Title: Characteristics of traveling ionospheric disturbances over Europe during HSS/CIR driven storm on Mar. 30 – Apr. 6, 2023 from GNSS, LOFAR and ionosonde data

Speaker: Sergii Panasenko (1)

Co-authors: Dalia Obrazova (1), Jaroslav Urbar (1), Hanna Rothkaehl (2), Barbara Martyjasiak (2), Mariusz Pozoga (2), Helena Ciechowska (2) (*may be extended in the future*)

Affiliation: (1) Institute of Atmospheric Physics, Czech Academy of Science. (2) Space Research Center, Polish Academy of Sciences

Abstract: Traveling ionospheric disturbances (TIDs) are wave-like plasma fluctuations. They propagate through the ionosphere at a broad range of scales and mostly are the manifestations of atmospheric gravity waves. Understanding the generation and propagation of TIDs during strong space weather variations are essential for predicting and mitigating TID negative effects on communication, navigation, and other technological systems that rely on the ionosphere, maintaining their resilience and efficiency.

The magnetic storms caused by different drivers such as coronal mass ejections (CME) and high-speed stream / corotating interaction regions (HSS/CIR) are known to have quite different effects on the ring current and the auroral activity. Moreover, despite the larger energy output of CME-driven storms, the energy coupling and input are often more effective for the magnetic storms driven by CIR activities. The TID intensity at the middle latitudes significantly depends not only from the storm driver, but also from the time of day, season, solar activity, intensity of perturbations and phase of the storm as well as the presence of other sources like tropospheric convention. Thus, the thorough analysis of the mid-latitude TID behavior during the specific storm (case studies) enable us to collect the observational results for further statistical analysis and better understand and predict TID characteristics during the storm period.

In the framework of PITHIA=NRF TNA "SUNDIAL" project, we thoroughly investigated the TIDs, originated by the HSS/CIR driven storm on Mar. 30 – Apr. 6, 2023. The data from dense GNSS receiver, LOFAR and ionosonde European networks were employed for joint analysis. We detected the several time intervals with TIDs propagated from the high latitudes towards the equator associated with an enhancement in auroral activity. Ionosonde and GNSS based results show the consistency in estimation of TID characteristics. The detected large scale TIDs have the dominant periods of 50 – 80 min, horizontal phase velocities of 400 – 600 m/s and horizontal wavelengths of 1300 – 3500 km. In addition, an analysis of the LOFAR scintillation data revealed the intensification of irregularities which is likely to be caused by medium and small scale TIDs.

Thus, the southward propagated TIDs in the broad range were detected and characterized during the selected magnetic storm interval. Based on this case study, we spotted that the TIDs at mid-latitudes were usually observed several (1 – 4) hours after the enhancement in the auroral activity characterized by IMAGE IE indices. We continue to analyze other HSS/CIR driven events to establish the validity of such relationship.