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Ionospheric fluctuations monitored with TEC gradients and ROTI

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Ionosphere from the radio wave's point of view is a highly dispersive and refractive medium. Moreover it is very unstable and multiple factors dependent. Thus permanent ionospheric monitoring is very important for all applications based on the sub- and trans-ionospheric radio emissions – both scientific and industrial. The basic – diurnal, seasonal and solar cycle driven – ionospheric variability is rather well known in general, but many impossible or difficult to predict fluctuations may interfere with the radio signal on the level that would seriously affect satellite or radio astronomical systems performance.
For several decades the ionospheric irregularities have been extensively studied by different techniques, including ground-based GNSS observations. It resulted inter alia in developing global maps representing in general the temporal state of the ionosphere. Ionospheric irregularities can also be monitored with the maps, by studying horizontal gradients of the plasma density (total electron content, TEC). 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.
GNSS-based ionospheric monitoring provides also instruments dedicated to plasma fluctuations detection. One of such well-know and widely used tools is the rate of TEC index (ROTI), which is currently available for whole community as an International GNNS Service (IGS) product (for southern hemisphere).
Presented 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 compared for the quiet time periods and geomagnetic storm events.