Using the CWB geophysical data to study pre-seismic anomalous signals preceding large earthquakes in Taiwan

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The Central Weather Bureau (CWB) build the Taiwan Geophysical Observation Network for monitoring the possible earthquake precursor signals. We analyze groundwater, earth tide and magnetic field data, and the data from the continuous GPS (cGPS) network. Wherein, we can use GPS data to calculate the total ionosphere electron content (TEC), or analyze baseline variations using high-quality cGPS data. In this study, we use the CWB geophysical monitoring data in an attempt to characterize the possible pre-seismic precursor signals of large earthquakes, which occurred in the past few years in Taiwan. For instance, the stress caused by the formation of regional geomagnetic field changes before the occurrence of many large earthquakes. The CWB had set up 12 stations to monitor variations of local geomagnetic total intensity field in Taiwan. The Ultra-Low Frequency (ULF) Analysis could be applied to investigate earthquakes, which is done using cross correlation values between the earthquake-related (0.01 – 0.1Hz) and relatively low (0.001 – 0.01Hz) frequency bands. When the correlation coefficient value stays low for several days, it may be related to the earthquake precursors. Furthermore, numerous studies indicated the possibility of a relationship between the ionosphere TEC short-term disturbances and large earthquakes. The Global Navigation Satellite System (GNSS) is integrated lots of Satellite System of different countries. The GPS and Beidou satellite system from United States and China are both included. The new TEC calculation technique of CWB provides now better spatial resolution because of the new Beidou satellite system of China. We use Global Ionosphere Map (GIM) to analyze the relationship between TEC anomaly variation and earthquakes ($M_L > 6$, depth < 30 km) occurred in Taiwan from 2000 to 2016. We recognize 15 events that show the TEC anomaly about 1-3 days before an earthquake. The pre-seismic baseline variation identified through cGPS data can also provide us some possible precursor signals although these tend to be long-term (months or years) signals. In this study, we attempt to exploit all the pre-seismic anomalous observations to propose a simple model, which can help us to detect precursor signals of large earthquakes.

Key words: cGPS, GNSS, ULF, TEC, precursor, Central Weather Bureau.