Simultaneous estimation of b-values and detection rates of earthquakes for the application to aftershock probability forecasting

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Reasenberg and Jones [1989, 1994] proposed the aftershock probability forecasting based on the joint distribution [Utsu, 1970] of the modified Omori formula of aftershock decay and Gutenberg-Richter law of magnitude frequency, where the respective parameters are estimated by the maximum likelihood method [Ogata, 1983; Utsu, 1965, Aki, 1965]. The public forecast has been implemented by the responsible agencies in California and Japan. However, a considerable difficulty in the above procedure is that, due to the contamination of arriving seismic waves, detection rate of aftershocks is extremely low during a period immediately after the main shock, say, during the first day, when the forecasting is most critical for public in the affected area. Therefore, for the forecasting of a probability during such a period, they adopt a generic model with a set of the standard parameter values in California or Japan.

For an effective and realistic estimation, I propose to utilize the statistical model introduced by Ogata and Katsura [1993] for the simultaneous estimation of the b-values of Gutenberg-Richter law together with detection-rate (probability) of earthquakes of each magnitude-band from the provided data of all detected events, where the both parameters are allowed for changing in time. Thus, by using all detected aftershocks from the beginning of the period, we can estimate the underlying modified Omori rate of both detected and undetected events and their b-value changes, taking the time-varying missing rates of events into account. The similar computation is applied to the ETAS model for complex aftershock activity or regional seismicity where substantial missing events are expected immediately after a large aftershock or another strong earthquake in the vicinity. Demonstrations of the present procedure will be shown for the recent examples in Japan. See Ogata[2005] for more detail.

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