## Has the stress over the focal region of the 2011 Tohoku-Oki *M*9 earthquake recovered to the pre-earthquake state?

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When the logarithm of the number of earthquakes equal or above a magnitude M is plotted against M, the frequency distribution is well represented by a line in a magnitude range where almost all earthquakes are detected. In the linear distribution known as the Gutenberg-Richter law, the b value (slope of the line), has been pointed out to relate to the stress in the seismogenic region: the b value is small in a high stress area such as fault patches, while it is large in a region under low stress condition, for example, in high-pore-pressure zones. Based on the empirical knowledge, Tormann et al. (2015), having obtained a result that the distribution of the b value in recent years in the focal region of the 2011 Tohoku-Oki M9 earthquake is similar to that at pre-earthquake times, considered that the stress over the focal region has already recovered to the state before the earthquake occurrence. Then, they suggest that the renewal process of large earthquake occurrence along the subduction zone is described by a stationary Poisson process, i.e., a similar size megathrust event is potentially possible to occur in overlapping volumes sooner than expected from estimated mean inter-event times of past events. Is that true? If this is the case, we have to re-consider the basic method of long-term earthquake prediction taken by the Earthquake Research Committee of the Headquarter for Earthquake Research Promotion, Japan. This is a serious problem. Here we investigated spatio-temporal change in the b value over the foal region of the 2011 Tohoku-Oki M9 earthquake in detail. The method of our analysis is basically almost the same as that taken by Tormann et al. (2015), but we improved the analysis somewhat by separating earthquakes in the sea region into two groups, those along plate boundary and such ones that occur above the plate boundary, and by taking temporal variation of spatial distribution of earthquakes into consideration. Our main results are as follows: The b value in the large slip area at the 2011 Tohoku-Oki M 9 earthquake has not yet returned to the small value just before the megathrust event elucidated by Nanjo et al. (2012). The b value had been becoming small before the 2011 Tohoku-Oki M9 earthquake in the focal region of the 1987 Miyagi earthquake (M7.4). The b value in the sea region off northern Sanriku has been notably small since the time before the megathrust event and the area of the low b values seems to have been

expanding to the west. The northern part of this low b value area overlaps with the starting point of the rupture of the 1944 offshore Sanriku earthquake (M7.5), but the southern part of the area does not overlap with any focal region of past large earthquakes.

In general, our results show that the *b* value over the focal region has not yet returned to the value before the 2011 Tohoku-Oki *M* 9 earthquake, inconsistent with Tormann et al. (2015). We think that it is necessary to monitor the progress of the low *b* value area off northern Sanriku, considering a possibility of occurrence of a large earthquake in the near future.

Keywords: the 2011 Tohoku-Oki earthquake , stress recovery, the Gutenberg-Richter law