



## **Ionospheric fluctuations and Total Electron Content gradients over Europe during quiet conditions and storm events**

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As ionosphere is a highly refractive and dispersive medium from the radio point of view, information about its state is crucial from the point of view of all application based on trans- and sub-ionospheric radio transmissions. Although in many implementation the general ionospheric plasma state is not as important as the rapid changes in its structure.

Those perturbations of the ionospheric plasma density are crucial from both scientific and application points of view, as they can severe affect radio signals used in the Global Navigation Satellite Systems (GNSS) and low frequency radio astronomy. For several decades the ionospheric irregularities have been extensively studied by different techniques, including ground-based GNSS observations.

The well known and widely used tool for ionospheric disturbances distribution is the rate of TEC index (ROTI). Recently, the Northern Hemisphere ROTI product has been implemented to the International GNSS Service (IGS) and available for community.

Nonetheless, ionospheric irregularities can be also monitored with ionospheric maps, by studying horizontal gradients of the plasma density (total electron content, TEC). region at high to middle latitudes. We developed the TEC gradient maps based on the global UQRG product and high-resolution (0.5 degree in latitude and longitude) regional TEC maps covering Europe. The obtained climatological characteristics of the spatial TEC gradients are superimposed and analyzed with the global and regional ROTI product in order to reveal development of highly intense plasma irregularities occurred at high and middle latitudes. During geomagnetic storm the complex of physical processes at auroal zone leads to development of intnse ionospheric irregularities and travelling ionospheric disturbances (TIDs). We presents results of the geomagnetic storm analysis including the 2013 and 2015 St. Patrick's Day geomagnetic storms.