Geophysical Research Abstracts,
Vol. 11, EGU2009-8440, 2009
EGU General Assembly 2009

Investigation of Ionospheric Disturbance due to Strong Earthquakes Using Total Electron Content

F. ARIKAN (1), S. KARATAY (2), and O. ARIKAN (3)

(1) Hacettepe University, Ankara, Turkey (arikan@hacettepe.edu.tr, 90 312 2992125), (2) Firat University, Elazig, Turkey (karatays@gmail.com), (3) Bilkent University, Ankara, Turkey (oarikan@ee.bilkent.edu.tr, 90 312 2664192)

The reliable and accurate prediction of highly destructive earthquakes hours before their impact is extremely beneficial both economically and socially. Increased observations of the ionosphere with the ionosondes, both top-side and bottom-side, before, during and after the strong earthquakes suggest that there are several disturbances and variations in the ionosphere especially in the critical frequency, ion temperatures and Total Electron Content (TEC) distributions. Therefore, many scientists all over the world suspect that the major cause of the disturbance of the ionosphere before, during and after the seismic activity might be due to the variation in the electromagnetic (EM) field and the chemical composition of the ionosphere. There have been various theories that try to explain EM anomalies associated with pre-seismic activity, and several theories have been formulated to explain their causes. Yet, ionosphere is a layer of the atmosphere which is an integral part of whole geomagnetic and geological framework. Therefore, relying on the evidence that there have been variations observed in the VLF, LF and HF signals, magnetic field of the earth and in the local electric field, a unified theory, that would explain the mechanism and cause of the disturbance in the layers of atmosphere, is a widely investigated research topic. In this study, the relation between Total Electron Content (TEC) estimates obtained from Earth-based GPS receivers and the strong earthquakes is examined using various statistical analysis tools both for the period that includes the earthquake, and ionospheric quiet and disturbed days during which no strong earthquakes are registered. For this investigation, five earthquakes in Japan that occurred over magnitude 5.9 in Richter Scale between 2003-2008, and the Sichuan, China earthquake with magnitude 7.9 that occurred on 12 May 2008 are chosen. For each earthquake, IONOLAB-TEC is computed for 15-days before and after the registered earthquakes; for the chosen ionospheric quiet days; and for the days which have very strong geomagnetic disturbance. For the statistical analysis, the cross-correlation coefficient (CC) which is used in the literature before, and the Kullback-Leibler Divergence (KLD) and L2-Norm Measures (L2M) which are used for the first time in literature in this context, are applied to the data sets. The analysis is performed on three different groups. In the first group, the CC, KLD and L2M are applied between neighboring GPS stations for the period before and after the earthquakes, ionospheric quiet day period and the ionospheric disturbed day period. In the second group, the TEC estimates for each day are compared with the TEC estimate of the consecutive day both for the earthquake period, quiet day period and disturbed day period. In the third group, an average quiet day TEC estimate is obtained for each station and the TEC estimates for the earthquake period and disturbed day period are compared with this average quiet day TEC estimate using CC, KLD and L2M. In total, more than 9500 values are computed and sorted according to magnitude of the earthquake, distance between the GPS stations, distance between the GPS station and the earthquake epicenter, depth of the epicenter, the 15-day period before the earthquake, 15-day period after the earthquake, ionospheric quiet day and disturbed day periods, and finally for the performance of CC, KLD and L2M. It is observed that none of the used methods can single out to be used as an earthquake precursor or an alarm signal. This is basically due to the fact that there are various external seismic and computational parameters that may contribute to a definitive conclusion. Some anomalies that are observed with limited numbers for the above mentioned methods for the earthquake days have also occurred for some quiet and disturbed days, especially with CC method. For the earthquakes with scale larger than 6, and with a certain proximity to the epicenter, the possibility of generating an alarm signal is more likely with a future detailed comparative study of the estimated TEC from nearby GPS stations in space and time.