Conference on Frontiers in Space and Atmospheric Sciences
(COFSAS – 2023)

March 15 - 16, 2023 (Virtual)

ABSTRACTS

IASES

KL (DEEMED TO BE UNIVERSITY)

BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY
LUCKNOW
प्रज्ञा शील करुणा
ESTABLISHED 1990

InRaSS

Plenary Talks

Variability of our nearest star the Sun

Dipankar Banerjee
Aryabhatta Research Institute of Observational Sciences, Nainital
Email: directoraries@aries.res.in, dipu@aries.res.in

I will give an introduction to Sun and its variability. We observed variability of different time scales on the sun and how it impacts our life will be the subject of discussion.

Recent advances in radar probing of the atmosphere and ionosphere

A K Patra
National Atmospheric Research Laboratory, Gadanki, Tirupati
Email: akpatra@narl.gov.in

Radars have proven to be very powerful tool for the study of earth's lower and upper atmosphere. There are two broad ways in which radar can be used for atmospheric/ionospheric probing: (1) using the refractive index fluctuations in the neutral atmosphere and ionosphere and (2) using the scattering properties of free electrons in the ionosphere. This talk will address how refractive index fluctuations in the neutral atmosphere and ionosphere can be used to study various aspects of the neutral atmosphere and ionosphere. This talk will cover (1) the basic techniques used in radar probing of the atmosphere and ionosphere, (2) atmospheric and ionospheric parameters measured and studies carried out, and (3) the challenging areas in the radar probing of the atmosphere and ionosphere.

Invited Talks

Probing Low Latitude Ionosphere with GMRT and NavIC

Abhirup Datta
Indian Institute of Technology Indore
Email: abhirup.datta@iiti.ac.in

In this talk, I will present some recent update on the probing the ionosphere using India's own NavIC constellation and the radio interferometer GMRT.

Longitudinal and hemispheric variabilities of the low latitude ionospheric dynamics and space weather effects

Venkatesh Kavutarapu
Physical Research Laboratory, Ahmedabad, India
Email: venkatkau@gmail.com

The equatorial electrojet (EEJ) is a narrow band of current flowing eastward at the ionospheric E-region altitudes along the dayside dip equator. Mutually perpendicular electric and magnetic fields over the equator results in the formation of the equatorial ionization anomaly (EIA), which in turn generates large electron density gradients with space and time. The EEJ and EIA exhibit strong variability with respect to longitudes, owing to the differences in the magnetic field geometry, large-scale wave features etc. In addition, the response of low latitude ionosphere during active space weather conditions shows significant longitudinal differences. Comprehensive understanding on the longitudinal variabilities of EEJ and EIA is essential for accurate ionospheric modelling over the equatorial and low latitudes. The role of EEJ on the day-to-day characteristics of EIA needs to be quantified for achieving improved accuracy in the estimation of ionospheric Total Electron Content (TEC) and corresponding range delays required for the satellite based communication and navigation applications. This talk presents an overview on the longitudinal and hemispheric variabilities of low latitude ionospheric dynamics during different solar and geomagnetic conditions. The longitudinal differences in the EEJ, EIA and the role of EEJ on the characteristic features of the EIA will be presented using the observations in the Indian and Brazil sectors. Ionospheric response in these two longitude sectors to geomagnetic storms in terms of the super plasma fountain, enhanced occurrence of density irregularities and modifications in the ionospheric height structure will also be discussed.

Study of Space weather and its effects on low latitude ionosphere

Abhay K Singh
Banaras Hindu University
Email: singhak@bhu.ac.in

Space Weather is the variation in Solar energy emissions (Prominence, Solar flare, CME etc.), solar wind, magnetosphere, ionosphere and thermosphere, which can influence the performance and reliability of a variety of space borne and ground-based technological systems. Space Weather is recognised as the cause of significant errors experienced by Global Satellite Navigation Systems (GNSS), Satellite Based Augmentation Systems (SBAS) and their users. In the present study, I have presented a brief introduction about Space Weather, its various events and effects of space weather on near earth environment. The response of low latitude ionosphere during active space weather events as intense Solar Flares and Geomagnetic Storms are presented.

Magnetic Field measurements in Space

Vipin K. Yadav
SPL / VSSC / ISRO
Email: vipin_ky@vssc.gov.in

Magnetic field measurements are regularly carried out around planetary bodies and in space to sample the local plasma and magnetic environment around a planetary body or at a specific location. This includes the estimation of nature and magnitude of the local interplanetary magnetic field (IMF) of the Sun also. The fluxgate magnetometers (FGMs) are an integral part of most of the spacecrafts as they are highly sensitive instruments which measure the feeble magnetic fields in outer space and the IMF. The IMF measurements can be used to study the properties of plasma waves coming out from the near Sun plasma environment. The plasma waves getting generated near the Sun carry the history of their generation mechanism along with them which provide information about the physical phenomena-taking place there. The first Lagrangian (L1) point can be an ideal location to carry out solar plasma wave studies, away from the Sun as well as from the Earth's magnetosphere. Aditya-L1 solar mission is the first Indian Solar Mission for L1 point to continuously observe the Sun and measure the solar wind energetic charge particle flux as well as the variations in IMF also has an FGM onboard. The Aditya-L1 magnetometer (MAG) is a dual sensor 3-axis magnetic sensor mounted on a 6 m boom away from the spacecraft so as to eliminate the magnetic contamination from spacecraft itself. The scientific objectives of this magnetic field experiment are to measure the magnitude and nature of local IMF at L1 point and to study the effect of extreme solar events such as coronal mass ejection (CME), solar magnetic storm, etc. on space weather near the Earth and solar plasma waves. These details shall be presented in this invited talk.

