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Detecting tectonic tremor during slow slip events in Costa-Rica using templates of ordinary earthquakes

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Slow slip events (SSEs) have been observed beneath the Nicoya peninsula in Costa-Rica for more than 10 years, and are accompanied by tremor activity both updip and downdip of the seismogenic region. However, tremor detection in this region can be challenging and time-consuming, as many local earthquakes occur amidst the tremor, so envelope-based techniques do not perform as well as they do in other regions. Matched-filter techniques are more appropriate to detect many of the individual low-frequency earthquakes (LFEs) that constitute tremor, but these techniques can also be time-consuming and restricted to small areas because they require a set of template seismograms for each LFE family.

In this study, we attempt to take advantage of the many local earthquakes to use the ordinary earthquakes' waveforms as templates to detect tremor all along the subduction interface. We use an extension of matched-filter techniques, a phase coherence (or matched field) method which can identify signals from locations near the template event even if the template and target signals have different source time functions. Because of this specificity of the coherence method, we should be able to detect tremor co-located with an ordinary earthquake, as long as they share similar Green's functions.

We create template waveforms from a catalog created by the Nicoya Seismic Cycle Observatory, whose events are located using local 3-D velocity model (DeShon et al. 2006). We first apply the method during a SSE event in June 2009, and initial investigations suggest that the tremor and earthquakes are similar enough: high coherence values are found at time of known tremor. Bursts of activity with various duration close to the trench are successfully detected, and their location is consistent with slip distribution of the SSE. Our final goal is to identify potential migration of these bursts related to the propagation of the main front of the SSE, as well as investigate the relation between their released seismic energy and duration. These findings will be finally discussed in comparison with tremor characteristics in other subduction areas.