Diurnal and sub-diurnal variations in slow slip in Cascadia: comparison of PBO borehole strain observations with tidal loading and tremor

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A number of studies have observed variations in non-volcanic tremor on timescales between a few minutes and a few days. Observations from borehole strainmeters allow us to detect variation in slow slip on some of these timescales. We examine data from PBO borehole strainmeters in Cascadia in order to look for tidal modulation of slow slip and for a correlation between slip and tremor. To do so, we combine data recorded at six strainmeters during four major slip events between 2007 and 2010. We find that, on average, the strain due to slow slip is tidally modulated, with 20 to 30% more slip during the favorable portion of the tidal period. Comparison with tidal loading calculations suggests that the maximum slip rate occurs between the maximum shear stressing rate and the maximum shear stress, but given changes in tidal loading along strike, it may be at either. This observed tidal modulation of slip can be compared relatively directly with tidal modulation in simulated slow slip events that are controlled by one of the mechanisms proposed to explain slow slip events.

The method of fitting the strain data is described in Hawthorne and Rubin (2010). We slightly modify our earlier method so that we can compare the strain data with a predicted time series, rather than simply looking for signals at the tidal periods. We obtain similar estimates of tidal modulation of slip by comparing the predicted tidal stresses with the observed strain. We also use this modification to compare the strain data with tremor. We find that the strain rate during slow slip is correlated with tremor detected by Wech and Creager (2008) and with the amplitude of seismic signals recorded at colocated stations. This is true even when we consider only variations in strain and tremor with periods shorter than two hours.

References
