# Slow slip events in Cascadia and New Zealand

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This project looked at the relationships between slow slip events, also called slow earthquakes, and fault locking in Cascadia and New Zealand. Slow slip events occur on the subduction megathrust, which is the contact between the subducting plate and the overriding plate. A slow slip event is slip on the plate interface, similar to an earthquake, but occurs over a longer time scale ranging from days to months or even longer. In both New Zealand and Cascadia, slow slip events occur below the depth of interseismic locking - the region of the fault that is stuck due to friction and will eventually rupture in large earthquakes. Slow slip events can trigger earthquakes, potentially including devastating megathrust events with magnitude of 8.5 or larger. This project aimed to better characterize slow slip events in these subduction zones, including where they are located relative to the locked zone. This will inform how likely these slow slip events are to eventually trigger a big earthquake. In addition, the results of this project form the basis for long-term monitoring of slow slip events in both subduction zones. Monitoring may yield observable changes in slow slip behavior prior to future large earthquakes.

We demonstrated interactions between earthquakes and slow slip events in New Zealand, including the first documented case of dynamically triggered slow slip. The 2016 magnitude 7.8 Kaikōura earthquake on the South Island triggered slow slip events over 200 km away on the Hikurangi subduction zone under the North Island.

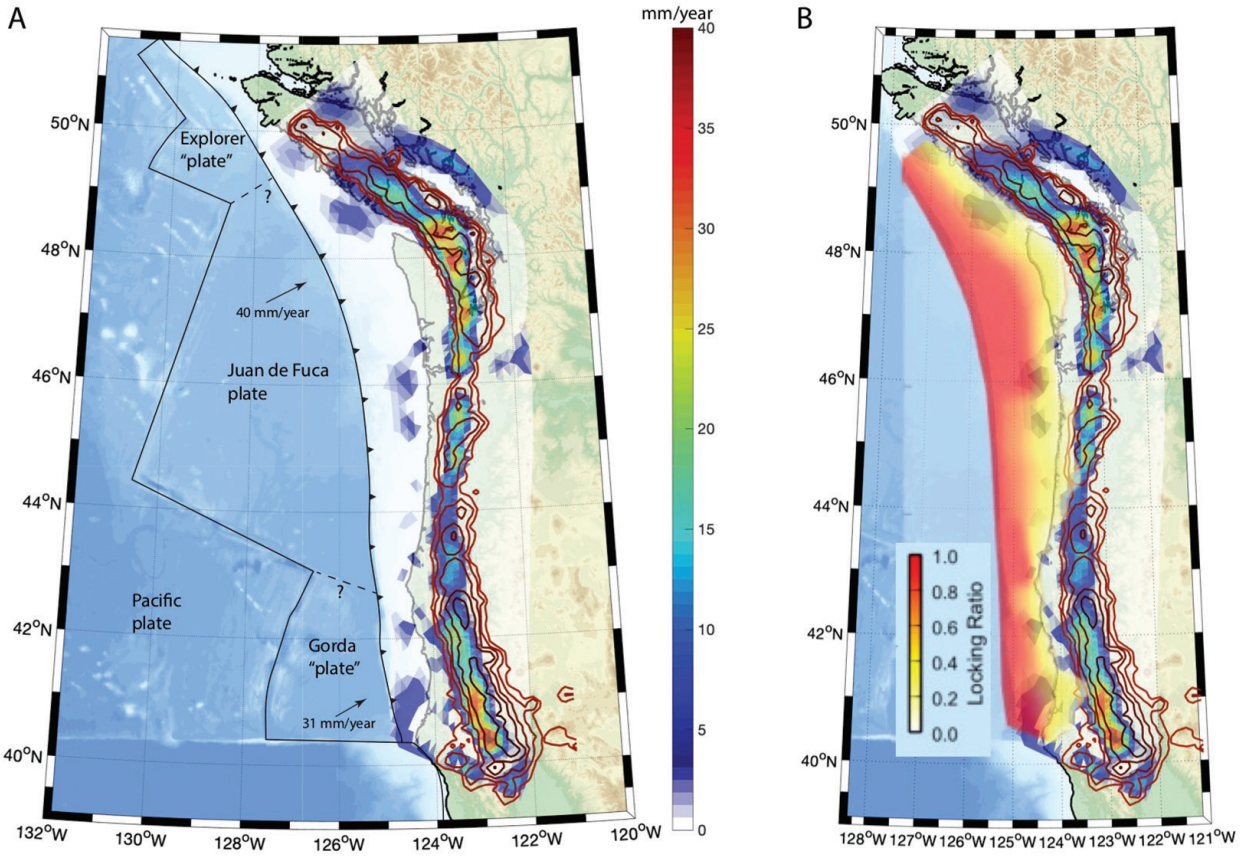


*Figure 1. A. Time-averaged episodic tremor and slip rate (colors) and contours of density of tremor detections (brown lines) on the Cascadia plate interface (modified from Bartlow, 2020); B. Same as A, but with a comparison to the location of the locked zone (red and yellow colors) from Schmalzle et al. (2014).*

