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Space weather during initial phase of solar cycle 25 and its impact on thermosphere- ionosphere system at different latitudes

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As part of SCOSTEP Visiting Scholar (SVS) program -2023, I got the opportunity to visit Institute for Space Earth Environmental Research (ISEE), Nagoya University, Japan and work under the supervision of Prof. Kazuo Shiokawa for the period 01 October-29 December 2023. The aim was to study the impacts of the geomagnetic storms of different intensities in the rising phase of the solar cycle 25 on ionosphere-thermosphere system from high to equatorial latitudes in the Indian longitude sector. During the events of geomagnetic storms, the dynamo region electric field in the equatorial ionosphere, which generally is in the eastward direction, is altered by two processes: Prompt Penetration Electric Field (PPE) or/and Disturbance Dynamo Electric Field (DDE). PPE is the mapping of interplanetary electric field to the E-region ionosphere, which is an instantaneous effect and DDE is the alteration in the electric field caused due to the change in the global wind pattern caused by the intense joule heating in the auroral region, which takes few hours to manifest over the equatorial latitudes.

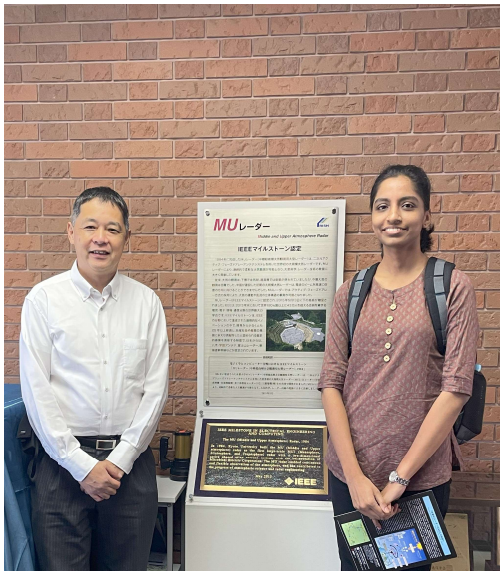

Photo taken with Prof. Shiokawa during the visit to Shigaraki MU radar observatory.

The drift of plasma irregularities in the ionospheric E-region is the best obtainable proxy for the estimation of dynamo electric field as there are no direct measurements available. The anomalous variation in the drift observed by 18MHz coherent, pulsed, monostatic HF radar at Thumba during 12 October 2021 and 28 November 2022 are found to be purely due to the mapping of the Interplanetary Electric Field (IEF_y) to the equatorial ionosphere as PPE, which is also supported by the Equatorial Electrojet (EEJ) strength over the location.

The geomagnetic storm that occurred due to a Coronal Mass Ejection (CME) from the sun during April 2023 is by far the strongest storm of solar cycle 25 in terms of the SYM-H index. Its effects on the equatorial region as well as low

latitudes were studied. The work was commenced by pondering about the source of the anomalously high electron density over Thumba (8.5°N, 77°E and dip lat.= 1.96°N). The GPS- Total Electron Content (TEC) observations from different locations in India reveal the presence of Travelling Ionospheric Disturbances (TIDs) from north to south over the region. TEC data from ISEE database reveals the presence of TIDs that travel from north to southern hemisphere crossing the equator. The TIEGCM simulation of meridional wind and temperature with data assimilation by Assimilative Mapping of Ionospheric Electrodynamics (AMIE) technique was done in collaboration with Dr. Gang Lu, High Altitude Observatory (HAO), USA. The model output also shows the propagation of Travelling Atmospheric Disturbances (TADs). The manuscripts on the results obtained from the work carried out at ISEE are under preparation and will be soon communicated to a reputed journal.

During the visit to Nagoya, I had a chance to visit the MU Radar observatory, Shigaraki and witness the radio and optical facilities available for the probing of the Ionosphere-Thermosphere System.