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高速摩擦を考慮した千島海溝南部で発生する超巨大地震の発生サイクルモデル
3D modeling of the cycle of megathrust earthquakes in the southern Kuril subduction zone considering high speed friction

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Studies on deposits of prehistoric tsunamis indicate the occurrence of destructive earthquakes (Mw 8.4) along the southern Kuril trench subduction zone (Nanayama et al., 2003). Intervals between inferred outsized tsunami events average nearly 400 years, but range widely from about 100 to 800 years (Sawai et al. 2009).

Recent studies on fault zones show that considerable weakening can occur at a high slip velocity because of pore-fluid pressurization via frictional heating or thermal weakening processes (Noda and Lapusta, 2010; Di Toro et al., 2011, Tsutsumi et al., 2011). Shibazaki et al. (2011) performed 3D quasi-dynamic modeling of the great Tohoku-oki earthquake cycle by considering high-speed friction. The present study models the megathrust earthquake cycle along the southern Kuril trench subduction zone, considering weakening of friction by thermal pressurization at high slip velocity.

We investigate the model considering a rate- and state-dependent friction law and thermal pressurization by using a spectral solver (Noda and Lapusta, 2010) to calculate the temperature and pore pressure evolution on a fault plane. Asperities for the 1952 Tokachi-oki earthquake (Mw 8.1) and the 1973 Nemuro-oki earthquake (Mw 7.8) are considered. The Geospatial Information Authority of Japan (2012) suggests that there is a slip deficit region at the shallower subduction interface between the two source regions, and in this respect, we set a larger asperity near the trench. We set the frictional properties of velocity weakening within the asperities and that of velocity strengthening outside of the asperities. Results show that when a rupture occurs around the large asperity near the trench, significant thermal pressurization occurs, resulting in large and fast slips. This rupture propagates to the stable creeping region and to the asperities of Mw 8 earthquakes. We examine conditions where observed recurrence intervals are reproduced. In cases where the recurrence interval of megathrust earthquakes is around 400 years, the size of the megathrust earthquakes reaches Mw 8.8.

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