sections of those displaced actually does not come back again. On the other hand, drought induced migration literature is inconclusive in many respects like: whether drought can actually induce migrations, if yes then whether it would be a temporary migration or a permanent one or international or otherwise.Up to 2000, environmental factors were directly correlated with migration patterns but after that other non-environmental factors were also included in the analysis. In search for answer for the second question it was found that literatures have tried to link climatic hazards with migrations in search for two main questions: (a) what is the weight of the climatic hazard against other non-climatic factors? And (2) what is the process through which a climatic hazard is influencing migration patterns filtered by other non-climatic factors? Here the first question is answered through comparing migration patterns between two situations (either spatially or temporarily): one hazard situation and the other one of non-hazard situation while controlling for other non-climatic factors. And where such comparison is not made between hazard and non-hazard situations, comparison is made between migrant and non-migrant groups after a hazard controlling for the other non-climatic factors. These all are in case where the impacts of only one hazard event is to be captured say one single cyclone or one single drought. But impacts of a series of hazards like series of droughts or floods are captured by time series or qualitative methods.To answer the second question, there is a craze among scholars to link the hazard to migration through economic factors in unidirectional way. The study concludes with suggestions for improvements in methodology for further future research.

Abstract ID – 160

Numerical Simulation of Lightning activity and its role on NOx production over Eastern Himalayas

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Abstract

Intense convective activity and greater atmospheric instability over the eastern Himalayas and foothill regions lead to the formation of lightning storms. The North East Region (NER) of India located in the Eastern Himalayan ranges is highly prone to lightning. Most significantly, the lightning occurs during pre-monsoon season, followed by monsoon due to the interaction of moisture-laden wind with the complex topography of the region. The Brahmaputra valley of NER experiences highest lightning flashes (18 flashes/km^2/month) during the month of April and May. In this study, we used WRF-Chem version 3.8.1 Model at 15x15 km resolution to simulate the lightning activity and its role in NOx production over the Eastern Himalaya foothills from period 15 April–15 May, 2014. The Intra-cloud (IC) and cloud-to-ground (CG) lightning flashes are calculated by using Price and Rind parameterization scheme in the WRF model. The model simulated NOx shows enhance concentration by the factor of 0.02- 0.05 ppb over the Eastern Himalayan domain during the lightning period. The prediction of lightning flash rates and lightning-generated NOx in the model is further evaluated using surface measured and satellite datasets.

Keyword: Eastern Himalayas, TRMM_LIS, WRF-Chem model, lightning flashes, NOX.

Abstract ID – 171

Interannual to Decadal prediction of Indian summer monsoon

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Abstract

We analyze the decadal runs from Depresys3 (MetOffice Hadley Centre), BCC (Beijing Climate Center), GFDL (Geophysical Fluid Dynamics Laboratory) and MIROC5 (Center for Climate System Research, University of Tokyo). The preliminary results show that an eight month lead prediction of ISM shows positive correlations over the Eastern part of India. Also the pattern correlation of the datasets show a large variation from year to year which could be understood by the analysis of teleconnections causing non linearities in prediction, if they are not due to some stochastic processes. Ratio of the predictable components indicate overconfident forecasts where the ensemble members agree well with each other but not with the observations. Most models seem to show a dry bias for ISM. The dry bias over the south eastern part of India in these runs are due to excess rainfall over the Indian Ocean south-west of the India. We are looking at the possible factors affecting the predictive skill of ISM by looking at the Monsoon indices which might attribute to the predictive skills.

