



How the 15 January 2022 Hunga Tonga- Hunga Ha’pai volcano eruption shook the ionosphere

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On January 15, 2022, the Hunga Tonga-Hunga Ha’apai (HHTH) volcano began to erupt at 04:14:45UT. The submarine HTHH volcano sent a plume of ash that reached as high as 33-35 km of altitude and generated a giant atmospheric shock wave that propagated around the world. The event seemed to generate two tsunamis: the one was generated by the underwater eruption and the other was triggered by the atmospheric shock that propagated faster than normal tsunami and was of larger magnitude. The shock waves and tsunami waves reached the ionosphere [e.g., 1, 2, 3].

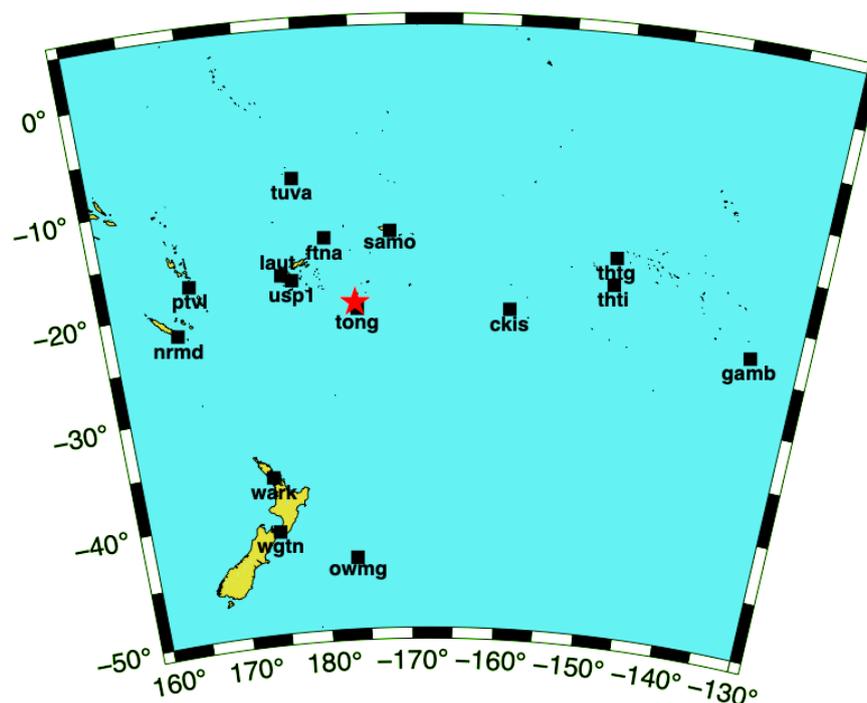


Figure 1. Geometry of GNSS sounding around the HungaTonga – Hunga Ha’apai volcano.

In this contribution, we present a detailed analysis of the ionospheric total electron content (TEC) response to the HTHH explosive eruption. For this purpose, we use data of ground-based GNSS receivers located around the volcano (Figure 1). Each receiver captured up to 30 satellites, providing numerous observation points. The TEC response was registered by the nearest stations ~15 minutes after the eruption onset. It first showed a huge TEC increase up to 5-7 TECU, which represents ~25-30% of contribution relative to the background ionospheric level which is unprecedented. The waveform of the co-volcanic ionospheric disturbances (CVID) was rather complex (Figure 2), most likely, due to several sub-events and explosions.

The first increase was followed by a huge and long-lasting depletion that was, most likely, due to the rarefaction phase of the huge shock-acoustic wave. Finally, some TEC data series showed the occurrence of the acoustic resonance that is occasionally observed during large earthquake and volcanic eruptions.

From ionospheric observations, we estimate the explosion power to be about $4.4 \cdot 10^{15}$ J, i.e. ~1MT in TNT equivalent. From the amplitude of the CVID and their relative contribution, and compared to previous observations of CVID, we conclude that the eruption's Volcanic Explosivity Index (VEI) was at least 5 or even 6 for this event.

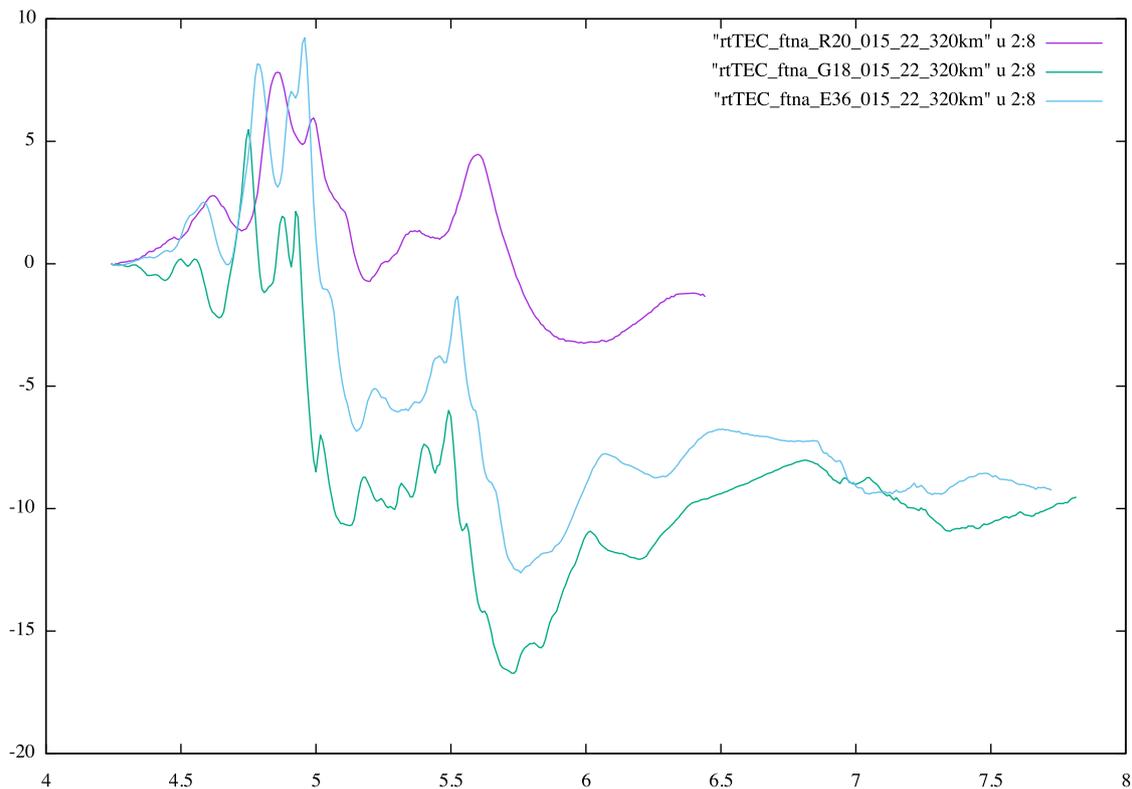


Figure 2. Ionospheric TEC response as registered by the FTNA GNSS receiver and R20, G18 and E36 satellites.

References

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