Analysis of GPS-TEC variation associated with large earthquakes using GAMIT

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Many ionospheric disturbances associated with seismic activities have been reported in various methods (e.g., Hayakawa and Molchanov, 2002). Among of them, analysis of electron density changes in the ionosphere seems to be one of the promising methods. We analyzed the variation of GPS-TEC in order to detect the anomalies prior to the 1999 Chi-Chi earthquake (M=7.3) by carrying out the monitoring of the ionospheric total electron content (TEC) derived from the signals recorded by ground-based GPS receivers.

GAMIT 10.21, which is developed by Massachusetts Institute of Technology and Scripps Institution of Oceanography, was used for the analysis. This software is globally utilized in geodesy and geophysics. From the data of six receivers in Taiwan (S101 (25.02N, 121.54E), S102 (22.04N, 121.56E), S103 (23.56N, 120.48E), S104 (22.82N, 121.19E), S105 (22.95N, 121.11E), S23r (22.65N, 120.61E)), we created two-dimensional GPS-TEC maps of the area of 21-26N and 119-123E. In this analysis, the single layer model of the ionosphere was adopted (height = 325 km) and the cutoff of satellite elevation angle was set at 45 degrees. We investigated the differential TEC (dTEC) defined by dTEC(t) = TEC(t) - TEC_model(t). Here TEC_model means the median values of TEC over the previous 15 days.

As a result, it is found that dTEC was decrease on 1, 3, and 4 days before the Chi-Chi earthquake in the large area over Taiwan. In the period, the influence by geomagnetic disturbance considered to be small because the Dst index was not changed notably. These results are in good agreement with Liu et al. (2000, 2001), and have suggested that the ionospheric disturbances prior to seismic activities can detect using GPS-TEC. It is required a detailed statistical check for the significance of anomalous changes. However, it suggests the existence of GPS-TEC anomalies associated with large earthquakes. We think that GPS-TEC contributes to the elucidation of the mechanism of the Lithosphere-Atmosphere-Ionosphere coupling.

In this presentation, we also explain the analysis result of the GPS-TEC changes associated with 2004 Sumatra earthquake (M=9.0).

References

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