Abstract ID – 207

Morphological response of Himalayan Rivers under the climate change

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Abstract

In recent decades intensity and frequency of flood has increased drastically. This has resulted into huge loss of lives and Gross Domestic Products (GDP). Researchers have attributed this increase in the magnitude and frequency of flood events as a response to the global climate change (Hirabayashi et al.2013). Various climate models have been developed to simulate extreme floods events of different frequency and magnitude. An assemblage of such climate modelsreveal that in most part of the world i.e; Southeast Asia, eastern Africa, and north part of the Andes, the frequency and magnitude of flood events are expected to increase. It is also projected that in warmer climate most of the river basin worldwide including the Ganga and Brahmaputra, the frequency of extreme flood is projected to increase by 10-30%. It is thus important to understand the river response under the projected climate change scenario. We propose a study that will investigate the impact of projected climate change on the morphology, flow and sediment transport regime of theHimalayan Rivers.

References: Hirabayashi, Y., Mahendran, R., Koirala, S., Konoshima, L., Yamazaki, D.,Watanabe, S., Kim, H.,& Kanae, S. (2013). Global flood risk under climate change. *Nature Climate Change*, *3*(9), 816-821.

Abstract ID – 217

Climate change in Eastern Karakoram Region: Current and Future Scenarios

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Abstract

Climate change and its impacts over high altitude areas have been documented by many researchers. But due to scarcity of observations above elevation of 5000m, the area lying above (i.e. Karakoram Range) has remained unexplored. But since this area has huge masses of glaciers in it, the study of current as well as futuristic climatic changes is vital to enhance our understanding about likely impacts on water supply in upcoming decades. This study evaluates current and future climatic changes over Eastern Karakoram region using observed data and Global Circulation Models (GCMs) respectively. Results of observed data indicate an overall warming by 0.75°C, 0.51°C and 0.70 °C in annual, winter and summer temperature during 1991-2015. Before studying futuristic changes in climatic parameters, the performance of various GCMswhich participated in Coupled Model Intercomparison Project Phase 5 (CMIP5) was evaluated in terms of simulating temperature and precipitation over Eastern Karakoram region. The evaluation was made by comparing ground based observations with historical data (1991-2006) of GCMs. The performance was assessed using various statistical indicators like Pearson's Correlation coefficient (R), Mean Bias Error (MBE), RMSE (Root Mean Squared Error), Nash-Sutcliffe coefficient of efficiency (CE) and Index of agreement alias Similarity index (IOA). Results indicate that 03 models viz. CMCC-CM (China), MPI-ESM-LR and BCC-CSM 1.1 m were found to be reliable models for studying climatic changes over study area. The evolution of temperature and precipitation over Eastern karakoram region during upcoming decades till year 2100 (2020-2100) under warming scenario (RCP 8.5) was studied using Multi-Model mean (MMM) of selected best models. Results indicate that MMM projects an increase in annual, winter and summer temperature by 4.24 °C, 4.5 °C and 3.98 °C during 2020-2100. As a result annual winter and summer time precipitation is projected to increase during same period.

Abstract ID – 221

Heavy Rainfall Forecasting skill of Global Forecasting System at District level over India during summer monsoon season

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Abstract

The extreme or heavy rainfall events are one of the natural hazards especially agricultural country like India, affect the economy of the country. In this study, the uncertainty in predicting heavy rainfall (>64.5mm) at districts level under particular meteorological subdivision of India has been evaluated using Global Forecasting System (GFS) T1534 model during summer monsoon 2017. The observed gridded rainfall is used to locate the heavy rainfall area over a particular district within the subdivision of India. In general, the NWP model under predicts the magnitude of the heavy rainfall. There are 34 heavy rainfall cases are identified with the help of IMD rain gauge observations. Out of 34 cases 14 cases are correctly forecasted and the remaining 20 cases are missed. Here 20 missing cases are selected to examine the causes of GFS model's failure in predicting the heavy rainfall events. Most of the cases, spatial shift (south-eastward) of the particular heavy rainfall system has been observed in the model forecast. Due to the spatial shift of the system in the model forecast, the location specific model forecast over a particular district becoming difficult. Model also shows temporal variability in predicting heavy rainfall. This study implies that the model rainfall forecast is much better at predicting the occurrence of light to moderate rainfall category than at predicting the magnitude and location of the heavy and extreme rainfall amounts. Various statistical skill scores of GFS model in predicting heavy rainfall at district level forecast are prepared and discussed in this paper.

