Relationship Between Amplitudes of Infrasound and Ionospheric TEC Disturbances by Vulcanian Volcanic Explosions

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We will compare infrasound records and TEC (Total Electron Content; number of electrons integrated along the GNSS line-of-sight) perturbations caused by the 2015 Kuchinoerabujima volcano eruption, and will evaluate the usefulness of the volcanic explosion scale inferred from TEC perturbations. Infrasound from a vulcanian volcanic eruption shakes ionospheric electrons at altitude of ~300 km. Heki (2006, GRL) investigated ionospheric disturbances by the 2004 September eruption of the Asama volcano using the GNSS-TEC method. We will compare such TEC changes with infrasound records, and study their quantitative relationship.
We compare amplitudes of changes of slant-TEC and infrasound (JMA volcanic activity reports) of five recent cases of vulcanian eruptions in Japan (the 2004 Asama, the 2009 Sakurajima, the 2011 Shinmoe (twice), the 2015 Kuchinoerabujima). The correlation coefficient was 0.5. We normalized the STEC change amplitude with the local vertical-TEC value inferred from GIM (Global ionospheric maps), and call it “F-scale”.
To confirm the usefulness of this scale, we checked the frequency spectra of infrasound records of the 2015 Kuchinoerabujima eruption. Generally speaking, infrasound by volcanic explosions is considered to have a peak around the period of 2–3 sec (Sakai et al., 2000, Kenshin-jiho [in Japanese]). However components with frequencies higher than ~0.1 mHz attenuate before it reach the ionosphere (Blanc, 1984, Ann. Geophys). Hence, it would be important to know such infrasound frequency spectrum to compare records of the two sensors (TEC and infrasound).
Information on infrasound recorded in volcanic eruptions is available in the JMA volcanic activity reports and Coordinating Committee for Prediction of Volcanic Eruptions reports. According to these documents, two JMA microphones (ACO TYPE7144, TYPE3348) and two NIED barometers (Vaisala PTB100) are installed in the Kuchinoerabujima. The JMA stations are located 2.3 km NE (>62.2 Pa) and 2.8 km NW (13.9 Pa) from the crater and the NIED barometers are located 1.7 km SE (350 Pa) and 1.5 km SW (280 Pa). The JMA microphone is sensitive to frequency band of 0.1–100 Hz, while the sampling interval of the NIED barometers is 1 sec.
We also try to improve observations of TEC oscillations, e.g. by converting slant TEC to vertical TEC and by correcting for the geometric attenuation caused by the propagation distance.

Keywords: GNSS, GPS, Volcano, Ionosphere, Earthquake

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