Ionospheric volcanology: GNSS-TEC observation & modeling of the 2015 Kuchinoerabujima eruption

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Efforts in last decade prove that ionosphere, mainly observed by GNSS measuring the total electron content (TEC), is sensitive to geophysical phenomena as earthquakes, tsunamis, and, more recently, volcanic explosions.
Kuchinoerabujima is a volcanic island located in ~200 km southwest of Kyushu, Japan. The volcano erupted at 0:59 UT May 2015 (VEI 3).
We found a concentric acoustic wave following the eruption in GNSS-TEC time series. We used 1 Hz GEONET (GSI) data for this analysis. The observed wave seems include high frequency (5–10 mHz) pulse disappearing in the first ~300 km around the volcano and a monochromatic wave (~5 mHz) observable for more than ~20 min and reaching the distance of ~400 km. The traveltime indicates the wavefront is almost spherical. We interpreted those signals as a combination of, first, the direct shock wave propagating within the atmosphere/ionosphere and, second, the acoustic wave trapped in the lower atmosphere/ionosphere by the effect of the cut-off frequency change with the altitude.
Our observation are also supported by various ground observations: barometers (NIED; AIST), microphones (NIED; JMA) and broadband seismometer (NIED). We detected ~1 hPa wide frequency range (2–70 mHz) air wave in near-field and ~15 mHz perturbation reflecting or refracting once or twice at ~100 km from the volcano. The difference of frequency components derives from the instruments noise level or dispersion of the wave.
In order to validate our hypothesis we support and discuss our observations with the light of the modeling with the main goal of constrain some physical parameters of interest in volcanology.

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