Keywords : GFS, NWP, global model, Heavy rainfall analysis, District level forecast, Indian summer monsoon, rainfall prediction skill.

Abstract ID – 252

Studies on the population dynamics of Epilachna vigintioctopunctata on brinjal ecosystem in relation to the ecological factors and the appearance of it's predator Geocoris sp in the New Alluvial zones of West Bengal.

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Abstract

Epilachnavigintioctopuncta is a serious pest in brinjal ecosystem which devour the leaves of the plants and cause foliage loss and fruit scaring. Population dynamics of the *Epilachna* 4^{th} instar grubs and its predator *Geocoris sp* were taken in the Regional Research station, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal at weekly intervals starting from the month April 2017 till the end of August 2017. Pest and predator population counts were taken from the upper, middle and lower leaves of the three randomly selected brinjal crop plants at weekly intervals. The results showed that the population of *Epilachna vigintioctopunctata* reached its peak during the month of July 2017 while the predator Geocoris population reached its peak during the last week of May 2017 and its population declined during the month of July 2017. The correlation studies of the maximum and minimum temperature with the fourth instar grubs of *Epilachna* showed negative correlation of -0.266 and -0.261 respectively. While correlation studies of rainfall (mm) with fourth instar grub of Epilachna showed positive correlation of 0.522. Also, Epilachna fourth instar grub population showed positive correlation of the value 0.522 when correlated with relative humidity percentage. However, the correlation studies of the *Geocoris sp* predator population showed negative correlation of -0.833 with the *Epilachna* fourth instar grub population.

Keywords : Brinjal, Correlation, *Epilachna*, *Geocoris sp*, Instar, Predator.

Abstract ID – 267

Relationship between wind speed, sea surface temperature and ENSO indices for the Indian Ocean region

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Theme: Observations in Climate Variability and Changes.

Abstract

Several studies reveal the role of Indian Ocean (IO) in shaping the climate on both regional and global scales. There are modes of climate variability, ranging from intraseasonal to interannual and also longer time scales. The El Niño-Southern Oscillation (ENSO) is the most significant interannual mode of tropical coupled ocean atmosphere phenomenon. During an El Niño event there are positive sea surface temperature (SST) anomalies over the IO approximately 3 to 6 months after SST anomalies peak in the tropical Pacific. The influence of the local SST and remote ENSO indices on the wind speed (WS) data is explored for the IO region using spatial correlation plots and significant correlation ranges. WS data is explored for the IO region for the months of July and January representing the SW and NE monsoons respectively. Particular years of the period 1950-2016 are classified as normal or El Niño or La Niña years and separate experiments performed. The spatial correlation plots are generated and p-values calculated for WS data for significant correlation ranges. In the first experiment spatial correlation plots are generated between WS and SST data for the month of January and July separately for all the 67 years (1950-2016) to analyze the local impact. To explore how WS is influenced by remote ENSO indices mentioned above respective spatial correlation plots are generated. In the next three experiments spatial correlation plots are generated between the WS and SST data for the normal, El Niño and La Niña months respectively to analyze the local impact during different ENSO phases. Then the spatial correlation plots are generated for the WS and the three ENSO indices namely, SOI, MEI and NINO3.4 one by one for the normal, El Niño and La Niña months separately for possible teleconnection features. Considering all the 67 years negative correlation is observed between WS and SST over Bay of Bengal (BOB) during July which is significant as per the p-values. It indicates higher (lower) WS at lower (higher) SST values. During the normal years (July) there is significant negative correlation over BOB which fades away from La Niña to El Niño years. During the El Niño years there is significant negative correlation between WS and SST off west coast of India in January and positive correlation off Sri Lanka during July. During the La Niña years there is significant negative correlation over BOB during July and significant positive correlation off Somali coast during January. During the normal January months there is negative correlation between WS and SOI off Sri Lanka and southern part of the west coast of India and positive correlation with MEI and NINO3.4. The correlations are significant and hence indicating teleconnection features of the wind parameters. During the El Niño years WS has significant negative correlation off Sri Lanka in January with SOI and significant positive correlation with MEI and NINO3.4 off Sri Lanka in January and July both. In the La Niña years there are no significant correlation patterns.

