

## **Ionospheric signatures of repeated passages of atmospheric waves by the 2022 Jan. 15 Hunga Tonga eruption detected by QZSS-TEC observations in Japan**

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A large eruption occurred on January 15, 2022, at the submarine volcano Hunga Tonga-Hunga Ha'apai, southern Pacific, and the atmospheric Lamb wave was observed to have traveled round the Earth multiple times with a speed of  $\sim 0.3$  km/s. Here, I compare their atmospheric signature from a dense array of barometers with the ionospheric signatures using total electron content (TEC) data by Quasi-Zenith Satellite System (QZSS) satellites obtained at  $\sim 1,500$  GNSS stations in Japan. I confirmed that the ionospheric disturbances passed over Japan at least four times, first from SE to NW, then from NW to SE, again from SE to NW, and finally from NW to SE. The propagation velocity of the ionospheric disturbances was as fast as the atmospheric Lamb wave, suggesting their origin as upward energy leakage from the troposphere. Although the atmospheric pressure disturbances remained of the order of  $1/1,000$  of the background values, TEC often showed disturbances with amplitudes comparable to the background values. Unlike the barometric records, waveforms and amplitudes of ionospheric disturbances exhibit large diversity along the wavefront, suggesting their turbulent nature. The first passage of the ionospheric disturbance started prior to the arrival of the Lamb pulse. I propose a simple model of upward acoustic wave propagation which qualitatively explains this apparently enigmatic phenomenon.

Keywords: QZSS, Hunga Tonga, TEC, Lamb wave, ionospheric disturbance, atmospheric pressure change