Interhemispheric nighttime medium-scale TID: influence of sporadic E layer

Project level: MSc

Supervisor: Zama Katamzi-Joseph, South African National Space Agency (SASNA)

Contact: zkatamzi@sansa.org.za

Description

Nighttime medium-scale traveling ionospheric disturbances (TIDs) are wavelike propagating perturbations occurring in the ionospheric F region during nighttime. These mostly quasi-periodic plasma structures are superposed onto the background ionospheric plasma distribution and are difficult to predict as they have widely varying sources. This means medium scale TIDs may affect the normal operation of radio systems and space weather forecasting abilities, thereby introducing uncertainty in the predicting power of these systems and/tools. They are thought to be generated from atmospheric gravity waves or through plasma instabilities, such as Perkins instability and sporadic E. Nighttime medium-scale TIDs have been studies using a multitude of instruments including all-sky imagers (ASI), which are cameras with specialized filters that measure nighttime airglow intensity. The aim of the project is to determine the role of sporadic E layer in generating and supporting nighttime medium-scale TIDs. Sporadic E layer is a thin enhancement of plasma occurring between 90 and 130 km. This study will involve the use of airglow intensity measurements from two ASIs located in conjugate locations in the southern and northern hemisphere to identify medium-scale TIDs and determine their characteristic parameters. In addition, ionosonde measurements from ionosondes within the field of view of the ASIs will be used to investigate the influence of sporadic E in their occurrence and on their properties.

Requirements:

- Background knowledge in aeronomy/ionospheric physics
- Computation and programming skills: e.g., image processing, 2D spectral analysis

Background Reading:

Ionosphere:

McNamara, L. F. (1991). The ionosphere: Communications, surveillance, and direction finding. Malabar, Florida: Krieger Publishing Company.

Hargreaves, J. K. (1992). The Solar-Terrestrial Environment: An Introduction to Geospace - the Science of the Terrestrial Upper Atmosphere, Ionosphere, and Magnetosphere. Cambridge University Press.

Medium-scale TIDs:

Katamzi-Joseph, Z. T., Grawe, M. A., Makela, J. J., Habarulema, J. B., Martinis, C., & Baumgardner, J. (2022). First results on characteristics of nighttime MSTIDs observed over South Africa: Influence of

thermospheric wind and sporadic E. J. Geophys. Res. Space Physics, 127, e2022JA030375. doi:10.1029/2022JA030375.

Narayanan, V. L., Shiokawa, K., Otsuka, Y., & Neudegg, D. (2018). On the role of thermospheric winds and sporadic E layers in the formation and evolution of electrified MSTIDs in geomagnetic conjugate regions. J. Geophys. Res. Space Physics, 123(8), 6957–6980. doi:10.1029/2018JA025261.

Otsuka, Y., Shiokawa, K., & Ogawa, T. (2004). Geomagnetically conjugate observations of medium-scale traveling ionospheric disturbances at midlatitude using all-sky airglow imagers. Geophys. Res. Lett., 31(15), L15803. doi:10.1029/2004GL020262.

Perkins, F. (1973). Spread F and ionospheric currents. Journal of Geophysical Research, 78(1), 218–226. doi:10.1029/JA078i001p00218.

Data Analysis:

Garcia, F.J., M.J. Taylor, and M.C. Kelley (1997). Two-dimensional spectral analysis of mesospheric airglow image data. Appl. Optics, 36, 7374, doi: 10.1364/AO.36.007374

Mondal, S., Srivastava, A., Yadav, V., Sarkhel, S., Krishna, M. S., Rao, Y. K., & Singh, V. (2019). Allsky airglow imaging observations from Hanle, Leh Ladakh, India: Image analyses and first results. Advances in Space Research, 64(10), 1926–1939. doi: 10.1016/j. asr.2019.05.047