

# Seismo-ionospheric precursors (SIPs) of the TEC associated with the 21 September 1999 M7.3 Chi-Chi earthquake and the statistical analyses on SIPs in Taiwan

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This study revisits the total electron content (TEC) derived from ground-based GPS receivers during the 21 September 1999 M7.3 Chi-Chi earthquake. It is found that TEC over the epicenter anomalously/significantly decrease in the afternoon period day 1, 3, and 4 before the Chi-Chi earthquake. We further statistically examine pre-earthquake ionospheric anomalies (PEIAs) of TEC associated with M greater or equal to 5.0 earthquakes in Taiwan about 6 years before the Chi-Chi earthquake (1994/1/1-1999/9/20) and find the characteristic of seismo-ionospheric precursors (SIP) in the polarity (i.e., increase or decrease anomalies), local time, lead time, duration, etc. of these earthquakes. The statistical result shows that the SIP characteristic is TEC significantly/anomalously decreasing in the afternoon period day 1-5 before the M greater or equal to 5.0 earthquakes, which suggests that the anomalies appearing day 1, 3, and 4 before the Chi-Chi earthquake most likely are SIPs. Statistical analyses of z test and ROC (receiver operating characteristic) curve are also applied to find the characteristics of temporal SIPs of TECs in Taiwan during 1994 -2019.

Keywords: Seismo-ionospheric precursor, total electron content, Chi-Chi earthquake, receiver operating characteristic