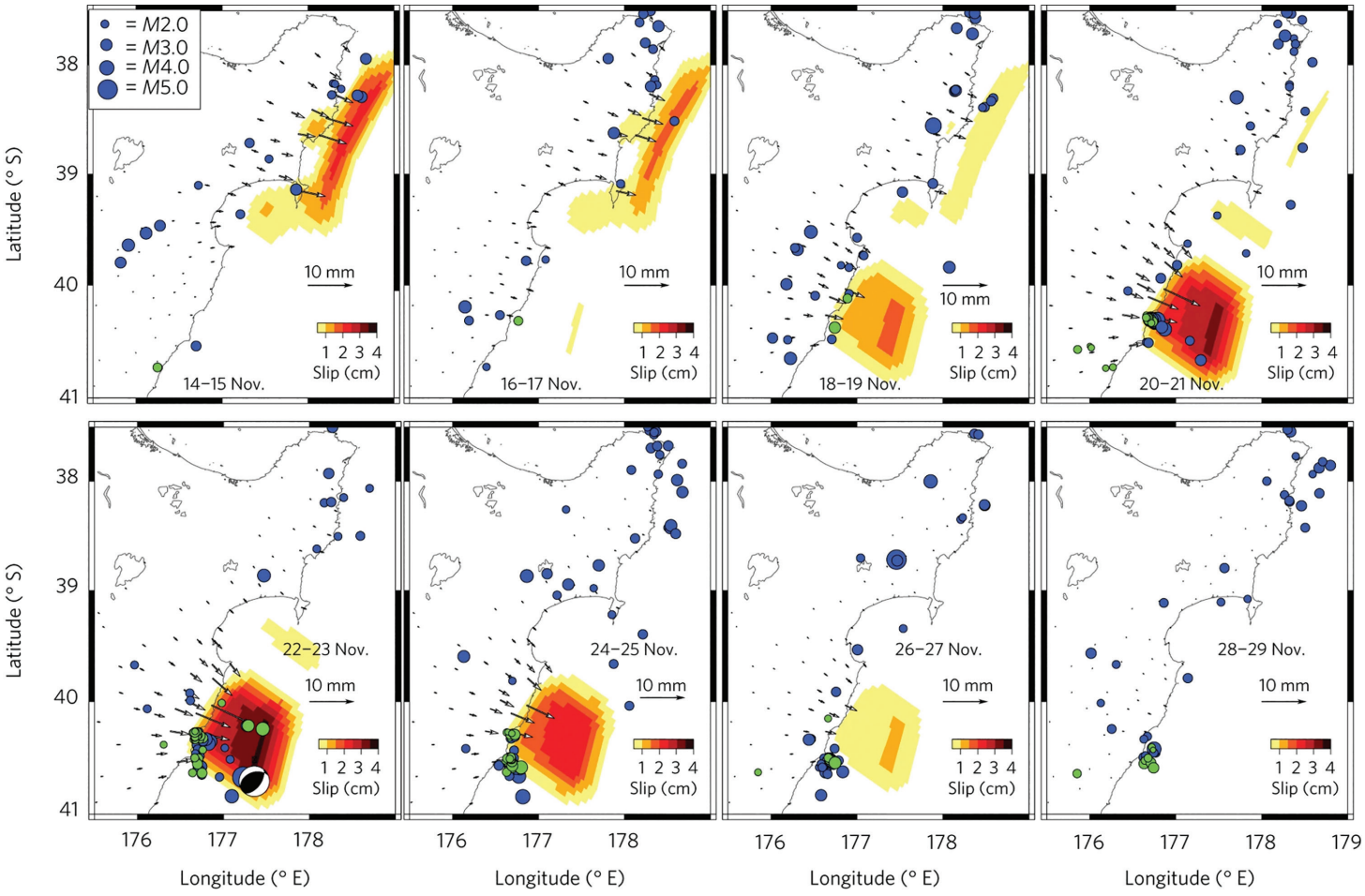


*Figure 2. Time-dependent slip inversion results from TDEFNODE during the time following the Kaikōura M7.8 earthquake. Slip amounts on the interface are shown in centimeters (yellow to red colours), and horizontal displacements for the cGPS sites from the best-fitting model are shown as arrows (with scale). The blue circles are earthquakes from the GeoNet catalogue for each time slice, and the green circles are repeating earthquakes determined from template matching. The focal mechanism on the fifth panel is for the Mw 6.0 thrust event on 22 Nov 2016 from www.geonet.org.nz. Figure from Wallace et al. (2017).*

We conducted time-dependent modeling of slow slip events in both subduction zones, allowing us to see slip move around on the plate interface. This allowed us to better illuminate the relationships between slow slip events and any earthquakes occurring nearby. For the 2012 Gisborne, New Zealand slow slip event, we conducted static and time-dependent models incorporating both onshore GPS data and offshore Absolute Pressure Gauge data. This allows for the best constraints to date on slow slip in this offshore region with a history of damaging shallow tsunami earthquakes.

In Cascadia, we also measured the cumulative effect of all slow slip events to quantify the role of slow slip in overall plate motion. We found it to be highly variable along strike. We also found a "gap" between the deep limit of the locked zone and the shallow limit of the slow slip zone, with hints of a possible second slow slip zone at the deep limit of locking. This means that slow slip in the main slow slip zone is not likely to trigger a great earthquake, but slow slip in the potential second slow slip zone might.

The results of this project were used to motivate funding for a new NSF-funded project aimed at detecting the second potential slow slip zone at the downdip limit of locking. ■

## References

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