Seasonal variation of seismicity in San-in district

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It has been reported that earth surface’s process such as tidal loading, ice and snow load, and heavy rainfall load, modulates seismicity in the crust (e.g. Heki, 2003). Moreover, laboratory fault experiments and numerical simulations suggest that seismicity should more strongly correlated with periodic stress near the characteristic nucleation time of fault (e.g. Beeler and Lockner, 2003). Thus, elucidation of the periodicity of seismicity provides us a new insight into seismicity model and earthquake physics.

We here investigate seasonal variation of crustal seismicity in San-in district using the JMA catalog (constructed by Japan Meteorological Agency) from October 1997 to June 2017 (magnitude >= 1.5). To decluster the earthquake activity, we apply Epidemic Type Aftershock Sequence (ETAS) model (e.g. Ogata, 1988) to the catalog, using multiple time windows with one month. Then, we tracked the background seismicity rate over time.

The background seismicity rate increases right after two large earthquakes (the 2000 Western Tottori earthquake and the 2016 central Tottori earthquake) and decreases gradually with time. These characteristics have already been reported by previous studies (e.g. Kumazawa and Ogata, 2013), implying that an external force such as after slip or fluid migration may drive the temporal increase in the background seismicity.

We analyze seasonal variation of background seismicity rate from April 2002 to Marth 2016, between two large earthquakes. We find that background seismicity rate slightly increases in spring and autumn. Interestingly, past large earthquakes in the studied region (magnitude >= 6.2) similarly took place more frequently in spring and autumn compared with the other seasons.

To verify statistical significance of this periodicity of small earthquakes, we compare the ETAS model and a combined model of ETAS model with trigonometric function (Iwata and Katao, 2006). The likelihood ratio statistics (LRS) shows that half-year seasonal variation is statistically significant.

This half-year seasonal variation would likely be explained by the following two factors; 1) a change in stress loading rate induced by the thaw in spring, and 2) a variation of pore pressures associated with rainfall in autumn.

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