D-region ionospheric disturbances after the 2011 off the Pacific coast of Tohoku Earthquake using LF transmitter signals

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So far, a lot of studies for the F-region ionosphere associated with earthquakes have been reported, although few studies for the D-region ionosphere have reported. It is difficult to observe the D-region electron density because of high collision frequency between plasma and the neutral atmosphere. In this study, we investigate the D-region disturbances associated with the 2011 off the Pacific coast of Tohoku Earthquake using intensity and phase of LF transmitter signals. The phase was converted to reflection height based on Earth-ionosphere waveguide mode theory. The reflection height corresponds to electron density in the D-region. The propagation paths are Saga-Rikubetsu (RKB) and BPC(China)-RKB. As a result, clear oscillations of the intensity over both propagation paths were simultaneously observed about 6 minutes and 12 seconds after the earthquake onset. The both periods of the intensity and reflection height oscillations were about 100 s. The one-to-one corresponding between the intensity and reflection height was not seen clearly. The changes of the intensity and reflection height for the oscillations were about 0.1 dB and 50 - 65 m, respectively. The time difference between the earthquake onset and the oscillations was consistent with the propagation time of the Rayleigh waves (seismic waves) propagating from the epicenter to the LF propagation paths along the Earth surface, plus the propagation time of acoustic waves propagating from the ground to 70 km altitude vertically. Thus, the LF oscillations may be caused by the acoustic waves excited by the Rayleigh waves.

