山陰地方の地殻内地震活動の季節変動性
Seasonal variations in crustal seismicity in San-in district, southwest Japan

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A growing body of evidence suggests that seismicity is seasonally modulated in a variety of tectonic environments (e.g., Gao et al., 2000; Heki, 2003; Bettinelli et al., 2008; Ben-Zion & Allam, 2013; Amos et al., 2014; Johnson et al., 2017). Identifying cyclic variations in seismicity leads to an improvement of our understanding about the physics of earthquake triggering.

San-in district, southwest Japan, is an active seismicity zone characterized as high shear strain rate by geodetic measurement (Nishimura and Takada, 2017). Moreover, Ogata (1983) has pointed out a possibility of seasonal variations in seismicity rate in the Inner Zone of southwest Japan. We here focus on seasonal variations in crustal seismicity in San-in district.

We used the JMA catalog (constructed by Japan Meteorological Agency) from 1975 through 2017 (magnitude M >= 3.0 and depth <= 20 km). We applied space-time Epidemic Type Aftershock Sequence (ETAS) model (e.g., Ogata, 1998; Zhuang et al., 2004) to the catalog and used a probability-based declustering procedure based on the work of Zhuang et al. (2002) to evaluate the significance of the seasonal variations, adopting uncertainties derived from the declustering scheme.

We demonstrated that semiannual variations in background seismicity rate, which increases in spring and autumn, are statistically significant from 1980 through 2017. The distribution of large historic and modern earthquakes (from 1850 through 2017, magnitude M >= 6.2, constructed by Chronological Scientific Tables) shows a similar pattern to recent background seismicity, suggesting that seismicity in San-in district has shown seasonal variations for over 150 years. There is some correlation between the monthly averaged background rate shifted backward 2 months and monthly averaged rain amount in the studied region. These results infer that seasonal variations in seismicity in San-in district can be explained by increasing pore pressure within fault zones, caused by infiltration of rainfall in autumn and decreasing surface mass due to snow melting in spring. Some correlation between seismicity and precipitation suggests that modulation of precipitation may be a key ingredient to produce time-dependence of background seismicity.

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