Opposite trends in heat waves and cold waves over India

Vijay P. Kanawade
University of Hyderabad
vijaykanawade@uohyd.ac.in

Heat waves and cold waves are anomalous weather events resulting from excessive heat and cold conditions, respectively, in the near-surface atmosphere. They may last from a few days to a few weeks, depending on the geography and climatology of the region. In this study, we have used the India Meteorological Department (IMD) daily maximum and minimum temperature data over the period from 1970 to 2019 to investigate the decadal variability and trends in the frequency of heat waves and cold waves over the four broad climatic zones of India. The frequency of the occurrence of heat waves increased by about 0.6 events per decade, while cold waves decreased by about 0.4 events per decade. While, the average duration of cold waves decreased over montane, arid and semi-arid, and tropical wet and dry climate zones, cold wave events frequency showed an increasing trend over the subtropical humid climatic zone of India. When compared to IMD observations, the CMIP6 models generally failed to capture the observed spatial features in the heat wave frequency trend and cold wave frequency trend. This suggests that CMIP6 model output data should be used cautiously to predict future changes in the heat wave and cold wave events frequency.

Space: Situational Awareness and Weather

Tarun Kumar Pant
Space Physics Laboratory, Vikram Sarabhai Space Centre, Thiruvananthapuram-22, Kerala
Email: tarun_kumar@vssc.gov.in

Spectacular progress in Space science and technology during recent years has allowed us a better understanding of the role of the near earth space in supporting our existence. This progress has also resulted in creating a sense of situational awareness when it comes to our assets in space. This development has also highlighted some interesting aspects of space, plasma, particles and magnetic field. My talk will present an update on our current understanding of the earth and space around it. The presence of most of our present day technological systems in near earth space makes it even more important for us to try and comprehend the complexities of this region. The talk will also cover and highlight the important processes that are in action in near and far earth space.

How Aditya-L1 mission can help in Space weather investigations

Dibyendu Chakrabarty
Physical Research Laboratory, Ahmedabad, 380009, Gujarat, India
Email : dipu@prl.res.in

The Aditya-L1 mission is India's first dedicated observatory class solar mission. The satellite will be placed in a Halo orbit around the first Lagrangian point of the Sun-Earth system for the unhindered view of the Sun round-the-clock. There are seven experiments on-board this mission. Four of these experiments are for remote sensing of the Sun and three experiments are planned for the in-situ sampling of the solar wind plasma and magnetic field. While the remote sensing experiments are designed to understand the Coronal Mass Ejections, solar flares and quiet sun processes, the in-situ experiments are designed to understand the solar wind plasma processes. These in-situ experiments are Aditya Solar Wind Particle Experiment (ASPEX), Plasma Analyzer Package for Aditya (PAPA) and Magnetometer (MAG). These experiments are designed to measure the solar wind (ions and electrons), supra-thermal and solar energetic particles as well as magnetic field in multiple directions. The measurements from these experiments can throw light on a number of complex processes (like origin, acceleration, seed population, anisotropy etc.) that are not comprehensively understood till date. Understanding of such processes are of paramount importance to connect the solar processes to the space weather conditions prevalent around our planet. The talk will highlight a few such exciting and unresolved scientific issues that can be addressed based on the in-situ measurements on-board Aditya-L1.

Challenges in Predicting Extreme Weather Events?

Abhilash S.
Advanced Center for Atmopsheric Radar Research, CUSAT
Email: abhimets@gmail.com

Extreme events such as heavy rainfall, droughts, floods, heat-waves, cold-waves, devastating thunder clouds, cloud burst and intense cyclonic storms are occurring frequently over Indian region during recent decades. The decision and policy makers including different stakeholders often demand for reliable prediction of the same across all scales starting from days to seasons. Immediate attention is needed in understanding and predicting these high impact weather events with sufficient lead time. It is therefore essential to review the capability and limitations of current observational techniques like satellite and radar in understanding the underlying physical processes responsible for the extremes as well as monitoring them in near-real time. Understanding and predicting extremes are challenging mainly due to the relatively small number of observed events and inability of the models in capturing the observed amplitude of the events, especially at longer leads. Large uncertainty in different models and inability of reliable metrics in verifying different measures of the extremes on all time scales is also challenging. In this context, identifying relevant physical processes in controlling and modulating these extremes are difficult and essential to be incorporated into the model formulation to capture the large scale favourable conditions at sufficiently longer lead time for effectively managing the hazards. The prediction skill for extreme precipitation events will be improved through an increased mechanistic understanding of historical events and a quantitative evaluation of model performance for simulating these events and their characteristic patterns. Earlier works using dynamical models (Waliser et al. 2003; Liess et al. 2005) has shown the potential prediction skill in the subseasonal range could be extended more than 15 days in advance using dynamical models. In the recent years, several studies validate the skill of subseasonal forecast. Liu et al. (2014) indicated that the NCEP CFSv2 showed reasonable skill of sub-seasonal prediction of summer monsoon rainfall over several tropical Asian ocean domains. Subseasonal predictability has also been studied in the context of prediction of boreal summer subseasonal variability mode (BSISO). Lee et al. (2015) examined the predictability and prediction skill of BSISO over the Asian monsoon region in the IntraSeasonal Variability Hindcast Experiment (ISVHE). They found the multi-model mean BSISO predictability and prediction skill with strong initial BSISO amplitude are about 45 and 22 days, respectively similar to Madden Julian Oscillation prediction skill. Systematic seasonal dry bias in rainfall is chronic in most of the coupled models and CFS is not an exception (Annamalai et al. 2007, Chaudhari et al., 2012, Pokhrel etal., 2013, Saha etal., 2014, Sharmila etal., 2015). On the other hand, the northward propagation of convection is realistically simulated by interactive atmosphere and Ocean (Sharmila etal., 2014) without affecting its chronic dry bias over Indian region. Moreover, it is found that the bias-correction in the forecasted SST improved the extended range prediction skill by realistic representation of northward propagation of Monsoon Intra Seasonal Oscillation (Abhilash etal., 2014).