Abstract ID – 283

A study of diurnal variation of the electrical and lightning properties associated with the convective clouds over the eastern and north-eastern part of India

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Abstract

A study is carried out to study the electrical and lightning properties with respect to convective clouds over two different climate regions, namely Kohima (25.67^{o}E; 94.07^{o}N) in Nagaland and Rampurhat (24.17^{o}E; 87.78^{o}N) in West Bengal. Atmospheric Electric Field (AEF) is measured from Electric Field Mill (EFM-100) for two years (2017- 2018) during the pre-monsoon (March-May) season. During the same period, different types of lightning strikes (Cloud-to-ground, Intra-cloud), with respect to convective clouds are identified using LD-350 Lightning detector (operates between 50 kHz to 500 kHz).Thermal infrared count (TIR1, 10.3 μm-11.3 μm) of INSAT-3D Level-1B Standard (STD) data is utilized to calculate the minimum brightness temperature (Tb) of the convective clouds. The convective cloud systemsare detected for contiguous pixels below 235K.

The diurnal variation of percentage of occurrence of AEF events (with a threshold of 0.5 kV/m,) cloud-to-ground strike rate and occurrence of convective cloud systems are analyzed. The result suggests that the maximum occurrence AEF events over Kohima (24%) and Rampurhat (28%) are during 12-15 hrs and 15-18 hrs respectively. Similar diurnal variation is also observed for the maximum mean value of AEF. The maximum mean value of AEF over Kohima and Rampurhat is found to be 4.8 kV/mand 10.9 kV/mrespectively. It is also observed that higher cloud-to-ground strike rate occurs during the period of higher AEF of the diurnal cycle. The maximum value of cloud to ground lightning over Kohima and Rampurhat is found to 38%and 43% respectively. These results are in agreement with diurnal variation of minimum Tb of the convective systems. Overall, the convective systems are more intense over the Rampurhat compared to Kohima.

Abstract ID – 343

Present status/challanges of regional weather prediction model to forecast fog during the WIFEX filed campaigns, India

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Abstract

The occurrence of dense fog and haze during wintertime in National Capital Region (NCR) Delhi (which located in Indo Gangetic Plains (IGP)) deteriorates visibility which causes severe disruption to the aviation, ground transport, and train services. The stable atmosphere, persistent low-level light/calm winds, the lower surface temperature in the region persisting for the most part of the night/day supported with abundant moisture favor dense sustained fog in this area. The dense network of the river systems, canals, reservoirs and other local water bodies also contributes in raising the relative humidity and another important land-surface forcings making IGP an ideal candidate for large-scale persistent fog formation. High emissions from various industrial and commercial sources also contribute in the moisture supply and high concentrations of pollution in this highly populated region. Overall, these multiple processes and their dynamics lead to persistence hazy/foggy conditions for extended winter periods.Conventional empirical models/approaches are not very accurate and numerical weather prediction (NWP) models are not efficiently incorporated in predicating fog and visibility conditions near the surface. Several factors could be responsible for this difficulty. First, aerosol particles that serve as cloud condensation nuclei are not adequately prescribed in model microphysical schemes. Most available microphysical schemes use a specified CCN concentration rather than using prognostic aerosol concentrations. Turbulent mixing within the boundary layer still needs to be better parameterized. When turbulent mixing intensity is too low, dew deposition at the surface reduces saturation point in the atmosphere and inhibits fog formation. When the turbulence intensity is high, however, it can stimulate condensation in a supersaturated surface layer of sufficient depth, leading to fog formation. Thus, better representations of turbulence processes, surface heat and moisture fluxes, and localized radiative cooling rates during clear nights are needed to improve mesoscale fog models. Finally, PBL processes depend critically on land use parameterizations, and thus accurate inclusion of land use is vital to capture fine-scale fog dynamics. Moreover, the models need to be tested and evaluated for several fog episodes to improve the forecasting skill.

