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Assessment of ULF geomagnetic precursor for short-term earthquake forecast

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There are many reports on earthquake precursors recently. Among of them, ULF magnetic anomaly is one of the most promising phenomena. Previous statistical studies showed that there were correlations between seismo-electromagnetic phenomena and sizeable earthquakes in Japan. In this paper, utilizing Molchan's error diagram, we evaluate whether these phenomena contain precursory information and discuss how they can be used in short-term forecasting of large earthquake events. In practice, for given series of precursory signals and related earthquake events, each prediction strategy is characterized by the leading time of alarms, the length of alarm window, the alarm radius (area) and magnitude. The leading time is the time length between a detected anomaly and its following alarm, and the alarm window is the duration that an alarm lasts. The alarm radius and magnitude are maximum predictable distance and minimum predictable magnitude of earthquake events, respectively. We introduce the modified probability gain (PG') and the probability difference (D') to quantify the forecasting performance and to explore the optimal prediction parameters for a given electromagnetic observation. The results show that the earthquake predictions based on electromagnetic anomalies are significantly better than random guesses, indicating the data contain potential useful precursory information. Meanwhile, we reveal the optimal prediction parameters for both observations. The methodology proposed in this study could be also applied to other pre-earthquake phenomena to find out whether there is precursory information, and then on this base explore the optimal alarm parameters in practical short-term forecast.