Tracking tsunami propagation and Island`s collapse after the Hunga Tonga Hunga Ha’apai 2022 volcanic eruption from multi-space observations

Mahesh N. Shrivastava
Universidad Católica Del Norte, Antofagasta, Chile
Email: mahesh.shrivastava@ucn.cl

The quantity and accuracy of satellite-geodetic measurements have increased over time, revolutionizing the monitoring of tectonic processes. Global Navigation Satellite System (GNSS) and satellite radar signals provide observations beyond ground deformation, including how earthquake and tsunami processes affect variations in the ionosphere. Here, we have studied the Hunga Tonga Hunga Ha’apai (HTHH) volcanic eruption 2022 and its associated tsunami propagation with the analysis GNSS derived Total Electron Content (TEC), Synthetic Aperture Radar (SAR) Sentinel-1 data and tide gauge observations. We utilized GNSS sites data within a ~5000 km radius from the volcanic

eruption for estimating the ionospheric perturbation as Vertical TEC. We detected acoustic gravity and internal gravity and lamb waves signatures in the TEC perturbation. The internal gravity waves concentrated in the southwest of Tonga, which directly correlates with the observed tsunami propagation direction with the tide gauge. However, the acoustic gravity wave signature in the TEC is dominant in the north direction suggesting a surface deformation, which can be verified with Sentinel-1A SAR amplitude data. It shows that within 5 hours of the volcanic eruption the central part of the HTHH island landscape disappeared with the biggest explosion. The unprecedented detail resolved by integrating satellite data yields previously unknown details of the deformation of the 2022 HTHH volcano eruption.

Radar sensing of atmospheric phenomena at a tropical location

Animesh Maitra
Institute of Radio Physics and Electronics, University of Calcutta, Kolkata 700009
Email: animesh.maitra@gmail.com

It was Marconi's transatlantic wireless telegraphy experiment in 1901, followed by Appleton's and Barnette's discovery of the ionosphere in 1925, that established the basis for radar sensing of the atmosphere. Since the invention of the radar system by Watson-Watt in 1935, the study of the atmosphere using different techniques revolutionized the fields of meteorology, radio remote sensing, and space exploration. This presentation covers the radar techniques used to study different atmospheric processes associated with convective and precipitation phenomena in Kolkata. At the Institute of Radio Physics and Electronics, University of Calcutta, radar observations are primarily made for the present study using a Micro Rain Radar, and supported by other instruments such as a microwave radiometer, disdrometer, laser precipitation monitor, optical rain gauge, electric field mill, and automatic weather station. The presentation highlights the observations on the types of rain, namely convective and stratiform, precipitation microstructure in terms of raindrop size distribution, and vertical wind velocity. The height profiles of rain DSD, which are otherwise inaccessible in remote areas, were characterized using space-borne radar measurements from Global Precipitation Mission (GPM) satellites. The presentation aims to show the effectiveness of radar sensing of the atmosphere in studying the convective features and their characterizations in the present location near the land-sea boundary.

Role of Radars in understanding MLT structure and dynamics

G. Kishore Kumar
Assistant Professor, Centre for Earth, Ocean and Atmospheric Sciences (CEOAS)
University of Hyderabad, Prof. CR Rao Road, Gachibowli, Hyderabad, Telangana, India-500046
Email: kishorekumargrandhi@gmail.com

The mesosphere and lower thermosphere (MLT) is a transition region between Earth's atmosphere and outer space. Wave and wave-dissipative processes are essential drivers for MLT energetics and dynamics. Dynamical forcing plays a vital role in MLT, even altering the radiative-driven mesospheric circulation. Being a transition region, MLT experiences forcing from both below and top. The lower atmospheric forcing through atmospheric waves couples the lower atmosphere with MLT. While outer space couples with MLT through transient forcing like space weather events. In recent decades, advancements in the radar remote sensing technique enabled us to study the MLT region on different time scales, from turbulence to long-period oscillations. In my talk, I will discuss how the radars enriched our knowledge about the MLT region and touch on the unresolved mysteries of MLT.

Microphysical features of clouds and precipitation for the severe rainfall events for coastal cities of India

Kaustav Chakravarty
Indian Institute of Tropical Meteorology, Pune
Email: kaustav@tropmet.res.in

