Near-source detection of near repeating seismicity triggered by shallow slow-slip, Northern Hikurangi, New Zealand

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The northern Hikurangi margin, offshore from Gisborne, New Zealand, exhibits a diverse range of interrelated seismogenic phenomena, including shallow slow-slip events (SSEs), large M>7 tsunamigenic earthquakes, microseismicity and tectonic tremor. SSEs at the northern Hikurangi repeatedly occur every 18-24 months, last for a few weeks, and exhibit large (>10 cm) displacements. In this study, we utilize data from a network of 15 ocean bottom seismometers (OBS) deployed between May 2014 –June 2015 (the Hikurangi Ocean Bottom Investigation of Tremor and Slow Slip, HOBITSS, experiment). This network was centred above the source region for two 1947 slow tsunami earthquakes and a large shallow SSE that occurred in late 2014 producing maximum slip of 20 cm, with ~5 cm of slip propagating to within 2 km of the seafloor.

Here we focus on characterizing spatio-temporal patterns in microseismicity asssociated with this 2014 SSE. Earlier SSEs in the region are known to have produced increased rates of seismicity down-dip of the geodetically modelled slip patch, consistent with regions of increased Coulomb failure stress on the megathrust as a result of interface slip during the SSE. Our study, which includes data from OBS instruments and terrestrial broadband and short-period instruments from the national GeoNet network, offers an improved, near-field insight into microseismic processes occurring during a shallow SSE, allowing for improved location and detection capabilities, and inferences on triggering processes.

To catalog microseismicity we utilize a network-wide matched-filter detection routine, using templates of clearly identifiable earthquakes to detect further microseismic events. This way, many smaller events are detected, particularly those which may be obscured in the coda of preceeding overlapping events, or those occurring below the noise level, leading to a lower catalog completeness than using classical energy-based detection methods. We initially identify local template events with a high signal to noise ratio using amplitude-based triggering and manual inspection of waveforms. P-and S-phases, cut to 2 second windows, from these template events are then used to perform waveform cross-correlation detection in the frequency domain. Following detection, the spatial pattern of microseismicity is examined by computing high precision relative locations through generation of lagged single channel cross-correlation derived phase picks. This method produces automatic phase picks to sub-sample accuracy, and allows for variation of detection location from that of the template event. We also identify repeating earthquakes, those events which exhibit high correlation coefficients and represent repeated failure of the same asperity, to constrain fault slip rates.

Keywords: microseismicity, slow-slip, subduction, matched-filter, New Zealand, Hikurangi

