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

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We investigate very low frequency (20 mHz) acoustic wave excited by the 2015 Kuchinoerabujima volcano eruption, Japan. The explosive volcanic eruption produces large pressure changes in the atmosphere resulting in acoustic waves, with a frequency mainly below about 20 mHz, that reach the thermosphere and induce strongly electron density fluctuation in the ionosphere. We succeeded in detecting perturbations in the total electron content (TEC) measurements with the Japanese dense array of Global Navigation Satellite System (GNSS) receivers, GEONET operated by GSI, and simultaneously pressure changes near surface with barometers (AIST, JMA and V-net operated by NIED) and broadband seismometers, (F-net operated by NIED) shortly after the eruption at 0:59 UT, May 29, 2015. We investigated the frequency components and travel times of the waves to better understand and constrain the volcanic source. Our observation suggested that the perturbation propagated with a spherical wave-front, in accord with ray tracing, and contain a pulse at 12 mHz and the acoustic continuous signature at 5 mHz.

We explain the former pulse centered at 12 mHz and visible in the TEC data as the main signature of the volcanic explosion as it's also visible in the barometric and seismic observations at the ground; and we explain the signal observed at around 5 mHz as a modal wave that leaks to the ionospheric altitude.

Additionally, we show preliminary results of GNSS tomography (Figure) and normal mode summation for a planet with atmosphere. The preliminary result is consistent with the ray tracing assuming of a point source located at the volcano position and spherical wave propagation proving that volcanic explosion are detectable in the atmosphere/ionosphere by TEC measured by GNSS.

The results presented in our presentation, could, in the near future, help to locate and constrain the volcanic source.

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