Effect of space weather disturbances on the high-latitude ionosphere

Anita Aikio[1]
[1]*University of Oulu, Finland*

The Sun and the solar wind are sources of space weather disturbances in the geospace environment, which can also affect and harm technological systems like power grid lines, HF communication, GNSS navigation, satellite operations, and health of astronauts. Two major types of solar disturbances are (i) interplanetary coronal mass ejections (ICMEs), which are magnetic eruptions from the solar corona, ejecting solar material into the interplanetary space and (ii) solar wind high-speed streams (HSSs), which originate from the coronal holes on the Sun. During their travel in the interplanetary space, HSSs interact with the slow solar wind, generating co-rotating interaction regions (CIRs). The effect of these two phenomena on the terrestrial ionosphere is a complicated and poorly understood process, which involves flow of mass and energy from the Sun, interaction with the Earth's magnetosphere, and final entry into the ionosphere. Space weather events are associated with several time scales. Both ICMEs and HSS/CIRs may trigger geomagnetic storms (duration a few days), during which several magnetospheric substorms (duration ~1-3 h) take place. While the ICMEs produce the largest geomagnetic storms, the storms produced by HSS/CIRs are typically weaker, but of longer duration. Substorms are characterized by strong auroral ionospheric currents and energy deposition from the magnetosphere to the high-latitude ionosphere.

In this talk, we will focus on the effects of HSS/CIRs on the high-latitude ionosphere (Grandin et al., 2019) on a time scale of several days (geomagnetic storm time scale). We will show multi-instrument studies of the high-latitude ionospheric response for HSS/CIR events by using ionosonde, riometer, magnetometer, EISCAT incoherent scatter radar and AMPERE data (Grandin et al., 2015 and 2017; Ellahouny et al., 2019, Pedersen et al., 2019). We will also show modeling effort of one HSS/CIR event utilising the IPIM (IRAP Plasmasphere Ionosphere Model) and EISCAT data (Marchaudon et al., 2018) and discuss future perspectives.

References

Ellahouny, N., A. T. Aikio, M. Pedersen et al., Characteristics of an HSS-driven magnetic storm in the high-latitude ionosphere, manuscript in preparation, 2019.

Grandin, M., A. T. Aikio, A. Kozlovsky, T. Ulich, and T. Raita (2015), Effects of solar wind high-speed streams on F-region peak densities in the high-latitude ionosphere: superposed-epoch study, J. Geophys. Res. Space Physics, 120, 10669–10687. doi:10.1002/2015JA021785

Grandin, M., A. T. Aikio, A. Kozlovsky, T. Ulich, and T. Raita (2017), Cosmic radio noise absorption in the high-latitude ionosphere during solar wind high-speed streams, J. Geophys. Res. Space Physics, 122, doi:10.1002/2017JA023923.

Grandin, M., Aikio, A. T., & Kozlovsky, A. (2019). Properties and geoeffectiveness of solar wind high - speed streams and stream interaction regions during solar cycles 23 and 24. Journal of Geophysical Research: Space Physics, 124. https://doi.org/10.1029/2018JA026396

Marchaudon, A., Blelly, P.-L., Grandin, M., Aikio, A., Kozlovsky, A., & Virtanen, I. (2018). IPIM modeling of the ionospheric F2 layer depletion at high latitudes during a high-speed stream event. J. Geophys. Res., Space Physics, 123. https://doi.org/10.1029/2018JA025744

Pedersen, M. N., H. Vanhamäki, A. T. Aikio, S. Käki, A. Viljanen, and A. Workayehu, Impact of Solar Wind High Speed Streams on Ionospheric Current Systems and Associated Space Weather Effects, manuscript in preparation, 2019.