Tidal modulation of slow slip detected using tiltmeters in Nankai subduction zone

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Episodic tremor and slip events have now been observed at many subduction zones worldwide. It has been shown that tectonic tremors are controlled by tides and passing surface waves, suggesting high sensitivity to small stress disturbances. Hawthorne and Rubin (2010) has detected that the slow slip events are also controlled by tides by using borehole strainmeters in Cascadia subduction zone. We address whether tidal modulation of slow slip is a general phenomenon by using tiltmeters in Nankai subduction zone, following the procedures proposed by Hawthorne and Rubin (2010).

We use tiltmeters at two stations of Hi-net operated by National Research Institute for Earth Science and Disaster Resilience. A set of analysis windows are selected to include slow slip events occurred from January 2001 to January 2013. Tilt record includes large undesired signals due to local deformation caused by the ocean loading and body tides. Therefore, we estimated local deformation empirically using tilt data without slow slip signals, and subtracted it from the original data to obtain signals caused by slow slip. The processed signals are modeled as a summation of sinusoids at four tidal periods and a linear trend, and simultaneously fit for all analysis windows.

The tidal modulation of the tilt rate is significant at 12.4 h (M2) period, at the 99% confidence level, which is consistent with the result of Hawthorne and Rubin (2010). The phase of maximum tilt rate at the M2 period appears to correspond to the maximum shear stress in the direction of plate motion on the plate interface right beneath each station.

Reference: Hawthorne, J. C., and A. M. Rubin (2010), J. Geophys. Res., 115, B09406.
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