In the recent decades, many urban areas all around the world, including the coastal megacities of Mumbai and Chennai, has witnessed the increasing threat of heavy rainfall and flooding. With the increase of population, as the cities continues to expand, the impact of urbanization creates unique problems related to land use, transportation, agriculture, housing, pollution etc. which in turn have measurable impact on weather and climate processes over these regions. The city of Mumbai and Chennai, situated on the western and eastern coast of peninsular India experiences heavy rainfall spells during the pre-monsoon, monsoon periods and post-monsoon periodfrom the cloud systems originating from the eastern and western part of the region respectively. The present study tried to highlight the morphology of the vertical structure of clouds and microphysical features of precipitation during the inter-seasonal and intra-seasonal phases of monsoon over Mumbai for a continuous period of 4 years (2018-2021). The study will also portray the cause and the impact of the severe rainfall events of Mumbai which creates severe flooding at the city quite frequent during the monsoon times. Further, the study also tried to analyse the microphysical characteristics of precipitation over Chennai during the monsoon and post-monsoon period. The analysis over Mumbai has been done by using a Joss-Waldvogel Disdrometer data set up at IMD campus in Santacruz along with the radar reflectivity data from S-band Doppler Weather Radar placed at Colaba in southern Mumbai. The preliminary results show that the Mumbai receives rainfall primarily from

easterly winds during the pre-monsoon time which then shifts to the south-westerly direction during the monsoon period. Looking into the diurnal variation of rainfall, three distinct rainfall peaks was noted for the pre-monsoon period. The corresponding vertical profile of radar reflectivity shows that these rainfall peaks are complimented with clouds of reflectivity more than 40 dBz and the presence of severe lightning flashes. But in case of monsoon month, no such distinct diurnal variations are visible over these regions. The dominance of urban convective environment in the pre-monsoon period and the impact of moisture supply from the marine sources over the city during the monsoon months are considered to be one of the contributing factors for the contrasting diurnal pattern of rainfall for these inter-seasonal phases of monsoon. Correspondingly, the giant cloud condensation nuclei (GCCN) from the bursting of sea salt aerosol in the Arabian Sea also plays a significant role in the enhancement of warm rain processes in the coastal urban region during the monsoon months. In addition to that while looking into the microphysical characteristic of rainfall, it has been found that the raindrops of diameter 2.5 mm and above dominate the pre-monsoon months with respect to the monsoon period. The convective urban environment characterized by higher localized CAPE aids vigorous thermals leading to smaller drops shifting aloft and thereby allowing bigger drops to precipitate locally during the pre-monsoon season. These findings and the observations that helped to develop the analysis, are expected to aid heavy rainfall analysis over the urban coastal regions in the future, particularly for the Indian monsoon regimes.

Lightning: Some Basic facts and protection for common people

Anirban Guha
Tripura University
Email: anirbanguha@tripurauniv.ac.in

Lightning kills thousands of people in India, and the trend is increasing in an ever-changing climate, despite efforts at all levels. One of the primary reasons is the lack of general awareness along ordinary people and basic education about lightning and its protection. The talk mainly focuses on the fundamental facts about lighting and ways to get protection in a non-technical and easy manner. It is believed that a coordinated effort is necessary to spread more awareness and mitigate the problem.

Modeling of atmospheric trace gases and aerosols over the South Asian region

Narendra Ojha
Physical Research Laboratory, Ahmedabad, India
Email: ojha@prl.res.in

Atmospheric trace gases (e.g., ozone, sulfur dioxide, hydrocarbons) and aerosols (particulate matter) deteriorate the air quality and significantly contribute to the climate change. However, the observations are often limited to a few chemical species and few stations in the rapidly developing South Asian region. In this regard, we performed atmospheric modeling over local to regional scales to study the impacts of emissions, photo-chemistry, and transport on the distribution of trace gases and aerosols. The simulations over local scales revealed strong non-linear response of NOx reduction on urban ozone build-up during COVID-19 lockdown. State-of-art observations were further combined to estimate hydroxyl (OH) radical in the tropical Indian conditions. Over regional scales, our results reveal large enhancement in PM2.5 over the Indo-Gangetic Plain (IGP) due to crop-residue burning in post-monsoon. Whereas the stagnant meteorological conditions during winter trap the anthropogenic emissions causing the widespread air pollution across IGP. In a sharp contrast, the hotspots of volatile organic compounds over western coast and northeast are linked to natural biogenic processes. Finally, the potential of machine learning in complementing the process-based modeling over contrasting Indian environments will be discussed.

Astrocloud instability To Structure Formation

Pralay Kumar Karmakar
Tezpur University
Email: pkk170722@gmail.com

This talk structurally plans to illuminate the atypical modal stability behaviours of the Dust-Acoustic Wave (DAW) and the Dust-Coulomb Wave (DCW) in self-gravitating magnetized viscoelastic spherical dusty astroclouds on the relevant astrophysical fluid scales of space and time. It evolves orderly in the extreme dust-fugacity regimes of low and high strengths. The spatiotemporal scales are so considered as to be quite suitable to see the physical mechanisms for triggering the initiation processes leading to bounded structure formation via the non-local gravito-electrostatic coupling mechanics. The basic model setup consists of constitutive inertial charge-fluctuating dust grains alongside non-thermal electrons and non-thermal ions in a generalized hydrodynamic framework. A normal spherical wave analysis over the perturbed cloud structuring equations yields a unique generalized quadratic dispersion relation with an atypical set of plasma-dependent multi-parametric dispersion coefficients. A constructive numerical platform shows that the triggered fluctuations are free from the viscoelasticity effects in the weakly coupled limit (WCL) against that in the strongly coupled limit (SCL). It is further found that the electron concentration, dust charge, and magnetic field play as stabilizing and accelerating agencies to the linear fluctuations. The ion concentration and non-thermality parameter show destabilizing and decelerating effects. The cloud dimension illustrates a unique stabilizing feature in the ultra-low frequency domain. Both the DAW and DCW are dispersive in the short-wavelength (acoustic) regime and non-dispersive in the long-wavelength (gravitational) regime. The distinctive WCL-SCL scenarios are demonstratively discussed alongside diversified dispersive properties elaborately. The explored nontrivial consequences establish correlative consistencies in light of the real astronomic circumstances towards the mystic mechanisms of varied bounded astrostructure creation and progression in the complex interstellar cloudfluid environs.