Therefore the Ministry of Earth Sciences (MoES), Government of India has taken up a multi-institutional initiative during winter seasons (December-February) of 2015-2018 to conduct an intensive ground-based measurement campaign in Delhi to understand different physical and chemical features of fog and factors responsible for its genesis, intensity and duration. The campaign is being conducted at the Indira Gandhi International Airport (IGIA), with full cooperation and support of Airport Authority of India and GMR, IGIA. India Meteorological Department, National Center for Medium-Range Weather Forecast under MoES and Indian Institute of Science Education and Research (IISER) Mohali are participating in the observational campaign being led by Indian Institute of Tropical Meteorology (IITM), Pune. The goal of the Winter Fog Experiment (WIFEX) is to develop methods for forecasting winter fog on various temporal and spatial scales and help reduce its adverse impact on aviation, transportation and economy, and loss of human life due to accidents. We ran forecast using WRF/WRF_Chem with recently setup IITM-High Resolution GFS (IITM-HIRES-GFS, 12km) Initial & Boundary conditions (IC/BC) during WIFEX2016-2017. Model derived LWC variations were intercompared with radiometer observations and depth and duration of fog layer at IGI airport has been evaluated. Out of 13 very dense fog events, WRF has forecasted 09 fog events We also carried out a case studies with WRF_Chem to investigate importance of aerosols for visibility forecast during fog event. We found that inclusion of chemistry has improved visibility simulations significantly but uncertainty in forecasting fog onset, dissipation and meteorological parameters. Primary results will be present during the work shop.

Abstract ID – 347

Impact of orographic subduction south of Himalayas over the Indian region in NCAR CAM5.1

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Theme: Weather/Climate Modelling at Regional & Global Scales.

Abstract

National Center for Atmospheric Research (NCAR) Community Atmosphere Model (CAM)5.1 is being used for the present study, where the orographic features south to the Himalayas have been subdued to sea-level. For the study two sets of model simulations are taken into consideration, i.e. CTRL, which has default model configurations and EXPT where the aforesaid modifications have been performed. Finite volume dynamical core is utilized for the model simulations. The removal of orographic features south of Himalayas results in an enhancement of in-situ surface air temperature mostly due to lapse rate effect with corresponding decline in the sea level surface pressure. Though, Somali Jet weakens, increase in the wind speed is observed over the Indian Summer Monsoon Region (ISMR). Due to modified monsoon dynamics, redistribution of vertical velocity, specific humidity, and CAPE is observed. The role of direct thermodynamical effect is more pronounced in comparison to remote dynamical impact, mostly because the region of subduction and region of impact are same. The precipitation over the Deccan region distributes almost uniformly, signifying the role of surface orography. The role of Western Ghats as the mountain barrier to the moisture laden winds infusing from Arabian Sea and source of convective precipitation due to orographic upliftment is strengthened.

