Coseismic ionospheric disturbances at different altitudes observed with HF Doppler

Kazuto Takaboshi[1], *Hiroyuki Nakata[1], Toshiaki Takano[1], Ichiro Tomizawa[2]

1.Graduate School of Engineering, Chiba University, 2.Center for Space Science and Radio Engineering, The University of Electro-Communications

Many studies have reported that ionospheric disturbances occur after large earthquakes. One of the main causes for these disturbances is acoustic wave excited by Rayleigh wave propagated on the ground from the epicenter. The acoustic wave perturbes ionospheric electron density in propagating the ionosphere. Several observations, such as GPS, HF Doppler, the ionogram, observed the ionospheric perturbations at appropriate altitudes for each observations. However, there are few reports for the direct demonstration of vertical propagation of acoustic waves using the single observation. Here, we have observed ionospheric disturbances at the different altitude simultaneously using HF Doppler system (HFD). In this system, radio waves at four different frequencies are observed, implying that the ionospheric perturbations at up to four different altitudes are observed by this system. In examining earthquakes occurred around Japan since 2003, we have found 3 events in which the ionospheric perturbations were observed with the multiple frequencies. From their wave forms, the higher components of the perturbations decay as the altitude is higher. In conjunction with the seismometer data observed below the reflection point of the HFD radio waves, the amplification ratio of the atmospheric wave from ground to the ionosphere have calculated in 3 bands (10.0-25.6, 25.6-45.5, and 45.5-76.9 mHz). Theoretical amplification ratio were also calculated based on energy conservation law, considering absorption by viscosity, thermal conductivity, and relaxation losses of atmosphere (Chum et al., 2012). In comparison of the theoretical amplification ratio, that determined by HFD is rather smaller. However, their height profiles are qualitatively consistent each other; higher frequency components are more greatly damped in at high altitude. There might be the reasons for this difference; attenuations of wave energy that is not considered, differences between model parameters and real values, and lesser conversion efficiency when ground motions excite infrasound waves.

Keywords: Ionospheric perturbation, earthquake, HF Doppler, acoustic wave

