Decrease in b-value prior to the 2003 Tokachi-oki earthquake(M8.0), Japan and the 2008 Wenchuan earthquake(M8.0), China

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The Gutenberg-Richter (GR) law: $log_{10}N(M) = a - bM$ denotes the relationship between the frequency-magnitude distribution (FMD), in which N is the cumulative number of earthquakes with magnitude equal to or larger than M. Constant b measures difference in the relative proportion of small and large earthquakes and shows the variation of seismicity activity and stress evolution before earthquake. Many studies reported that decrease of b-value prior to great earthquakes.

Because of the capability of detection, weak earthquake are sometimes omitted from the record, which lead to the deviation of FMD. It's necessary to calculate the Magnitude of Completeness (Mc), above which the earthquakes are able to be recorded completely and the FMD will follow the GR law. Furthermore, Mc changes along with the change of detection capability. Therefore, we investigate the temporal variation of Mc and chose the maximum value of it to represent the Mc of the whole analyzed period. We divide the catalog into windows in chronological order and apply bootstrap method on each window to randomly resample a subset of 300 series. In each series we use MAXC (maximum curvature) technique to compute Mc and take the mean value of all series as Mc of the window. To estimate the temporal variation of b-value, we also divide the catalog into windows and apply maximum likelihood method to compute b-value of each window to investigate the daily variation of b-value. We use Akaike Information Criterion (AIC) to compare each b-value to b-value of the period with normal seismicity, and ΔAIC between 2 b-values shows significance of difference. By resampling a subset of 1000 windows from the reference period and compute the b-values as reference, we are able to compare each b-value with 1000 reference b-values and compute ΔAIC individually. Using percentage (P) of$\Delta AIC \geqq 2$ helps to evaluate significance level of difference in b-value objectively.

Firstly, we investigated the daily variation of b-value of the Tokachi-oki region prior to the 2003 Tokachi-oki earthquake (M8.0), Japan, using the earthquake catalog of 1990-2014 from Japan Meteorological Agency (JMA). It shows that b-value started deceasing several years before earthquake and P（$\Delta AIC \geqq 2$） suddenly increased 3 months before. Then, we applied the same process on the Wenchuan region prior to the 2008 Wenchuan earthquake (M8.0), China, using the earthquake catalog of 2000-2013 from China Earthquake Networks Center (CENC). It comes out that we got the highly similar result with the Tokachi-oki earthquake. These results suggest that b-value analysis has a potential capability of medium-to-short term forecast to M8.0 class earthquakes.

Suggested references

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