GPS ROTI Maps as new IGS ionospheric product characterizing the ionospheric irregularities occurrence – current stage and perspectives

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Today, society increasingly relies on GNSS signals across a wide range of industries and critical systems. It is important to understand how satellite navigation signals passing through the earth's ionosphere can be disrupted. The objective of this work is to develop, establish and continuously threat product and supporting service on order to represent the quiet-time background of the ionospheric irregularities occurrence, as well as strong ionosphere fluctuation events responsible for degrading of the GPS positioning and radio communication.

The International GNSS Service (IGS) has accepted and releases the new ionospheric product to characterize the ionospheric irregularity occurrence and intensity as deduced from multi-site ground-based GPS observations. This approach is implemented in in-house software for multi-step processing and interpretation of carrier phase delays in dual frequency GPS signals. We used measurements with 30 s sampling rate from about 700 GPS stations located at high and middle latitudes of the Northern Hemisphere where the highest concentration of the GNSS users presents. The product stands on the GPS-based index ROTI (Rate of TEC Index) and has a polar projection within a range of 50°-90°N in geomagnetic latitude and 00-24h magnetic local time. Fig.1 shows sample of the IGS ROTI Maps product visualizations. The new service allows regular monitoring of ionospheric irregularities over the Northern Hemisphere. We demonstrate results of the IGS ROTI Maps product analysis for representative periods with geomagnetically quiet conditions and severe geomagnetic storms in 2014-2015 in order to demonstrate performance and ability of this product to depict the development of ionospheric irregularities in the area of interest. During space weather events the ionospheric irregularities oval, as deduced from the ROTI maps, expands significantly toward midlatitudes with simultaneous increase of irregularities intensity, which can lead to degradation of the GPS precise positioning performance at the lower latitudes.

The actual daily ROTI Maps product bases on the already proved methodology, in particular within the framework of the European Space Agency (ESA) project MONITOR-2. It was successfully used for analysis of the ionosphereic fluctuation activity at GPS wavelength bands and estimation of their average intensity. The database with the ROTI maps product, available on the CDDIS FTP, can be applied for retrospective study of the Space Weather impact on the GNSS positioning in the "worst case scenario" domain. As part of the future development of the IGS ROTI product we demonstrate a great potential of ROTI mapping approach to study ionospheric irregularities evolution and dynamics with a high spatio-temporal resolution.

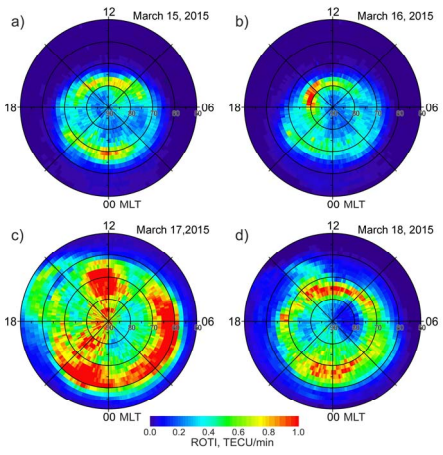

Figure 1. Examples of the daily GPS ROTI maps for representative (a-b) quiet and (c-d) disturbed days.