Ionospheric Height and Electron Density Variation caused by the Tonga Volcano Eruption Observed by Ionosonde Network in Japan

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The submarine eruption of the Tonga volcano on January 15, 2022, sent an ash plume up to the stratosphere (~40 km) and created a shockwave that traveled around the globe for several days. This super event has energized the ionospheric research community and several papers regarding ionospheric response using two-dimensional TEC maps have been published. However, there is no study of the ionospheric height variation using an ionosonde network to this date. Here, we report the ionospheric height and electron density variation observed using an ionosonde network from four locations in Japan: Okinawa, Kagoshima, Tokyo, and Hokkaido. A 30-min detrended GPS-TEC data over Japan were mapped to their conjugate points in the southern hemisphere. A traveling ionospheric disturbance (TID) can be seen in the keogram of the conjugated data around 08:00 UTC moving westward, away from the volcano location. The timing of the observed TID agreed well with the start of the increase of the virtual height (h’F) of the bottom layer of the F-region, except for Hokkaido. The increase of the h’F lasted around ~1 hour and then a sharp decrease took place. The peak of increase and decrease were ~45% and ~40% compared to the quiet day, respectively. Another distinct feature was an increase in the critical frequency of the F-layer (foF2) which reached ~2 x compared to the quiet day. An unusual ~3-4 TECU perturbation can also be seen in the TEC data. The peak timings of the TEC and foF2 agreed well with each other. Spread-F events were observed in all locations ~30 mins after the peak of the negative excursion of the h’F which was likely caused by the sharp gradient of the h’F.

Keywords: Tonga volcano eruption, Ionospheric height and Electron density variation, Ionosonde network observation

