Ionosphere Irregularity Monitoring with multi-GNSS Observations: Methodology and Applications

Ningbo Wang[1,2], Zishen Li[1], Ge Wang[1], Andrzej Krankowski[3], Kacper Kotulak[3], Adam Fron[3]

(1) Aerospace Information Research Institute, Chinese Academy of Sciences, China

(2) Institute of Astronomical and Physical Geodesy, Technical University of Munich, Germany

(3) Space Radio-Diagnostics Research Center, University of Warmia and Mazury in Olsztyn, Poland

The nominal ionospheric delays affecting the signal propagation conditions of Global Navigation Satellite Systems (GNSS) can be predicted and mitigated by advanced ionospheric models. However, the rapid phase and amplitude fluctuations caused by severe ionospheric irregularities may induce unpredictable range errors and other severe problems in many applications of GNSS. For ionospheric irregularity monitoring, ROTI (Rate Of ionospheric TEC change Index), AART (along arc vertical TEC rate) and SRTI (Single Receiver TID Index) are employed to characterize the irregularity degree of the ionosphere. Additionally, a new ionospheric activity indicator, rate of ROT change index (RROT), was proposed based on the single-differenced rate of ionospheric TEC change (ROT). The ionospheric activity indicators ROTI, AART, SRTI and RROT can be easily computed from dual-frequency GNSS signals (e.g., GPS and GLONASS L1 and L2 carrier phase measurements) from regional and/or global GNSS receivers. Specifically, AART and SRTI indicators are used to generate the station-based ionospheric irregularity monitoring products, while ROTI and RROT indicators are preferred to reconstruct global irregularity maps with a temporal resolution of 15 minutes and a spatial resolution of 5 and 2.5 degrees in longitude and latitude, respectively. Along with the ionospheric phase scintillation observations derived from the Canadian High Arctic Ionospheric Network (CHAIN), the temporal and spatial variations of ionospheric irregularity and scintillation are also analyzed during a three-year period starting from 2015.