Active Brownian dynamics

Mamata Sahoo
University of Kerala
Email: mamata@keralauniversity.ac.in

Active matter is a special kind of soft matter system, where the individual constituents are capable of self-propelling by their own and hence are inherently driven far away from equilibrium. These individual constituents are termed as self-propelled or active particles. In the recent years, self-propulsion in active matter is a rapidly growing area of research because of its enormous applications in the fabrication of different types of nanorobots, artificial swimmers, and other self-driven systems. In this talk, I will discuss some of the interesting aspects of active Brownian dynamics and its responce to the external fields.

Estimation of total electron content (TEC) from GPS/GNSS receivers

Gopi K Seemala
Indian Institute of Geomagnetism
Email: gopi.seemala@gmail.com

The ionosphere is a part of earth's upper atmospheric shell where the electrons and ionized atoms and molecules, that spans from an altitude of about 50 km to more than 1,000 km. In the ionosphere, the charged particles or electrons and ions are created by the photo-ionization due to solar radiation incidence on neutral atoms and molecules of air. The ionosphere can conduct electrical currents as well as reflect, deflect and scatter radio waves. Almost all the ionospheric effects experienced by the radio signal are proportional, at least to a first order to the total number of electrons or total electron content (TEC) encountered by it while traversing through the ionosphere. In this talk, the derivation of TEC from raw data of a GNSS receiver is presented and discussed.

Contributed Talks

GPS-TEC variations during the ascending phase of 24th solar cycle over the Indian equatorial and low latitude regions

Nilesh Patel
B. K. M. Science College, Valsad, Gujarat, India
Email: patel.nilesh569@gmail.com

Ionospheric Total Electron Content (TEC) is studied here using the Global Positioning System (GPS) data for four different low latitude stations: Bangalore, Hyderabad, Surat and Lucknow. GPS-TEC observations over a near equatorial station Bangalore, low latitude station Hyderabad, equatorial ionospheric anomaly (EIA) crest region Surat and beyond crest region Lucknow during the ascending phase of the 24th solar cycle (2010–2014) is analyses. In this study, we report the diurnal and seasonal variation of TEC and dependence of TEC with solar activity. From the seasonal analysis, it found that greater values of TEC were observed during equinox months followed by winter and summer. The appearance and disappearance of "winter anomaly" were observed at the station for different years.

Simulation of Near Earth Space Radiation and its Hazards

Ritabrata Sarkar
Institute of Astronomy Space and Earth Science
Email: ritabrata.s@gmail.com

Interaction of high-energy radiation from the solar and cosmic origin with the magnetospheric and atmospheric environment surrounding the Earth primarily causes the space radiation environment near Earth. More specifically the Cosmic Ray Albedo Neutron Decay (CRAND) is believed to be the principal mechanism for the formation of inner proton radiation belt – at least for relatively higher energy particles. We discuss about the Monte Carlo simulation procedure and the results of the near-Earth space radiation environment due to the interaction of high-energy particles of cosmic origin. We also discuss the imposed hazards due to these radiation, like: radiation dose in human body, background contamination in astronomical detectors, etc.

Unveiling the observations of Travelling Ionospheric Disturbances and Plasma Blobs over Srinagar, J and K, India

Mohammad Rafeeq Rather
University Of Kashmir, Srinagar
Email: rafeeqmsph@gmail.com

We report some intriguing ionospheric events that occurred during some nights of July, 2019 observed through an all sky airglow imager installed at University of Kashmir (UOK), Srinagar, India. The notable phenomena observed during some of the nights of this month include i) Simultaneous existence of a bright band type southwestward propagating Medium Scale Travelling Ionospheric Disturbance (MSTID) and a rarely observed northwestward propagating MSTIDs ii) Electrified southwestward moving nighttime MSTIDs which tended to rotate and align along the North-South direction and iii) The North-South aligned plasma depletion structures drifting westward followed by the N-S aligned plasma blobs near midnight time. The detailed analysis of these events and their characteristics and evolution processes has been carried out, and it was found that the westward drift of plasma depletions occurred during geomagnetic quiet conditions. The detailed description of the observed features and the possible mechanisms responsible for these ionospheric events will be presented.

Sub-ionospheric VLF perturbations observed at low latitude station Dehradun India

Dayanand
Babasaheb bhimrao ambedkar University Lucknow
Email: ndaya760@gmail.com

We report first observations of Very Low Frequency signal perturbation on two transmitter signals NWC (19.8 kHz) and VTX (18.2 kHz) recorded during one year (October 2020 to September 2021) at VLF recording station Dehradun, India. The early, early/fast, early/slow, early onset, Step like, LORE and LEP like VLF perturbations are observed on signals from both the transmitters. These perturbations are observed during local night time of receiving station. The maximum number of perturbations on the VTX signals are LORE and Step like events, while for NWC signal early/slow and LEP events. For VTX signal amplitude change is less varies between 0.5-2.8 dB, compared to NWC signal where observed change varies between 1-5.3dB. The time duration for most of the events observed in the VTX signal 1.2 -48 minutes, while it varies between 1.8-17 minutes. It is interesting to see that observed event time duration and amplitude change is larger compare to previous observations. A detailed analysis results will be discussed during the meeting. The early/fast VLF events are found to occur more often in the nighttime than in the daytime whereas step-like early events predominantly occur in the daytime. Most of the early VLF events are associated with amplitude changes between 0.2–0.8 dB with only a few cases > 0.8 dB. In general, the recovery time of daytime early/fast VLF events

is less when compared to the nighttime early/fast VLF events. The lightning location data provided by the World-Wide Lightning Location Network and broadband VLF data recorded at Suva have been analyzed to identify the location of causative lighting discharges along the great circle paths between transmitter and receiver, and the sferics associated with causative lightning of early VLF events. This research is the first to report both daytime early/fast VLF perturbations with faster recovery and also step-like early VLF perturbations initiated and ended by the lightnings which are most likely associated with red sprites and/or elves occurring in the daytime.