Abstract ID – 397

Analysis of Tropical Cyclone over North Indian Ocean during 1987-2016

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Abstract

The tropical cyclones are one of the major natural calamities that have a devastating effect on the life and livelihood over coastal region. In this study, tropical cyclones over the North Indian Ocean (NIO) for a period of thirty years (1987-2016) have been analyzed. The cyclonic storms are categorized into Extreme Storms (very severe cyclonic storm and above), Moderate Storms (cyclones and severe cyclonic storm) and Weak Storms (deep depression and depression). A thorough analysis is carried out on these cases with respect to the track, intensity, duration and number of storms formed. To understand the different behavior in the tracks and intensity of cyclones, two cyclonic cases originating in the Bay of Bengal (BOB) in the ambiance of similar synoptic features are considered. Out of the twotypical cyclonic storms, one cyclone sustainsits intensity after landfall over Indian coast and moves into Arabian Sea (AS), while the other cyclone diminishesitsintensity after landfall. The sea surface temperature (SST), mean sea level pressure (MSLP), zonal and meridional wind are analyzed. Further, these characteristics are also studied in detail with simulation using Weather Research Forecast (WRF) model.

Abstract ID – 399

Role of land surface processes in simulation of Indian Summer monsoon with Regional Climate Model.

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Abstract

The land surface processes plays an important role in simulation of seasonal climate features. Appropriate representation of land surface schemes in climate models are essential for better simulation. In this study, role of two land surface scheme on the simulation of Indian summer monsoon features using Regional Climatic Model (RegCM4.5) are investigated. For this purpose, nested simulations are performed with a resolution of 60 km covering CORDEX region of South Asia and nested domain of 20 km over Indian subcontinent. Two land surface schemes of BATS and CLM are coupled with RegCM 4.7. Both experiments, model was initialized on 1st May 2001 and integrated upto 1st Oct 2003 with initial and lateral boundary condition taken from ERA interim reanalysis. Weekly SST data from NOAA has been used throughout simulation period. The simulated rainfall and temperature are validated with IMD and CRU data sets. The results show that in both domain BATS schemes simulate temperature and rainfall over Indian subcontinent in close agreement with CRU and IMD observation as compared with CLM scheme.

Abstract ID – 421

Assessment of Signature of Climate Change over Bengaluru

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Abstract

The capital city of Karnataka, Bengaluru one of the major Metropolitan city in south India has undergone a rapid urban growth process over the years and resulting major regional climate change. In this study, the urban evolution process over Bengaluru region associated with the analysis of multi-source meteorological data along with the land use and land cover change studies using satellite remote sensing and GIS are being carried out. It is evidenced from the study that the loss of green areas (forest, vegetation and agriculture) in the process of urbanization growth over the years may result the regional climate changes over the city. The climate changes caused by urbanization is well observed in the variable temperature and rainfall trend. The results also show increasing trend in the frequency of extreme temperature and rainfall. This information along with the land use can be useful for the population dynamics and urban planners can consider the same for the adaptation.

Abstract ID – 428

Determining the Temperature extremes from 1975 to 2005 over Jaipur, Rajasthan

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Abstract

The aim of this study is to determine the temperature extremes for Jaipur, Rajasthan. 24-hr average maximum and minimum temperature data of Jaipur for 30 years (1975 – 2005) was collected from Indian Mereological Department, Delhi. Maximum and minimum temperature data were analyzed to determine the 90thand 10thpercentile values. Values less than the 10thand greater than the 90thpercentile were extracted and counted for each day per year and repeated for each year over the three-decade period.Results shows the extreme temperature trend as the percentage occurrence of warm days indicates the maximum temperature is above 40□C i.e. 90thpercentile valueis increasing over the years at a steady rate while the percentage occurrence of cold days in which the maximum temperature is below 24□C i.e. 10thpercentile value is decreasing during the three decades. The increase in the warm days may be attributed to increase in greenhouse gases, radiations due to anthropogenic activities.This study will also investigate the correlation between temperature and maximum consecutive days (1-day/5 days) precipitation; Percentage of days at 90thpercentile/10thpercentile and other methods to find out clarity in significant increase in warm days over the year and a decrease in the cold days and to forecast the weather based on temperature in recent years.

