# Ionospheric disturbances over Japan and Australia following the eruption of Hunga Tonga-Hunga Ha'apai on 15 January 2022

*Susumu Saito[1], Yuichi Otsuka[2], Atsuki Shinbori[2], Takuya Sori[2], Michi Nishioka[3], Septi Perwitasari[3]

1. Electronic Navigation Research Institute, National Institute of Maritime, Port, and Aviation Technology, 2. Institute for Space-Earth Environment Research, Nagoya University, 3. National Institute of Information and Communications Technology

Around 04 UT on 15 January 2022, Hunga Tonga-Hunga Ha'apai in Tonga caused huge eruption. Propagating atmospheric pressure enhancements on the Earth's surface was observed following the eruption. At the same time, a moderate geomagnetic storm was going on. We investigated complex behaviors of ionospheric disturbances in the period.

We used GNSS data observed by receiver networks to detect ionospheric disturbances as perturbation to the total electron contents (TEC). By using data from 200 selected stations of GEONET (GNSS Earth Observation Network), traveling ionospheric disturbances were observed over Japan. Two types of TIDs were observed. The first one was observed from 07 UT on 15 January 2022. It had a wavelength of about 400km and propagated at 200-400 m/sec in the WNW direction. The second one was observed from 11 UT. It had a wavelength of about 800 km and propagated at 300-400 m/sec in the NW direction. The arrival of the first one was about 4 hours earlier than the arrival of the atmospheric pressure change on the ground, while the arrival of the first one coincided with the arrival of the atmospheric pressure change. The first one was found to include small-scale irregularities represented by ROTI (rate of TEC index), while only some part of the second one had irregularities.

When the first TID was observed over Japan, TIDs propagating in the WSW direction over Australia. The TID structures observed over Japan projected over Australia along the geomagnetic field line had very similar structure of those observed over Australia. This indicates that the first TID observed over Japan is very likely to be caused by mapping of the electric field along the geomagnetic field line. This electric field driven TID may have generated small-scale irregularities as observed as ROTI enhancement.

On the other hand, the TID mapped to the southern hemisphere did not match well that observed simultaneously in the southern hemisphere. This indicates that the mechanisms causing the first and second TIDs were different.

Thus, the ionospheric disturbances observed in the period after the eruption of Hunga Tonga-Hunga Ha'apai was very complex. Further investigation including detailed small-scale structures of TEC as well as numerical and theoretical analysis.

Keywords: Volcanic eruption, Traveling ionospheric disturbance, Ionospheric irregularity, Coupling between surface phenomena and the ionosphere

 