Nonlinear Dynamics Of Flow-induced Instability In Strongly Correlated Astrophysical Plasmas

Tanushree Bezbaruah
Tezpur University
Email: tanushree.bez21@gmail.com

This contribution presents a theoretic model formalism developed to explore the nonlinear dynamics of gravito-electrostatically coupled streaming (flow-induced) instability modes excitable in viscoelastic quantum dusty plasmas having astrophysical relevance. It comprises of weakly correlated lighter electrons, ions; and strongly correlated heavier dust grains. The inertialess electrons are treated as a degenerate quantum fluid, inertial ions as a classical inviscid fluid, and massive dust particles as a classical viscoelastic fluid. A dimensionality-dependent physical parameter is adopted as, $\gamma = [(D-2)/3D]$, called the Bohmian quantum correction prefactor, D denoting the system dimensionality. A nonlinear normal mode analysis against the defined hydrodynamic homogeneous equilibrium procedurally marks a unique conjugational construct of gravito-electrostatically coupled extended pair Korteweg-de Vries (ep-KdV) equations with atypical multiparametric coefficients. A numerical calculation scheme upshots in two distinct classes of nonlinear wave structures. It includes (a) Electrostatic regular periodic pulse-like patterns and (b) Self-gravitational extended bell-shaped solitons. The amplitude variations of the streaming-induced fluctuations in multi-parametric windows of astronomic relevance are analysed illustratively. The main implications and applications of this proposed investigation are finally outlined in a broader horizon alongside the future scope.

Three dimensional FDTD modelling of tropospheric lightning induced electromagnetic perturbations

Rajat Tripathi
Babasaheb Bhimrao Ambedkar University
Email: rajatbbau85@gmail.com

Electromagnetic waves in radio frequency range dominates lightning discharge phenomenon. These waves are found to be associated with the quasi-electrostatic field owing to removal of charges in thundercloud due to rapid lightning current pulse. A need for improved model electron heating due to lightning induced electromagnetic pulse (EMP) is being worked upon by various researchers globally in an attempt to find a simple explanation for various features of lightning induced transient luminous event (TLEs: elves, sprite etc.)'. Ionospheric heating in electron density disturbances play major role in such phenomena. In this work, we try to compare results of simulations at time scales less than and greater than 1 ms and compare with available experimental findings. Full electromagnetic simulations will be carried out for 14-22 km. Data set observed in various seasons will be taken as reference. A number of previously used FDTD models will form basis to get improvised model in this project.

Recent advances in the Space Weather and Atmospheric Sciences in Antarctica: Contributions from India

Anand Singh
National Centre for Polar and Ocean Research
Email: aks@ncpor.res.in

Atmospheric observations starting from the surface meteorology to remote sensing of upper atmosphere, ionosphere and magnetosphere have come a long way in the past four decades of the Indian Antarctica expeditions. The major expansion of the related scientific programme started with the third Antarctic station, located at a distance of about 3000 km from the earlier Indian research bases, Dakshin Gangotri/Maitri. Year-round data acquisition with a suite of experiments and open access to the researchers have contributed immensely in the understanding of climatology of the region, variability and long-range transport of anthropogenic aerosols, dynamics of the upper atmosphere/ionosphere/magnetosphere in response to the Sun-Earth interaction, etc. This work highlights some of the key questions being addressed by the Indian scientists and important contributions in the space weather and atmospheric sciences, with a focus on the former.

Intense chorus waves result in the limitation of electron fluxes in the heart of the outer radiation belt

Suman Chakraborty
Northumbria University
Email: suman.chakrabarty37@gmail.com

In this study, using 7 years of Van Allen Probes electron flux and chorus wave measurements, we show a new and distinct population of very intense chorus waves that are generated in the heart of the outer radiation belt (L^* = 4 – 6) during the main phase of geomagnetic storms. During 70 isolated geomagnetic storms in the entire Van Allen Probe era (2012 – 2019), we found that during the storm main phase, the power of chorus waves increases by ~2 – 3 orders of magnitude above the pre-storm levels when the fluxes of ~10 – 100 keV electrons approach or exceed a certain energy-dependent flux value theoretically predicted by Kennel and Petschek (KP) more than 50 years ago. In the original KP theory, it was predicted that at the limit, it is the intense chorus waves that scatter electrons into the loss cone preventing any further increase of flux, thereby maintaining the flux at the limit. In this study, we further used POES electron flux data to show that the precipitating flux indeed increases during the storm main phase in a similar manner as predicted in the original KP theory. We also investigated the properties of these intense chorus waves. Our results thus have a very crucial impact on the understanding of the dynamics of the Van Allen radiation belts and in the future, these results can be implemented in radiation belt models to study the impact of the high-intensity chorus waves on the radiation belt electron population.

