



Long time series analysis of ionospheric TEC disturbance over seismically region in southwest China during low solar activity

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Recently, there are growing interests in studying the seismo-ionospheric disturbance prior to earthquakes, mainly including the anomalies in the electric field, magnetic field and plasma parameters. However, there are still some controversies over this topic, mainly because of strong day-to-day variability of the ionosphere itself. It is hard to determine whether the different forms of ionospheric disturbances are associated with earthquakes or not.

Using data of Crustal Movement Observation Network of China (CMONC) and IGS (International GNSS Service), we attempt to give a statistical investigation about the total electron content (TEC) perturbation before 30 Mw6.0+ earthquakes during January 2000 to December 2010 in China. To determine the abnormal TEC signals, a quartile-based process is performed. At each time point we calculated the median M using the TEC values at the same local time for the preceding 15 days. In addition, we calculated the maps of differential TEC from global ionosphere maps (GIM) in the above period. It is shown that TEC anomalies were detected before 20 earthquakes, nearly 67%. The anomalies represent positive before most events and occurred mostly within 2-6 days before the shocks, significantly during the afternoon period, 1200–2000LT. Part of perturbations appeared more than one time. Moreover, the affected area of TEC is not coincide with the vertical projection of the epicenter but shifts equatorward and is controlled by equatorial ionization anomaly (EIA) crest.

On the other hand, we analyzed variations of TEC over southwest China during a period of low solar and geomagnetic activity in April–October 2008, based on the data of CMONC. During that time, six large earthquakes with magnitude $M \geq 6.0$ occurred around the southwest region of China. The method to detect abnormal TEC signals is same with above statistical study. Known that the decisive role in the ionosphere state is performed by space weather effects, we compared the TEC variations with time series of EUV solar radiation, Bz component of the interplanetary magnetic field (IMF), index of geomagnetic activity Dst and planetary index Kp, respectively. It is found that the observed anomalies in the regional TEC were in good correlation with the variations of above solar and geomagnetic activities. We have not detected obvious TEC disturbance before five earthquakes expect for Wenchuan earthquake. In order to additionally check the spatial occurrence of the observed anomalies, we chose a ‘check-region’ with the same geomagnetic latitudes as the epicentral area of the six considered earthquakes, and analyzed the TEC changes. The result shows that the time series of anomalous TEC in ‘check-region’ is similar to the epicentral area, which was dominated by space weather.

Therefore, we are suspicious of the results of statistical investigation showed here or other similar papers, which indicates the difficulties in identifying earthquake precursors in the ionosphere TEC. The seismo-ionospheric coupling process is complex, and it is necessary to strengthen the observation of multi-parameters on the ground, in the atmosphere and ionosphere synchronously.