

The relationship between ionospheric disturbances detected by HFD and ground perturbations associated with earthquakes

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Many studies have reported that ionospheric disturbances occur after giant earthquakes. One of the causes is the acoustic wave excited by surface waves propagated on the ground from the epicenter. In this study, we compared the ionospheric vertical drift velocity calculated from HF Doppler (HFD) observation and vertical ground motions recorded at seismometer directly beneath the reflection point of the HFD radiowave in order to elucidate relationships between them. The HF Doppler observation is able to detect ionospheric disturbances since this can observe ionospheric vertical drift from Doppler shift of HF radiowaves transmitted from the Chofu campus of The University of Electro-Communications. In this study, using Doppler shift data for 5006 kHz, ionospheric disturbances associated with earthquakes are detected. To obtain accurate vertical drifts, we determined reflection altitudes of radiowave from ionogram data (Kokubunji) using POLAN (ionospheric density profile calculation software). For seismometer data, we used 2 types of seismic networks installed by NIED, Strong-motion Seismograph Networks (K-NET, KiK-net) and Broadband Seismograph Network (F-net).

We examined the correlation of the maximum values of ionospheric vertical drift velocity and vertical velocity of ground motion for 30 events ($M \geq 6$, 2003~2013). HFD observatories are Sugadaira, Oarai, and Iitate. The closest seismometer from each reflection points were selected.

As for Sugadaira observatory (20 events), ionospheric velocity tends to increase in proportion to the square root of the ground velocity regardless of types of seismometers. In the other two observatories (Oarai, Iitate), ionospheric velocities are not proportional to square root of the ground perturbations. This is because sufficient events are not supplied (6~12 events) in these observatories. However, the ionospheric vertical velocity increases with the ground velocity. If the numbers of the events are larger, the correlations of these observatories would be the same as the result of Sugadaira.

Keywords: ionosphere, HFD, earthquake, acoustic wave, seismometer, ground perturbations