R010-15
C 会場 ：11/5　AM1 （9:00-10:30）
09:00～09:15

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Impacts on GNSS by ionospheric irregularities observed over Japan on 15 January 2022

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On 15 January 2022, various ionospheric disturbances were observed over Japan. Traveling ionospheric disturbances (TIDs) which were shown to be associated with the volcanic eruption of Hunga Tonga-Hunga Ha'apai, Tonga (Saito, EPS, 2022). Following the TIDs, another types of ionospheric disturbances accompanying enhanced small-scale irregularities represented by the rate of the total electron content (TEC) index (ROTI) were observed at several locations over Japan at geographic latitudes as high as 38N (33.8 in the magnetic latitude). The characteristics of the irregularities appeared to be similar to those associated with the storm-enhanced density (SED) or storm-induced plasma stream (SIPS) observed in the geomagnetic storms (Saito et al., JPGU, 2022). They were unusual ionospheric disturbances, because the geomagnetic activities were not so high as to excite SED or SIPS events. It was also unusual to have strong irregularities at such higher latitudes. At the same time, ionospheric irregularities were also observed at the low latitude part of Japan. In this study, impacts of these unusual ionospheric irregularities on applications of Global Navigation Satellite System (GNSS).

We used GNSS observation data from GNSS receivers of the GNSS Earth Observation Network (GNSS) operated by the Geospatial Information Authority of Japan (GIS). ROTI maps generated by the data from GEONET is used to identify the spatial and temporal variation of the irregularity structures. Closely separated GNSS station pairs are used to estimate the spatial variation of the ionospheric TEC which is equivalent to the propagation delay of the GNSS signals.

GNSS scintillation receivers at Ishigaki (24.3N, 124.2E, 19.6 Magnetic Latitude) are used to observe the small-scale irregularities. A set of closely separated GNSS receivers with mutual distances of 0.1-2.2 km located at the New Ishigaki Airport is used to evaluate the impacts of the ionospheric irregularities on the GNSS ground-based augmentation system (GBAS) which is the aeronautical navigation system to guide aircraft for approach and landing. There were 13 and 10 GPS/Galileo/QZSS satellites transmitting at L1 and L5 bands, respectively and 9 and 9 satellites for L1 and L5, respectively experienced the S4 index stronger than 0.25. However, the spatial TEC variations were not so much as those typically associated with the plasma bubbles. Indeed, the irregularities were associated with TEC depletions embedded in regions of TEC enhancement, which is different from the typical plasma bubbles.

References:
Saito, S. (2022), Ionospheric disturbances observed over Japan following the eruption of Hunga Tonga-Hunga Ha'apai on 15 January 2022, Earth, Planets and Space, https://doi.org/10.1186/s40623-022-01619-0.
Saito, S., Yoshihara, T., Takahashi, T. (2022), Ionospheric irregularities and scintillations during the geomagnetic storm on 15 January 2022, JPGU2022.