

Variation of ionospheric TEC before and after the Iwate-Miyagi Nairiku Earthquake in 2008

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Ionospheric Total Electron Content (TEC) can be measured easily by Global Positioning System (GPS), and GPS-TEC technique has been widely used as a tool to investigate various disturbances in ionosphere. In Japan, dense continuous GPS array GEONET is available, and many results have been reported on coseismic ionospheric disturbance (CID), traveling ionospheric disturbance (TID), disturbance associated with volcanic eruptions, and so on.

Several studies report that TEC decreased 3-5 days before earthquakes in China, America and Taiwan. Global Ionospheric Maps (GIM) are made analyzing worldwide GPS stations and are available on line. Liu et al. (2009) analyzed such GIM before and after the 2008 Wenchuan earthquake (Mw 7.9) and found TEC decrease in afternoon hours from 6 days to 4 days before the earthquake. They also studied TEC behavior before 35 past earthquakes (M larger than 6) during the last decade, and found similar TEC decreases in 3-5 days before 17 earthquake (M larger than 6.3).

The 2008 Iwate-Miyagi Nairiku Earthquake (Mw 7.1), a relatively large earthquake that occurred within the Japanese Islands, offers an ideal situation to study its precursory electromagnetic signals. Here we investigate temporal and spatial changes in TEC using GEONET GPS data and GIM, and discuss the existence of precursors as well as CID.

In this study, we analyzed RINEX data of the Mizusawa GPS station located near the epicenter over a month, and estimated TEC in zenith direction every hour. Original data files are split into individual days. To stabilize the TEC solution at day boundaries, we estimated common values for satellite phase biases with arcs crossing the day boundaries. We further stabilized the solution by converting differences in subionospheric point (SIP) longitudes into those in time. We found unexpected TEC decrease of a few hours duration including the time of the earthquake, but its causal relationship with the earthquake remains unknown. We also applied the envelope method (Dautermann et al., 2007; Liu et al., 2000) to objectively detect TEC anomalies before earthquakes.

GIM in the same period suggested that there were several days showing TEC decreases, but they do not occur only before earthquakes, so it would be premature to discuss their relevance to the earthquake.

References

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