Slow slip events response to tidal stress in western Japan

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Slow slip events (SSEs) often occur in the Nankai subduction zone, Japan, within a band-like zone extended from the center of Honshu to western Shikoku. SSEs are believed as shear slip on the plate interface, where the frictional property changes from velocity weakening to strengthening in the dip direction. Therefore the dynamics of SSEs may give some hints on the processes related with the depth dependent friction.
The tidal modulation of SSEs has been identified by statistical analysis using strain data of Plate Boundary Observatory, in the Cascadia subduction zone [Hawthorne & Rubin, 2010]. Here, we show the results of similar statistical analysis using strain data recorded at borehole stations maintained by National Institute of Advanced Industrial Science and Technology. Target SSEs were selected from the catalog of short term SSEs detected by using GNSS [Nishimura et al., 2013].
For each SSE, we calculated shear stress by ocean and solid earth tide in the slip direction on the plate interface, assuming focal mechanism determined by Nishimura et al. [2013]. The ocean tide is calculated by convolving the spatial distribution of theoretical ocean height for NAO.99b [Matsumoto et al., 2000] and theoretical Green's functions [Okubo & Tsuji, 2000] for PREM. The solid earth tide is calculated using tide-generating potential of Tamura [1987].
We estimated tide components due to regional deformation from raw strain data before and after an SSE period, and removed them from the raw strain data to make processed strain data. The processed data show transient deformation related with the SSE, accompanied with oscillation in phase with the calculated tidal shear stress on the plate interface. The correlation between the oscillation in SSEs and tidal stress was confirmed statistically. Moreover, the oscillation is clearly visible without statistical processing during the period of some SSEs, providing strong evidence of tidal modulation.
The processed strain rate is consistent with slip rate predicted by a velocity strengthening friction law and tidal shear stress on the plate interface. This suggests a possibility to constrain frictional parameters at SSE locations. Our results suggest that even a small (~kPa) disturbance of shear stress may control slip speed to some extent in the transition zones of the subducting plate.

Keywords: strain data, slow slip, tidal modulation

