GNSS-based ionospheric monitoring

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An increasing demand on a better modelling and understanding of the behavior of the ionosphere is required by the scientific community which uses electromagnetic wave signals reflecting on or passing through this atmospheric layer. For that, the Total Electron Content (TEC) is a parameter allowing the description of the ionospheric behavior in response to different solar activity levels. Presently, one of the challenges of the Space Weather community is to monitor and to predict the Earth's ionospheric TEC in response to variations of the solar activity and geomagnetic storm events.

One of the main perturbations encountered by Global Navigation Satellite Systems (GNSS) signals when traveling from the satellite to the Earth is the ionospheric refraction. As the ionosphere is a dispersive medium, the ionospheric refraction depends on the signal frequency. Thus, the combination of GNSS measurements on two separate frequencies allows determining the ionospheric delay between a ground receiver and a satellite. It is thus possible to build ionospheric maps representing the vertical TEC (vTEC) as a function of latitude, longitude and time from the observations of a network of GNSS stations.

This paper will discussed the different models (empirical, observations) presently used for many scientific and civil applications. We will mainly focused on the GNSS-based vTEC maps delivered from different agencies with different latencies (i.e. minutes to days), area extents (i.e. local to global), grid resolutions (i.e. few degrees to lower than 1°) and time scales (i.e. few minutes to hours). Finally, we will present the ROB-IONO software which monitors the ionosphere over Europe in near-real time since 2012. This product allows the detection of abnormal ionospheric activity in near real-time and is used by the Solar Influences Data Center (SIDC) as one of the indicator of the space weather conditions at earth level.