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Predicting aftershocks using ensembles following the May 12 2008 Wenchuan China earthquake

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This research considers forecasting the number of large aftershocks in a given interval of time following the May 12, 2008 Wenchuan China earthquake (Mw 7.9). First, we investigate the Gutenberg-Richter frequency distribution as a potential forecasting technique. The Gutenberg-Richter distribution quantifies the linear relationship between the frequencies of earthquakes and their sizes, and indicates how many earthquakes greater than or equal to the magnitude M can be expected in some time period for a given region. To build our model we divide the aftershock sequence into smaller discrete time periods. We then calculate the parameters of the GR distribution for each period, and use these parameters to predict the number of earthquakes in each subsequent period. We compare these estimates to those obtained using well known models, Omori-Utsu and ETAS. The parameters of these models are calculated using all data available up to a point in time, and these parameters are used to forecast the number of earthquakes in a subsequent period of time.
The parameters of the Gutenberg-Richter distribution are calculated using shorter periods of time than the Omori-Utsu or ETAS parameters, and therefore the Gutenberg-Richter predictions can be considered as containing instantaneous information about the aftershock sequence. The Omori-Utsu and ETAS predictions are less sensitive to instantaneous fluctuations in earthquake rate. We then combine the Omori-Utsu or ETAS predictions with the Gutenberg-Richter predictions to create a consensus forecast of the expected number of aftershocks above a designated magnitude. The ensemble prediction is a long term prediction modified with instantaneous information, and should therefore do better than either type of prediction individually.
The results are illustrated over a variety of interval lengths of 10 to 20 days for a longer period of data than previously investigated by the authors. The numbers of earthquakes predicted by each technique are presented. The results show that the forecasts created by the windowed Gutenberg-Richter model perform as well as the more common aftershock forecasting methods. The ensemble forecasts are also shown to produce reliable predictions, and are more accurate when forecasting the number of aftershocks greater than or equal to M5.

Keywords: Wenchuan, aftershocks, earthquake prediction, ensembles