Effect of periodic loading on the repeating behavior of short-term slow slip events

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It has been reported that Earth tides affect the activity of episodic tremor and short-term slow slip events (hereinafter, short-term SSEs) in Nankai and Cascadia (e.g., Nakata et al., 2008; Rubinstein et al., 2008; Yabe et al., 2015). In addition, Ide and Tanaka (2014) reports that long-period loading by the ocean also affects the occurrence of deep low frequency tremor. The tidal effect on the SSEs has been also examined by numerical studies (e.g., Hawthorne and Rubin, 2013). In our previous study, we considered the stress perturbation on the plate interface by the Earth tides (especially, semi-diurnal (M2) and fortnight (Mf) tides). In this study, we examined the case with the longer period which is dominant in ocean loading.

We evaluated the effect of periodic loading assuming a flat plate interface with the dipping angle of 15 degrees. Our numerical model is similar to our previous study (Matsuzawa et al., 2010). A rate- and state-dependent friction law (RS-law) with cutoff velocities is adopted as the friction law on each element. We assume a circular short-term SSE region with the radius of 6 km at the depth of 32 km. (a-b) value in the RS-law is negative within the short-term SSE region, and positive outside the region. Stress perturbation is given by sine function with the amplitude of 0.1 kPa. Incorporating this stress perturbation, we calculate the evolution of slip on the plate interface.

In the case of the period of 1 year, which is dominant in actual ocean loading, the recurrence interval of SSEs becomes shorter than that of the previous one around the maximum of stressing rate. On the other hand, the recurrence interval becomes longer around the minimum of stressing rate. These are similar to the case with shorter loading period (e.g., M2 tides). However, the recurrence of SSEs is not clear for about eight years after the large slip at surrounding area. This is similar to the case without periodic loading, while recovery of repeating SSEs can be seen after one year in the case with M2 and Mf tides. Such recovery gradually becomes quicker with the decrease of the period from 1year.

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