Is the *b* value of foreshocks an effective signature in the prediction of a large earthquake occurrence?

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The Gutenberg-Richter frequency-magnitude distribution of earthquakes is now well established in seismology. The slope of the relation between frequency and magnitude (*b* value) is typically 1, but it often shows variations around 1. Spatial and temporal changes in *b* are thought to reflect stress state in the Earth's crust (Schorlemmer et al., 2004, 2005). In this context, such observations that *b* values of foreshocks (earthquakes that occur immediately before large earthquakes, close to the hypocenters) are lower than the typical $b = 1$ have been considered to indicate that areas near hypocenters of large earthquakes are under high stress. However, it has remained uncertain whether *b* values of foreshocks are significantly low compared to those of stationary seismicity and aftershocks in the area, so as that the *b* value can be used as an indicator of impending large earthquakes.
In order to clarify the above-described issues, we have conducted a systematic investigation into *b* values of foreshocks of large earthquakes in and around the Japanese islands. Here we show preliminary results obtained by the investigation. We used the earthquake catalog of the Japan Meteorological Agency (JMA). The criteria adopted to define a main shock is that a larger earthquake does not occur in the previous y_1 days and within a distance *L*. In addition, a larger earthquake must not occur in the selected area in the following y_2 days. We used $L = 100$ km, $y_1 = 3$ days and $y_2 = 0.5$ days. In our preliminary analysis, mainshocks were chosen from earthquakes with a magnitude (*M*) of 5-6 that occurred in and around the Japanese islands during 1995-2016. Foreshocks are all events occurring in the preceding time interval of $t = 3$ days and within a circle of radius *R* km from the mainshock epicenter. We chose $R = 10$, 30, and 50 km. These *R* values are equivalent to 2, 6, and 10 fault lengths of *M*5-6 class earthuakes, respectively. In choosing these parameter values, we referred Lippiello et al. (2015). Further study will be required to define appropriate parameters.
Schorlemmer et al. (2005) found that normal faulting events have the highest *b* values, thrust events the lowest and strike-slip events intermediate values. We used information on the focal mechanisms from the F-net Broadband Seismograph Network database to classify main shocks as strike-slip, thrust or normal events. We then stacked foreshocks for each of the types of mainshock faulting and computed *b* values of foreshocks corresponding to each of the styles of faulting. We found that *b* value of foreshocks varies systematically according to the rake angle of faulting and the result is consistent with that obtained by Schorlemmer et al. (2005). We plan to conduct a more thorough investigation into the *b* values of foreshocks. We are going to expand our analysis to offshore earthquakes, including the 2011 Tohoku-Oki earthquake (Nanjo et al., 2012; Tormann et al., 2015), before which a very clear decrease in the *b* value to as low as $b = 0.5$ was observed near the hypocenter.

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