

Two-dimensional distributions of GPS-TEC disturbances associated with Sakurajima eruptions

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We analyzed the disturbances total electron content (TEC) in association with Sakurajima eruptions. The TEC data were derived from the GNSS Earth Observation Network (GEONET) of the Geospatial Information Authority of Japan (GSI). The intersection of the line of sight connecting each GPS satellite and GPS receiver at an altitude of 300 km is defined as the Ionospheric Pierce Point (IPP). The relationship between the position of the IPP and the two-dimensional distribution of TEC disturbances were examined. We analyzed five cases of volcanic eruptions during 2007 ~ 2014. The magnitudes of the eruptions were evaluated by the maximum value observed by the infrasound meter at Higashikourimoto.

In the eruption occurred on 2009/10/3, clear TEC fluctuations were observed. In the other events, the fluctuations were not observed although the magnitudes of some events were larger than the eruption on 2009/10/3. From the distribution of the TEC fluctuations, it is found that the fluctuations were observed in the south of the volcano after about 12 minutes.

This is because the geomagnetic field in Japan directs north-downward. Since the plasma moves along the direction of the geomagnetic field and the acoustic waves due to the eruption propagate almost parallel to the magnetic field (Otsuka et al. 2006). In order to estimate this effect, we calculated the angle α between the propagation direction of the wave and the geomagnetic field. As a result, TEC fluctuations were observed in the region where $|\cos \alpha| > 0.9$.

Since the acoustic waves are compressional, and TEC is the integral of the electron density in the line-of-sight direction, the magnitude of the TEC fluctuations depends on the direction of the acoustic waves and lines of sight between satellites and receivers (Heki, 2006). To estimate the effect of this relation, we also calculated the angle β between the propagation direction of the waves and the line of sight. As a result, TEC fluctuation was observed in the region of $|\cos \alpha| > 0.9$ and $|\sin \beta| > 0.8$.

TEC fluctuations are observed in the area where the influence of the geomagnetic field is sufficiently large and the angle between the propagation direction of the atmospheric wave and the line of sight of the observation is close to a right angle. It is possible to observe fluctuations that are not visible in the TEC data as they are by making corrections for these factors.

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