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Mid-latitude ionospheric irregularities' climatological signatures described with ROTI

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For years Global Navigation Satellite Systems (GNSS), due to incomparable volume of observations available, became one of the key technique in ionospheric studies. Numerous institutions from whole the world are involved in preparing maps of Total Electron Content (TEC). Besides general information of the absolute plasma density, GNSS can register signal fluctuations originated by different-scale structures within the ionospheric plasma, considered as ionospheric irregularities. Those are important in many ways to technological and scientific users. Strong ionospheric gradients can affect trans ionospheric radio communication. On the other hand enhanced occurrence and magnitude can be treated as a part of space weather events. Last but not least, ionosphere is often considered as a plasma laboratory – studies on different-scale structures can be an important part of plasma mechanisms research. In 2015 International GNSS Service (IGS) introduced a product dedicated to the ionospheric irregularities phenomenon – Rate of TEC Index (ROTI) maps for the northern hemisphere. ROTI is a statistical measure of radio wave fluctuations of ionospheric origin.

This work presents climatological signatures of the ROTI-described irregularities occurrence. Climatological variability analysis includes diurnal, seasonal, and solar cycle temporal scales. Presented results include also periods of enhanced geomagnetic activity and correlation between geomagnetic disturbances and ionospheric irregularities. Better understanding of the ROTI performance will help to establish a near real-time multi-GNSS ionospheric structures monitoring system, that could feature also other monitoring techniques, such as ionosondes, satellite-based in situ plasma measurements and even radio astronomical observations. Such experimental multi-GNSS near real-time service was established within the Polish-Chinese bilateral project "ARTEMIS: Advanced methodology development for Real-Time Multi-constellation (BDS, Galileo and GPS) Ionosphere Services."