



Ionospheric scales derived from UPC-IonSAT Global Ionospheric Maps

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Abstract

The ionospheric response to high geomagnetic activity, the ionospheric storm, can enlarge GNSS positioning errors by the increase of ionospheric electron density and disable high-frequency communications by the decrease of the ionospheric electron density. In addition, the ionospheric perturbations with high spatial and temporal components of VTEC gradient might also enlarge GNSS positioning errors and even incapacitate Satellite-Based Augmentation System (SBAS) and Ground-Based Augmentation System (GBAS) services^{[1][2]}. UPC Quarter-of-an-hour time resolution Rapid GIM (UQRG) is derived from GNSS carrier phase measurements assuming a two-layer tomographic TEC model and interpolated by Kriging technique with a spatial resolution of 5° and 2.5° in longitude and latitude, respectively^[3]. The characteristics and performance of UQRG GIMs^{[4][5]} have allowed us to define two new GIM-derived ionospheric scales:

(1) The Ionospheric storm scale derived from UQRG GIMs (IsUG^[6]) is defined as the percentage deviations of hourly median VTEC extracted at each grid point of historical UQRG (from 1997 to 2014), and it is normalized (subtract the mean and divide by the corresponding standard deviation) in order to remove the dependence of VTEC variations on season, local time and geographical location. The level of ionospheric storm from the proposed ionospheric storm scale is consistent with previous studies.

(2) The VTEC gradient derived from UQRG GIMs (VgUG^[7]), which allow to obtain full (non-relative) values of TEC spatial gradients and temporal variations separately. Indeed the Regional VTEC spatial Gradient indices, based on UQRG (RVGU) and the Regional Ionospheric Disturbance index based on UQRG (RIDU), are proposed to estimate the regional ionospheric perturbation degree over selected regions. In addition, the spatial and temporal components of VTEC at grid points of UQRG on a global scale are also introduced. Compared with quiet ionospheric state, the VTEC spatial and temporal gradient indices are able to capture the variations of VTEC spatial and temporal gradient during the disturbed ionospheric state.

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