Low frequency Earthquakes Illuminate the Southern Edge of Cascadia Subduction at the Mendocino Triple Junction

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The Cascadia Subduction Zone hosts a broad zone of tremor, associated low-frequency earthquakes (LFEs), and episodic slow slip downdip of the highly coupled megathrust zone. Tremor and LFEs are thought to be generated by thrust-type slip on the subduction interface. Meanwhile, automated tremor monitoring (Wech and Creager, 2008; https://www.pnsn.org/tremor) occasionally detects an anomalous zone of tremor at the southern edge of Cascadia, offset 50-100 km westward from the main zone of activity, near the expected southern edge of the subducting Gorda slab at the Mendocino triple junction. It is unknown whether this tremor occurs on the edge of slab, on the subduction interface fault, or on a crustal fault.

To investigate the geometry and generation mechanism of this tremor zone, we develop multiple LFE templates to detect events from 2019 to 2024. By stacking detections of the initial templates, we obtain templates with higher signal-to-noise ratios for which clear P and S arrivals can be identified on multiple stations. This procedure facilitates both improved event detection and location of each LFE family. We find that, in contrast to tremor/LFE behavior in the main zone, LFEs in this "Mendocino" zone exhibit small bursts of activity every few days, with nearly constant activity rates and no evidence of large episodic events during the five-year study period. Preliminary locations show a relatively concentrated zone of activity, but with depths that vary from 24-32 km. Although this is similar to the expected depth of the subducting slab surface in this area, the depth variation, if confirmed by refined locations, may support LFEs being generated by strike-slip motion on the southern edge of the subducting Gorda slab.

The results may have important implications for understanding and monitoring plate motion at the southern edge of Cascadia. Because this activity occurs westward of the main tremor zone, it is directly adjacent to the primary seismogenic zone, which is capable of generating M9 earthquakes. Careful locations could also constrain the southern edge and depth of the Gorda slab in this area, which has been the subject of recent debate. Ongoing LFE monitoring could reveal any periods of accelerated activity in this area, potentially contributing to time-dependent assessments of earthquake hazard.