2nd URSI AT-RASC, Gran Canaria, 28 May – 1 June 2018

High-latitude ionospheric scintillations during geomagnetic disturbances

Shasha Zou*(1), Doga Ozturk(1), Jade Morton(2)
(1) University of Michigan, Ann Arbor, MI, USA, 48109; e-mail: shashaz@umich.edu
(2) University of Colorado, Boulder, CO, USA; e-mail: jade.morton@colorado.edu

Ionospheric scintillation is a rapid fluctuation of radio-frequency signal phase and/or amplitude, generated as a signal passes through the ionosphere. It occurs when a radio frequency signal in the form of a plane wave traverses a region of small-scale irregularities in ionospheric electron density. The high-latitude ionosphere contains complex ionospheric density structures due to the coupling between the magnetosphere, ionosphere and thermosphere. This region is known to host frequent ionospheric scintillations.

We use two closely-spaced multi-constellation GNSS receiver arrays at Poker Flat and Gakona, Alaska, which collect open signals transmitted from GPS, GLONASS, Galileo, and Beidou satellites. These systems generate high rate GNSS carrier phase measurements at multiple frequency bands during ionospheric scintillation events [1].

Taking advantage of these two arrays, we study the characteristics and formation mechanism of ionospheric irregularities, as well as their scintillation effects during geomagnetic disturbances, including substorm, storm and interplanetary shock [2, 3, 4]. Various instruments, including Poker Flat incoherent scatter radar (PFISR), ground magnetometers and all-sky imagers, as well as Block-Adaptive Tree Solar wind Roe-type Upwind Scheme (BATSRUS) global MHD model in the Space Weather Modeling Framework (SWMF) are used to understand the solar wind-magnetosphere-ionosphere coupling processes during these disturbances and the resulting large-scale high-latitude convection and field-aligned current configurations. Ionospheric irregularities and scintillations are then studied in the context of the evolution of these geomagnetic disturbances. For example, the global MHD model and ground magnetometer at Poker Flat were used to track the interplanetary shock induced convection and field-aligned current perturbations when they moved from the day side to the night side [4]. The Poker Flat GNSS receiver array detected transient phase scintillations when these field-aligned currents moved across Alaska.

References:

1. Morton, Y., Y. Jiao, and S. Taylor, “High-latitude and equatorial ionospheric scintillation based on an event-driven multi-GNSS data collection system,” Proc. Iono. Effects Sym., Alexandria, VA, 2015.

2. Zou, S., M. B. Moldwin, A. Coster, L. R. Lyons, and M. J. Nicolls (2011), GPS TEC observations of dynamics of the mid-latitude trough during substorms, *Geophys. Res. Lett.*, *38*, L14109, doi:10.1029/2011GL048178.

3. Zou, S., M. B. Moldwin, A. J. Ridley, M. J. Nicolls, A. J. Coster, E. G. Thomas, and J. M. Ruohoniemi (2014), On the generation/decay of the storm-enhanced density (SED) plumes: role of the convection flow and field-aligned ion flow, *J. Geophys. Res.,* 119, 543–8559, doi: 10.1002/2014JA020408.

4. Zou, S., D. Ozturk, R. Varney, and A. Reimer (2017), Effects of Sudden Commencement on the Ionosphere: PFISR Observations and Global MHD Simulation, *Geophys. Res. Lett.* , 44, doi:10.1002/2017GL072678.