Ionospheric anomalies possibly associated with large earthquakes

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Many anomalous electromagnetic phenomena possibly associated with large earthquakes have been reported. TEC (Total Electron Contents) anomaly is one of the most promising phenomena preceding large earthquakes. Recently, some statistical studies have revealed that negative TEC anomalies significantly appear a few days before large earthquakes occurred in Indonesia, Taiwan, and China. However, those regions are located in geomagnetic low latitude and affected by the Equatorial ionization anomaly (EIA).

In this paper, we examine pre-earthquake ionospheric anomalies in time series and perform a statistical test by using TEC derived from global ionosphere maps (GIM) around the Japan area for the first time. The normalized GIM-TEC (GIM-TEC∗), which is computed based on 15 days backward running mean of GIM-TEC, have been investigated for minimizing possible confounding effects of consecutive earthquakes and identify the abnormal signals. Superposed epoch analysis have been performed for the statistical analysis of TEC anomalies associated with M>=6.0 earthquakes during the 12-year period of May 1998 - May 2010. The statistical result indicates the significance of the positive TEC anomalies 1 - 5 days before earthquakes within 1000 km from the epicenter around Japan. Furthermore, those anomalies depend on the epicentral distance and magnitude of earthquakes.

Keywords: Total Electron Content, Ionosphere, earthquake, earthquake precursor, Global Ionosphere Maps, Superposed Epoch Analysis