

Examination of ionospheric disturbances at different altitudes associated with Tohoku earthquake using HF Doppler sounding

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It is reported that ionospheric disturbances occur after giant earthquakes. One of the reasons for these disturbances are the infrasound wave excited by ground motions.

The infrasound wave propagates upward and produces perturbations of electron density in the ionosphere. Such perturbations are detected by a network of ground-based GPS receivers as TEC perturbations. Using these TEC perturbations, horizontally propagation of the ionospheric disturbances from the epicenter is examined. However, characteristics of vertical propagation of infrasound have been rarely reported. In this study, the coseismic ionospheric disturbances in the different altitudes are examined using HF Doppler (HFD) and GPS-TEC. The HF Doppler sounding system is enable to observe the vertical speed of the ionosphere in the midpoint between the transmitter and the receiver at the different altitudes. We observed fluctuations induced by Tohoku earthquake. The ionospheric disturbances determined by HFD and TEC data were observed about 9 and 10 minutes after the surface wave arrived below the observation point, respectively. Because it takes about 20 minutes for the acoustic wave to arrive directly from the tsunami to HFD observation point, the initial disturbances observed by HFD and TEC were excited by the ground motion. The frequencies of the disturbance. Obtained by the seismograph and HFD data (5.006, 6.055 MHz) were about 3 - 20 mHz, and those in the HFD data (8.006, 9.595 MHz) are 3 - 5 mHz. HFD data (8.006, 9.595 MHz) the frequencies of the disturbances obtained by, 3 - 5 mHz, were the same as those of TEC disturbances associated with earthquakes. In the lower frequency components with 7 - 20 mHz, the acoustic wave excited by the seismic wave tend to attenuate at a high altitudes. Therefore, it is considered that the variation attenuated with the data in HFD data (8.006, 9.595 MHz).

Keywords: ionosphere, earthquake, HF Doppler, TEC