Analysis of vertical profiles of ionospheric disturbances caused by the tsunami associated with the Tohoku earthquake using GPS occultation observation

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It is reported that ionospheric disturbances are caused by large earthquakes. One of the causes is the infrasound wave excited by surface waves and/or tsunami. The characteristics of the ionospheric disturbances horizontally propagating after large earthquakes have been examined by using a network of ground-based GPS receivers. On the other hand, the vertical propagation of ionospheric disturbances, especially due to tsunamis, is rarely reported. In this study, to examine the vertical propagation of the ionospheric disturbances due to tsunamis, we have examined electron density profiles observed by GPS radio occultation measurements of FORMOSAT-3/COSMIC satellites. The data is provided by CDAAC (COSMIC Data Analysis and Archive Center). We analyzed the ionospheric disturbances caused by a tsunami associated with Tohoku Earthquake (M9.0) occurred at 5:46:18 on 11th March 2011 (UTC). We analyzed density profiles observed within 3 hours after the passage of the tsunami. Extracting the fluctuation components from observed height profiles of ionospheric electron densities using the Chapman model, short-wavelength fluctuations of 10-30 km were confirmed in data points observed in the northeast direction from the epicenter. On the other hand, there was no such short-wavelength fluctuation in the data observed in the southeast direction from the epicenter. In addition, we analyzed the data observed about 8 hours after the passage of the tsunami. Short-wavelength fluctuation was still confirmed in the data observed in the northeast direction from the epicenter. The results showed that the fluctuations continued for a long time after the arrival of the tsunami. The tsunami observation data using DART (Deep-ocean Assessment and Reporting of Tsunami) system provided by NOAA (National Oceanic and Atmospheric Administration) shows that the sea surface was continuously disturbed for a long time after the passage of the tsunami. This may be related to the fact that the ionospheric disturbance appeared for a long time in this analysis.

Keywords: ionospheric disturbance, occultation observation

