International Beacon Satellite Symposium BSS-2016
Trieste, Italy

Monitoring of the ionospheric irregularities over the Northern Hemisphere

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ABSTRACT

The ionosphere plays an important role in GNSS applications because it influences on the radio wave propagation through it. The ionosphere delay is the biggest error source for satellite navigation systems, but it can be directly measured and mitigated with using the dual frequency GNSS measurements. However, GNSS signal, fading due to electron density gradients and irregularities in the ionosphere, can decrease the operational availability of navigation system. Ionospheric effects are typically characterized by measuring its impact on amplitude and phase of the received GNSS signal. The most widely considered measures are the scintillation indices (i.e. amplitude and phase), and the TEC rapid changes.

The ionospheric irregularities monitoring technique is based on a classical approach used the ROT (Rate of TEC), the de-trended rate of line-of-sight TEC change, and ROTI – index calculated on 5 min interval with 30 sec sampling rate [Pi et al, 1997]. For the overall representation of the spatial evolution of the ionospheric irregularities there is produced the daily map of the ROTI index as a function of geomagnetic local time on the specific grid. Taking into account that the Earth's ionosphere is formed by superimposing of the Earth's magnetic field and Solar irradiance level, the ROTI behavior can be represented as a function of a magnetic local time (MLT) and corrected magnetic latitude (MLAT) for a specific day. We use the corrected geomagnetic (CGM) coordinates with the Definite/International Geomagnetic Reference Field (DGRF/IGRF) models. This polar map represents a daily map with 00–24 MLT time frame. The grid size is 8 min MLT by 2° MLAT, with the latter covering 50– 90°. ROTI data were binned and averaged in each MLAT-MLT bin, i.e., the map resolution is 20 bins along MLAT axis and 180 bins along MLT axis. In general, the averaged ROTI value in each bin corresponds to the probability of the GPS signals phase fluctuations caused by passing of radio signals through the ionospheric irregularities. For daily ROTI maps, we averaged and binned all ROTI values collected during 00–24 UT period of a considered day.

In the UWM Space Radio-Diagnostic Research Center it was established the specialized GPS data processor for the routinely producing of the daily ROTI maps. For every map generation

there are processed the GPS observations from more than 700 permanent stations, available from IGS, EPN, UNAVCO networks and the Plate Boundary Observatory (PBO) mission. The final ionospheric fluctuation product in graphical and ASCII format is regularly uploaded on to the monitor.estec.esa.int website via ftp protocol. Currently it is available data for more than 500 days since the service's establishment. The product latency is determined by the input data availability and it usually takes about 48 h.

Key words: Ionosphere, GPS, Irregularities, Monitoring

References: Pi, X., A. J. Mannucci, U. J. Lindqwister and C. M. Ho (1997), Monitoring of global ionospheric irregularities using the worldwide GPS network, *Geophys. Res. Lett.*, 24, 2283.

Acknowledgements: The authors thank IGS, UNAVCO and EUREF for making available GPS measurements data.