Deep learning of ionosphere anomaly for prediction of magnitude M≥6.0 earthquakes in Taiwan

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Abstract

A short-term (30 days before an earthquake) prediction of an earthquake is a big challenge in seismology. We apply deep learning to the ionospheric total electron content (TEC) data between 2003 and 2019 to predict the occurrence days of earthquakes with a magnitude M ≥ 6.0 in Taiwan. The bidirectional Long Short-Term Memory (Bi-LSTM) network is used to obtain the sequential TEC variations. The features include sequential vectors of TEC, the geomagnetic index Dst, the solar activity index F10.7, sunspot number (SSN), and solar emission index Lyman-α. The daily values of the features, F10.7, SSN, and Lyman-α, are converted into hourly values, depending on the solar elevation angle. The occurrence of earthquakes can be predicted by the difference between the TEC obtained from the deep learning model and the observed TEC data. Eighteen trained models are used to predict the TEC data for 32 positive periods, each consists of 30 days before an earthquake of M ≥ 6.0, and 25 negative periods without any earthquake of M ≥ 5.3. The results show that all positive cases are successfully predicted, giving a true positive rate (TPR) of 100%. Among the 25 negative cases, 12 of them are predicted “NO”. Overall, high accuracy of 77.19% is obtained. The hourly features and deep learning developed in this paper can be used to provide a daily forecast scheme for M ≥ 6.0 earthquake in Taiwan.