Abstract ID – 432

Significance of Tropical Cyclone Heat Potential in Tropical Cyclogenesis in the North Indian Ocean

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Abstract

Tropical cyclones (TC) originating over the tropical oceans areone of the most destructive and deadliest natural disasters. Cyclogenesis depends on variousocean and atmospheric conditions. However, both statistical and numerical prediction models used in cyclone related studies primarily give more weightage to the atmospheric parameters with sea surface temperature (SST) being the only oceanic parameter used. Past studies found that the oceansubsurface has strong role in the formation and intensity changes of cyclones. In the current work, we have analyzed pre-storm (7 days prior to cyclogenesis) oceanic subsurface conditionslikeTropical Cyclone Heat Potential (TCHP), SST, Net Heat Flux (NHF) and Latent Heat Flux (LHF)for 55 cyclones from 2001-2016 intheNorthern Indian Ocean (NIO) region. From the analysis, no appreciable change is observed in SST within these 7 days prior to cyclogenesis and the value is nearly same as on the day of genesis. Whereas, TCHP values reduce by almost 45KJ/cm^2, from the 7thday prior to genesis, and the day of genesis.The analysis for NHF and LHF revealeddecreaseand increase, respectively, in their magnitudes as one approaches the day of cyclogenesis. LHF increases by a maximum of 140 Wm^{-2} from 7-days prior to cyclogenesisto the day of cyclogenesisfor most of the TCs in the NIO and corresponding NHF is decreases. This initial observations lead us to conclude that, the any changes in the value of LHF and NHF is reflected in the TCHP, which is responsible for providing favourable condition for the TC genesis.

Key words: TCHP, SST, NHF and LHF and TC**.**

Abstract ID – 443

Analysing the variability in rainfall contributed by cyclonic disturbances and its inputtoclimatological rain totals over India

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Abstract

Every year cyclonic disturbances (CDs) cause huge destructions along the coastal places of world basins. Apart from strong wind, torrential rain associated with CDs causes flood and landslides over the places. Present study investigates the contribution of rainfall by CDs to India during peak North Indian Ocean cyclone seasons under the influence of warming climate by using high quality daily rainfall data.Eastern and western Indian states suffer landfalling CDs formed over Bay of Bengal and Arabian Sea respectively. Among eastern coastal states, the accumulated rainfall is higher over Andhra Pradesh (AP), Tamil Nadu (TN), Odisha and southern West Bengal during pre-monsoon season. Among western coastal states, Karnataka and Kerala collected maximum accumulated rainfall from CDs. During post-monsoon season, coastal AP, TN, Odisha and Karnataka, and coastal Kerala received high-accumulated rainfall. In terms of percent contribution, while Gujrat received ~130%, AP and TN received up to 60% of rainfall contribution by CDs during pre-monsoon. During post-monsoon,Gujrat, Odisha, and AP received maximum percentage (i.e. up to 50%) of CD rainfall. Over most of the states, the CD rainfall is observed to have a decreasing trend during both TC seasons. CDs contribute considerable amount of rainfall to central and northern India during post-monsoon season, which is helpful for agricultural purpose.

Abstract ID – 476

Changing pattern of Heat-stress in India at District level

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Abstract

Heat stress is one of the most direct impacts of climate change on human health. Currently, mortality burden attributed to heat stress is the third largest in India amongst all the natural causes. The stressdue to the hot environmentis a combined effect of temperature, humidity, wind and solar radiation. IPCC has also projected the increase inthe frequencies of extremely hot days in the future under a warming climate. The studies in India so far mostly focused on the heat waves and no comprehensive study has been carried out yet to understand heat stress variability in the geographically diversified six climate zones of India and its relation to economic loss. Here we are trying to quantify heat stress by a world-wide popular heat index, *Wet Bulb Globe Temperature* (WBGT) using meteorological data from ERA-Interim reanalysis at 0.125° resolution for the period 1981-2010. District level statistics have been extracted in a GIS platform for the first time. Heat stress conditions are classified following the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values(TLV) of WBGT(in °C) such as, 'comfortable' (<18°C), 'warm' (18°C - 24°C),'hot'(24°C - 28°C), 'very hot'(28°C - 30°C) and 'sweltering'(≥30°C) conditions to understand the work loss as per the ACGIH's work/rest regimen guideline. Most parts of India are found to exceed *sweltering* condition in peak summer months. 76% and 71% of districts are exposed to *very hot* conditions in the month of May and June respectively. Sweltering days have been increasing in 25% of districts by >3 to 6 days per decade during March to June. Our results identify the districts, vulnerable to heat stress in India. We have also found that present thresholds are not matching with public perceptions and so we need to redefine the thresholds for different comfort class for Indian scenario for proper utilization of *work and rest regimen*.We recommend for carrying out comprehensive study including human physiological response so that, the thresholds for the vulnerable conditions can be fine-tuned for the Indian condition which can be used for a better heat action plan and to reduce economic loss in India.

