Propagation direction analysis of medium-scale travelling ionospheric disturbances (MSTIDs) observed with 2D GPS-TEC map using M-transform

Septi Perwitasari[1], Takuji Nakamura[1], Takuya Tsugawa[2], Yoshihiro Tomikawa[1], Mitsumu Ejiri[1] and Masaru Kogure[1]
[1]*National Institute of Polar Research (NIPR)*
[2]*National Institute of Informations and Communications Technology (NICT)*

We developed an analysis method using the 3D FFT (Matsuda-transform, M-transform) to study the propagation direction of MSTIDs observed by the GPS-TEC data. This method requires a time series of 2D GPS-TEC map as an input. To obtain the preprocessed 2D GPS-TEC map for the input, we first converted the slant TEC to the vertical TEC and then calculated the perturbation component of the TEC by subtracting the vertical TEC with the 1-hour running average of each light of sight (LOS). We mapped the TEC perturbation to the ionosphere shell at 300 km which has a spatial resolution of 0.15x0.15° in longitude and latitude and temporal resolution of 30 seconds [*Saito et al*., 1998, *Otsuka et al*., 2002 and *Tsugawa et al*., 2007]. To compensate the rarity of the data, we filled the gap with the mean of surrounding pixel (15°x15°) and used 5 minutes binning. As a result, the preprocessed map can be expected to detect the TEC variations with period of 15-60 minutes. This method to obtain the preprocessed 2D GPS-TEC map can be applied to a wide area with a dense GPS receivers network (e.g. North America or Northern Europe). We then applied the M-transform to the time series of the 2D TEC map to obtain the phase velocity spectrum of the MSTIDs. In this study, we applied the M-transform to the 2D TEC map over North America. We used horizontal wavelength of 150-500 km, phase speed of 0-300 m/s and wave period of 15-60 minutes as wave parameter inputs of the analysis. To analyze the longitudinal dependence of nighttime MSTIDs, we divided the North America into west (100°-130°W) and east (60°-90°W) part. We found that the nighttime MSTIDs occurrence is higher by ~50% in the west than the east part. The nightly average of the spectrum obtained from June-July 2006 in the west part shows that the dominant propagation is southwestward/westward with a phase speed of 50-200 m/s. In the east part, the average nightly spectrum shows that the dominant propagation is southward/southwestward with a phase speed of 50-150 m/s. This disagreement on the propagation direction between the west and east part of the North America could be caused by the declination of the magnetic field line. The local time dependence analysis shows that the peak of the MSTIDs occurrence is around midnight (22-3 LT) in both part. For the daytime MSTIDs, we analyzed the central part of the North America (80°-120°W and 30°-60°N) on November-December 2006. We found that the daytime average spectrum shows that the dominant propagation direction is southward with a phase speed ranging from 50-300 m/s. From the day to day variation analysis, we found several cases of multiple propagation directions which could indicate different gravity wave source. However, the analysis is still ongoing; we will discuss more in detail in the presentation.

Reference:

Otsuka, Y., T. Ogawa, A. Saito, T. Tsugawa, S. Fukao, and S. Miyazaki (2002), A new tecnique for mapping of total electron contentc using GPS network in Japan, Earth Planets Space, 54, 63-70.

Saito, A., S. Fukao, and S. Miyazaki (1998), High resolution mapping of TEC perturbations with the GSI GPS network over Japan, Geophys. Res.Lett., 25, 3079–3082.

Tsugawa, T., Y. Otsuka, A. J. Coster, and A. Saito (2007), Medium-scale traveling ionospheric disturbances detected with dense and wide TEC maps over North America, Geophys. Res. Lett., 34, L22101, doi:10.1029/2007GL031663.