Characteristics of Ionospheric Electron Density Anomalies related to Geomagnetic Storms and large Earthquakes

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Pre-seismic electron density anomalies have been a widely discussed phenomena in ionospheric studies. However, it is not well-known what causes these anomalies and what is the possible source mechanisms. These are still having not been elucidated questions and more investigations are needed to make clear that phenomena. The another question is how to distinguish ionospheric anomalies from other disturbances such as geomagnetic storms. In many cases, simultaneous geomagnetic activities make it difficult to detect an earthquake precursor effect in the ionosphere. Therefore, a characterization and classification of magnetic storm and earthquake signatures is necessary to make reliable forecasting. For this purpose, in this study, we investigated the similar and differing effects of magnetic storms and earthquakes on the ionospheric composition.
Int this study, the time period after magnetic storms and before earthquakes were mainly investigated. The selection of earthquakes was carried out between 1998 to 2013 with M>6 and depth<30 km. Following this, to detect the anomalous behaviour, we examined the temporal and spatial distribution of TEC values of those cases by using GIM-TEC data. Thus, we found that 28 earthquakes had caused anomalous changes in the ionosphere. We further examined these earthquakes with tomography method to investigate their 3D distributions. There we found that 13 of them had also shown the similar anomalous effect. Meanwhile, magnetic storm cases were chosen between 1998 to 2013 within the intense storm category in which Dst < -100 nT. And the onset time was selected in daytime hours from 6 am to 6 pm. By applying this criteria, 42 magnetic storms were extracted. Among them, we selected arbitrarily 10 different storm cases and same analysis steps was followed to determine the anomalous changes. For TEC analysis, we mainly made use of TEC data from both local receivers (GPS-TEC) and global receivers (GIM-TEC). The GPS-TEC data sets were inverted to electron density form (Ne) in the tomography process with neural networks to examine the 3D electron density distribution of the ionosphere. On the other hand, since the TEC is sometimes slower to respond to compositional changes in the ionosphere, we further employed the ionospheric foEs, NmF2 and hmF2 quantities as complementary data. There, we prepared time series figures of these parameters and compared their responses against storm and earthquake effects. Results will be presented in the presentation.

Keywords: Geomagnetic Storm, Earthquake,TEC(Total Electron Content), Tomography, foEs, NmF2, hmF2