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Delineation of future Cascadia megathrust rupture by Episodic Tremor and Slip

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The rapidly expanding GPS networks along the greater Cascadia forearc have enabled identification of nearly 40 isolated Episodic Tremor and Slip (ETS) events from 1992 through 2008. ETS events are observed throughout the forearc, from northern California to southwestern British Columbia, with station density generally increasing towards the north. Events located in well-instrumented regions can be tracked as they migrate laterally north-south along the plate boundary, but increasing station density has resolved many smaller transients that could not previously be confidently identified. At the specific latitude of the northern Washington State and southwestern British Columbia, the 14-month average recurrence interval still holds true, 6 events after first recognition. Elsewhere, this periodicity is not observed. Along central Oregon, an 18-month recurrence is evident, while in northern California (Yreka) the 11-month periodicity previously documented still holds true. Sporadic smaller events appear frequently throughout the subduction zone, including within the region known for the 14-month periodicity. For the most recent events that have the best GPS and seismic coverage, there is an increasingly strong correspondence between GPS-inversions for slip and tremor epicentral locations.

GPS offsets for the largest 23 events inverted for slip show moment magnitudes ranging from 6.3 (smallest resolvable with GPS) to 6.8, and typically 2-3 cm of slip. The largest spatial extent of the events resolved to date is just under 500 km along strike, and maximum duration is seven weeks, which lies in marked contrast to other subduction zones. Averaged over many ETS events, the upper limit of transient slip in the vicinity of Seattle, WA lies just west of the heavily urbanized Puget Sound region, suggesting that the lower limit of megathrust seismic rupture may extend much closer to this area than previously thought.

A comparison of GPS with tremor analyses of 23 well-recorded events over a ten-year period yields a highly linear relationship between moment release, as estimated from GPS, and total duration of non-volcanic tremor, as summed from regional seismic arrays. All Cascadia events detected since 1997 for which seismic data is available, which collectively span the Cascadia arc from northern California to Vancouver Island, Canada, release moment during tremor at a rate of 5.3 ± 0.38 x 1023 dyne-cm per hour of recorded tremor. This empirical tremor magnitude scale enables continuous estimation of moment dissipation via tremor monitoring along the deeper Cascadia subduction zone that poses the greatest threat to its major metropolitan centers.