Real-time TEC monitoring services for International Reference Ionosphere – IRI

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Abstract

The purpose of this dissertation was to demonstrate the suitability of two GNSS VTEC products – climatological GMBT and real-time GMRT for assimilation to the IRI model. Both products were developed by the Author on the basis of products created by the Ionospheric Working Group of IGS in accordance with the requirements set by the International Reference Ionosphere group.

The work uses the results of the project: „Advanced methodology development for Real-Time Multi-constellation (BDS, Galileo and GPS) Ionosphere Services", funded by The National Centre for Research and Development (NCBR) and Ministry of Science and Technology (MOST), in which the author was responsible for developing a methodology for creating real-time global VTEC maps.

The work carried out was aimed at testing the research hypothesis: „Assimilation of GNSS VTEC products to the IRI model allows for a significant improvement in the representation of climatological and observational parameters and creates new research opportunities".

The dissertation included: (1) a detailed analysis of the method of calculating the VTEC value in the IRI model, (2) a description of the methodology for the assimilation of GNSS products to IRI through the assimilation models IRTAM and GAMBIT, (3) a description of the IGS Iono WG ionospheric products and tasks related to the real-time product performed under the ARTEMIS project, (4) analysis of time series and global distributions of VTEC values in geomagnetic storms and calm (solar minima) conditions comparing the GMBT climatological product with the VTEC climatological product represented by the IRI model, as well as the actual state ionospheres from a GMRT product with a GMBT climatological background.

The presented analyzes and completed tasks prove that GNSS VTEC products meet the significant demand of IRI users for a reliable representation of this parameter, also covering the high layers of the ionosphere and ocean areas that have not been represented by the IRI model in sufficient quality so far. The introduction of global products based on actual GNSS VTEC observations also opens up the possibility of generating new products and indexes that have not been available on a global scale so far, as exemplified by the slab thickness mapping in the GAMBIT system.

The GMBT product developed by the author of the dissertation is already used by IRI users around the world and GMRT is currently in the implementation phase. Their further development will be carried out in accordance with IRI requirements and as new IGS Iono WG studies become available.

Keywords: ionosphere, IGS, IRI, VTEC, space weather