Ionospheric Variations to an Intense Geomagnetic Storm of 26 August 2018 over Low latitudes and Polar Regions

Uma Pandey
Indian Institute of Technology Kanpur
Email: pandeyuma68@gmail.com

During, the minimum phase of Solar Cycle 24, a few geomagnetic storms occurred in this year and the shock related to it arrived at Earth's magnetosphere, which resulted an intense storm of 26 August 2018. This storm is significant not only because of the extremely high magnetic activity, but also due to its great impact on the geo-magnetosphere. The ionospheric response to this storm has been investigated using14 GPS receivers at the low latitudes and Polar Regions in the Asian and Antarctica sectors. Analysis of GPS-TEC data during the geomagnetic storm found positive and negative storm effect over low and high latitudes. The enhancement in VTEC data before the commencement of the geomagnetic storm is observed over all the locations at low and mid-latitude region which is attributed to the pre-storm solar induced events likeCMEs, proton events. Observed storm effects whether it is positive or negative during the period of geomagnetic storm could be caused by prompt penetration of electric field, disturbance dynamo electric field, neutral wind composition changes, and storm-induced wind lifting effects which are discussed in this paper. Disturbance in ionospheric TEC during the geomagnetic storm is a major issue in navigation/aviation/communication application

using GPS and other satellite communication system at low and high latitudes and advance knowledge of such disturbances is useful to improve them.

Utilizing a VHF wind profiler to study ionospheric characteristics and its coupling with the lower atmosphere

Rakesh V.
Cochin University of Science and Technology, Cochin-682022
Email: rakesh.acarr@cusat.ac.in

A state-of-the-art 205-MHz wind profiling radar designed for measuring both the horizontal and vertical wind components from 315 m to beyond 20 km has been installed at the Cochin University of Science and Technology (CUSAT), India (10.04°N, 76.33°E, dip angle ~7.1°N). Subsequently, the radar was operated with special configuration to probe the ionosphere. After a series of experiments, the radar was successfully configured to receive ionospheric reflections from about 90 to 700 km range covering the E and F layers, with high resolution (45 m for the 90-110 km region). The received echoes are identified as signatures of field-aligned irregularities (FAIs) of the E and F regions of the ionosphere. The E region echoes were observed at an altitude range of 90-110 km. Both continuous and quasi-periodic structures were identified. Further analysis from the spectrum shows that the E region FAIs are Type 2 in nature. The night time spread-F events are also observed . This talk portrays the scope of employing 200 MHz range of very high frequency (VHF) band for ionospheric observations, and the technical details and the results of the experiment conducted with this stratosphere-troposphere (ST) Radar.

Simulation Study of Laser Pulse Propagating in Plasma

Akanksha Saroch
Isabella Thouburn College, Lucknow
Email: akshusaroch@gmail.com

Interaction of high power laser fields with ionized plasma can be utilized for a number of applications including laser induced fusion [1], high harmonic generation [2], laser-plasma channeling [3] and laser plasma acceleration [4]. In 1979, Tajima and Dawson showed that relativistic plasma waves are suitable for the development of compact plasma-based particle accelerators [5]. In their scheme, external electrons were accelerated through very high acceleration gradients sustained by relativistic plasma waves driven by laser pulses. Laser-plasma accelerators, which have been proposed as compact next-generation accelerators, rely on laser excitation of large amplitude plasma waves (with 10–100 GV/m field gradients) for trapping and acceleration of particles.

It is observed that the amplitude of the generated wakefields depends on the shape of an ultrashort, intense laser pulse. Interaction of highly relativistic short laser pulses with plasma and nonlinear wakefield generation by the laser pulses with realistic shapes has been studied by Berezhiani et al [6]. Considering super-Gaussian beam profile, THz radiation generation has been shown [7]. In the current study, evolution of longitudinal electrostatic wakefields, due to the propagation of a linearly polarized, super-Gaussian

laser pulse through homogeneous plasma has been presented via two-dimensional PIC simulation study. The wakes generated are compared with those generated by a Gaussian laser pulse in the relativistic regime. Separatrix curves are plotted to study the trapping and energy gain of an externally injected test electron, due to the generated electrostatic wakefields. An enhancement in the peak energy of an externally injected electron accelerated by wakes generated by super-Gaussian pulse as compared to Gaussian pulse case has been observed. This study will be significant for the development of experiments on generation of large amplitude longitudinal wakes which can further be utilized for the purpose of particle acceleration. Keywords: Super-Gaussian laser pulse; Two-dimensional particle-in-cell simulations; Wakefield generation; Electron acceleration References: [1]. C. Deutsch, H. Furukaw, K. Mima, M. Murakami and K. Nishihara, Phys. Rev. Lett. 77 (1996) 2883. [2]. P. Jha, R. K. Mishra, G. Raj, and A. K. Upadhyay, Phys. Plasmas 14 (2007) 053107. [3] P. Monot, T. Auguste, P. Gibbon, F. Jakober, G. Mainfray, A. Dulieu, M.L. Jaquet, G. Malka and J.L. Miquel, Phys. Rev.Lett. 74 (1995) 2953. [4]. P. Jha, A. Saroch, R.K. Mishra and A.K.Upadhyay, Phys. Rev.ST-A&B 15 (2012) 081301. [5]. T. Tajima and J.M. Dawson, Phys.Rev. Lett. 43 (1979) 267. [6]. V. I. Berezhiani, D. P. Garuchava, , S.V. Mikeladze, K. I. Sigua, N. L Tsintsadze, S.M. Mahajan, Y. Kishimoto, & K. Nishikawa, Phys. Plasmas 12 (2005) 062308. [7]. H. K. Malik and A. K. Malik, Europhys. Lett. 100, (2012) 45001.