Abstract ID – 517

The unprecedented changes in the South Asian Monsoon precipitation in the future warming scenario.

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Abstract

Monsoon exhibits the most significant seasonal variation and is responsible for the giant hydrological cycle that showers the whole South Asian region. They are the seasonal reversal of the wind circulation that arises as a result of the thermal contrast between the land and oceans. It is the major source of the fresh water for the entire region, which supports the agriculture, hydropower, industrial development, etc. It is still an immense challenge for the scientific community to foretell about the future monsoon accurately. It is because of the physiography and the complex behavior which show limitations for both global as well as the regional model to simulate the mean monsoon climate. Using the suite of CMIP5 MMEs (Multi-Model Ensembles) and coupled regional model simulations, the variability associated with the precipitation has been studied in the three different time slices. This will give an insight that how the South Asian Monsoon precipitation will unfold in the future under warming scenario. We have illustrated the number of wet days (annual as well as seasonal) in the reanalysis simulation and compared with observations. Model is able to produce the observed numbers quite realistically. The wet days future analysis shows that the changes in summer as well as during the pre and post monsoon period over South Asia in all the time slices. Apart from this we have also studied the future changes in the annual mean precipitation over the study region.

Keywords -Wet days, CMIP5, MMEs.

Abstract ID – 518

High-resolution numerical weather prediction model approach to analyse a land depression during 2017 Indian Summer Monsoon season

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Theme:Weather/Climate Modelling at Regional & Global Scales.

Abstract

In association with the active phase of 2017 Indian Summer Monsoon season, a low-pressure area formed over Indo Gangetic belt in the second half of July month. It intensified gradually and concentrated into a depression over northwest Jharkhand in the morning of 23rd July. Till early morning of 27th July, it moved north-westwards and maintained the intensity of depression. It weakened into a well-marked low presser zone in the morning of 27th July. This study is focused on the numerical simulation of the above-discussed land depression event using the advanced core of Weather Research and Forecasting (WRF) model. Dynamics of the land depression has analysed to enhance our understanding of the system. Spatial distribution of the depression induced rainfall, surface wind and central sea level pressure has validated with observations. Model results are found good in this direction and have fulfilled the motivation of the study up to a great extent.

Key Words: Land depression, WRF, Rainfall.

Abstract ID – 519

Seasonal Prediction of Extreme Rainfall episodes over India

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Abstract

Vulnerability disaster due to extreme rainfall during south west monsoon over India has increased manifolds in the recent time. Like monsoon rainfall prediction it is also important and challenging task for the seasonal prediction of the extreme rainfall episodes over the continental India because this prediction can be used in the pro-active disaster management during the long monsoon season in India. In this study a variable resolution general circulation model (VARGCM) is configured and calibrated for the seasonal prediction of the extreme rainfall during monsoon for the period 1998-2013. The skill of model prediction in simulating monsoon extreme periods is evaluated by validating the same with the high resolution gridded rainfall data available from the India Meteorological Department (IMD). It is observed that the VRGCM has potential skill in the seasonal prediction of extreme rainfall episodes over India.

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