

Study on variations in the D-region ionosphere after the 2015 Nepal earthquake using VLF/LF transmitter signals

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In the D-region ionosphere, oscillations of LF (low frequency, 30-300 kHz) transmitter signals with a period of 100 s were reported about five minutes after mainshock of the 2011 Tohoku earthquake [Ohya et al., JGR, 2018]. The reflection height of the LF waves was estimated to be 67 km at 05:46 UT on 11 March, 2011, and the LF oscillations were caused by acoustic waves excited by seismic Rayleigh waves based on simulation of neutral atmosphere. However, this is only one report for coseismic disturbances in the D-region ionosphere. In this study, we investigate the D-region ionospheric variations associated with the 2015 Nepal earthquake using VLF (very low frequency, 3-30 kHz)/LF transmitter signals that reflect in the D-region ionosphere. The mainshock of the Nepal earthquake (Mw 7.9) occurred at 06:11:26 UT on April 25, 2015. The propagation path was BPC (68.5 kHz, 34.63°N, 115.83°E) - TKN (Takine, Fukushima, 37.34°N, 140.67°E). Intensity and phase were observed with a sampling time of 0.1 s. We compared between the VLF/LF transmitter signals and vertical velocity data of seismometers provided by IRIS (Incorporated Research Institutions for Seismology), USA. Based on wavelet analysis, a periodic component of about 100-300 s was seen in both the VLF/LF signals and seismic velocity at arrival time of acoustic waves excited by Rayleigh waves. The coherences between the VLF/LF variation and the seismic velocity were 0.91 and 0.85 for amplitude and phase, respectively, which were significant at the 95% confidence level. If the acoustic waves were excited at the midpoint of BPC-TKN propagation path by the Rayleigh waves that propagated horizontally from the epicenter, and propagate upward up to the D-region height 70 km, the propagation time from the ground to 70 km height would be 225 s. The propagation time of the Rayleigh wave calculated from seismograph data was 1057 s, and the whole propagation time of the Rayleigh and acoustic waves was 1252 s (= 21 min and 22 s). The arrival time of the acoustic waves was in good agreement with the VLF/LF oscillations. Therefore, the acoustic waves excited by the Rayleigh waves caused the ionospheric variations. In this session, we will discuss this VLF/LF variations in more detail.