Study of Tropospheric and Ionospheric Responses of Pre- and Co-Seismic Irregularities using Satellite and Ground Based Techniques

Soujan Ghosh
National Atmospheric Research Laboratory
Email: soujanghosh89@gmail.com

The study of Earthquakes and their preparation mechanism is a highly complicated process due to their an-isotropic and multi-parametric nature. Several approaches were made to identify the exact location, time, and magnitude of a forthcoming earthquake. Among different precursory phenomena mentioned in the publications on earthquake predictions, the atmospheric and ionospheric ones are probably the youngest. It is established that the pre-earthquake processes are not only associated with the inner earth but also have significant effects above the surface that could reach up to the altitude of the order of hundreds of kilometers. A wide range of convincing atmospheric and ionospheric parameters was identified for short-term precursory studies of large earthquakes. Chemical, thermal, and acoustics perturbations in different layers of the atmosphere in the vicinity of the earthquake epicenters were also found to contribute to this process. The mechanism through which these perturbations propagate into the upper layers of the atmosphere is known as Lithosphere-Atmosphere-Ionosphere Coupling (LAIC). The geophysical and geochemical changes that are caused by such coupling can be used as a precursory tool for seismic activity. We present evidence of such LAIC mechanism using a wide range of parameters. We investigate such parameters using ground and space-based instruments and analysis techniques during and before some strong earthquakes having magnitude greater than 5. All our results appear to agree

satisfactorily with the expectations from the proposed LAIC mechanism. We believe these parameters could be very useful for short-term precursory studies.

Ionospheric Imprints of the 29 July 2021, Mw 8.2 Chignik Earthquake, Alaska

Sunil A S

Department of Marine Geology and Geophysics, CUSAT, Kochi, India

A. S. Sunil1, P. S. Sunil1,2, M. N. Shrivastava3,4,5, A. K. Maurya6, D. Thomas7, and G. Gonzalez3,4

1Department of Marine Geology and Geophysics, CUSAT, Kochi, India,
2CUSAT-NCPOR Centre for Polar Sciences, CUSAT, Kochi, India,
3National Research Centre for Integrated Natural Disaster Management, Santiago, Chile,
4Department of Geological Sciences, Universidad Catolica del Norte, Antofagasta, Chile,
5Millenium Institute on Volcanic Risk Research-Ckelar Volcanoes, Antofagasta, Chile,
6Department of Physics, Babasaheb Bhimrao Ambedkar University, Lucknow, India,
7Presently at CSIR Fourth Paradigm Institute, Bangalore, India

Presenting Author's Name: Sunil A. S.

Email: sunnil.as@gmail.com

The lithosphere of the Earth, along with the surrounding atmosphere, work as a coupled system, affecting each other through various coupling mechanisms in response to different events such as earthquakes, volcanic eruptions, tsunamis, and more. However, the energy exchange at the lithosphere-atmosphere boundary is very small because of the large acoustic impedance contrast. During large magnitude earthquakes and tsunami, some of the released energy transfer to the overlying atmosphere, causing pressure waves to travel to higher altitudes in the ionosphere and cause electron density perturbations known as Co-seismic Ionospheric Perturbations (CIP). Recently, on July 29th, 2021, a powerful earthquake with a magnitude of Mw 8.2 occurred in Alaska due to thrust faulting on or near the subduction zone interface between the Pacific and North America plates. We studied the associated co-seismic deformation by analyzing GPS static displacements. Additionally, we investigated the characteristics of ionospheric electron density perturbations caused by this event. To extract the desired signals, a bandpass filter of 1 – 10 mHz is applied to the Total Electron Content (TEC) time series derived from dual-frequency Global Positioning System (GPS) data. Signals with significant amplitudes are observed in multiple satellites from multiple GPS stations. Interestingly, our analysis revealed that the distribution of ionospheric signal amplitudes did not match the ground deformation pattern. To investigate this behavior, we modeled the effects of the geomagnetic field and background ionization density, which significantly affect the evolution of CIP at ionospheric heights. Our results suggest that the combined effect of these two parameters is responsible for the unique CIP distribution observed in this earthquake.

Occurrence characteristics of Equatorial F-region Irregularities (EFIs) from GNSS observables at a low-latitude location in India

Siva Sai Kumar Rajana
CSIR - Fourth Paradigm Institute
Email: sivasai7552081@gmail.com

The plasma irregularities in the upper atmosphere seriously threaten the reliability of communication, navigation and other technological systems whose operation depends on trans-ionospheric signal propagations. In the present study, we investigate the characteristics of Equatorial F-region Irregularities (EFIs) at a low-latitude location in India from 2010 to 2019, using the Rate of Total Electron Content (TEC) Index (ROTI) derived from the Global Navigation Satellite System (GNSS) receiver observables. The findings revealed that EFIs exhibit significant diurnal and seasonal variations and are highly dependent on solar activity. The occurrence and intensity of EFIs are observed to be higher during the maximum solar activity phase. Also, the study found that EFIs are more prominent during the equinoxes, which could be attributed to the increased photoionization and plasma density resulting from the perpendicular angle of incidence of the Sun radiation. The effectiveness of the ROTI as a tool for detecting and characterizing EFIs is also demonstrated. The outcomes from the analysis highlight the importance of understanding the behavior and characteristics of EFIs towards improving the accuracy and reliability of GNSS-based applications in the equatorial region, particularly during high solar activity periods. Keywords: Plasma irregularities; Equatorial F-region Irregularities; GNSS; ROTI; High solar activity.