

Study of equatorward-extending structures of ionospheric irregularity using GPS-TEC in Northern America

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There are about 2700 dual-frequency GPS receivers in Northern America. The GPS receivers provide the data of carrier phase and pseudo-range measurements at two frequencies every 30 seconds. Phase and group velocities of the GPS signals are advanced and delayed, respectively, by electrons in the ionosphere. So the Total Electron Content (TEC) along the entire line-of sight (LOS) between receiver and satellite can be derived by analyzing the GPS data.

We used the Rate of TEC change Index (ROTI) to detect the ionospheric irregularities. ROTI is the standard deviation of Rate of TEC change (ROT) in 5 minutes, and ROT is the changes of TEC in 30 seconds. The two dimensional maps of ROTI can be obtained from all available GPS data in North America. For projecting ROTI on the two dimensional map, we assume that there is the ionized single layer at altitude of 300 km. The spatial resolution is $0.75^\circ \times 0.75^\circ$ in latitude and longitude.

A magnetic storm occurred on 17 March 2015. It started at 05 UT, and Dst index reached a minimum of -223 nT at 23 UT. Enhancement of ROTI were seen at 09:00-11:00 UT and 21:00-24:00 UT. The ROTI enhancement region observed at 09-11 UT was consistent with auroral region observed from DMSP satellites. At 21-24 UT, Storm Enhanced Density (SED) was seen from absolute TEC map, and ROTI enhancement was observed in SED and poleward region of SED.

Equatorward-extending structures of ROTI enhancement region were seen at 09:00-10:30 UT and 13:00-15:30 UT in equatorward of auroral region, northern latitude of 40-50 degrees. The scale of the Equatorward-extending structures were about 150 km in the parallel direction. We calculated the drift velocity of plasma in east-west and north-south direction from data of HF radar at Christmas valley (43.27°N , -120.36°E) using least squares method. The enhancement of eastward drift velocity were seen at 09-11 UT and 12-14 UT and the drift velocity were about 500m/s. In this study, we examine the relationship between the fine structures of ROTI enhancements and plasma drift.

Keywords: Ionosphere, TEC, GPS, ROTI