

Observation of Global Ionosphere Responses to the Hunga Tonga-Hunga Ha'apai Eruption

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The explosive eruption of the Hunga-Tonga volcano in the southwest Pacific at 0415UT on 15 January 2022 triggered gigantic atmospheric disturbances with surface air pressure waves propagating around the globe in Lamb mode. In space, concentric traveling ionosphere disturbances (CTIDs) are also observed as a manifestation of air pressure waves in New Zealand ~0500UT and Australia ~0630UT. As soon as the air pressure waves reached central Australia ~0800UT, conjugate CTIDs appeared almost simultaneously in the northern hemispheres through interhemispheric coupling, much earlier than the arrival of the surface air pressure waves to Japan after 1100UT. Apart from the conjugate effect in the Asia Pacific Region, CTIDs over Northern and Southern America, Europe and Africa regions were observed. They show long wavelength CTIDs likely driven by the Lamb wave followed by shorter wavelength CTIDs showing gravity wave characteristics. The gravity wave scale CTIDs are secondary waves. Accompanying strong CTIDs over Asia-Pacific region, extreme poleward-expanding conjugate plasma bubbles were seen in the rate of total electron content index (ROTI) over 100-150°E, reaching ~40°N geographic latitude. This is associated with fluctuations in FORMOSAT-7/COSMIC-2 (F7/C2) ion-density measurements and spread-F in ionograms, indicating the plasma bubble of equatorial origin instead of coming from the localized plasma instability. We investigate the physical drivers responsible to the strong poleward expansion of the equatorial plasma bubbles (EPBs) by considering the combined effect of magnetic disturbances and the volcano driven waves. Figure 1 shows the ROTI maps during the local evening of the event day showing the strong EPBs over Asia-Pacific sector, whereas other sectors did not show this peculiar enhancements of EPBs.

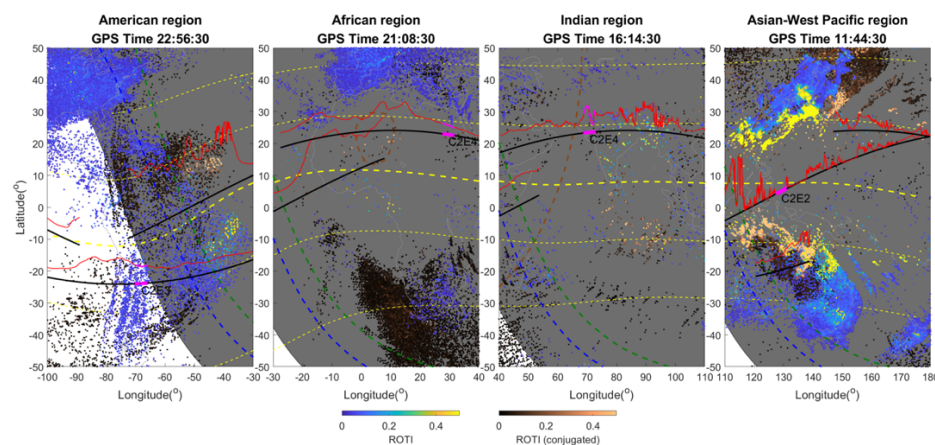


Figure 1. ROTI maps over selected longitude sectors. The selected time in the plot corresponds to the period when the ROTI appeared most prominent over that region. The left colormap indicates the ROTI observed over the given location, while the right colormap denotes the ROTI values projected from corresponding conjugate hemisphere to that location. The red line shows the in-situ ion-density measurements by FORMOSAT-7/COSMIC-2 during a 30-minute interval of the plotted time. The brown dashed line is the simulated ground locations of the barometric Lamb wave. The blue and green dashed lines denote E- and F-region terminators and the gray shaded region represents the regions under the ground-sunset.

References

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