Using earthquake focal mechanisms to investigate slow slip driving forces in the northern Hikurangi

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Understanding the processes that drive slow slip events (SSEs) may assist in improving our understanding of the physics of both slow and fast earthquakes. Recent work has shown that the stress ratio, R, retrieved by focal mechanism inversion systematically decreases prior to SSEs in New Zealand's northern Hikurangi subduction zone, and subsequently increases during the evolution of each SSE. These R fluctuations are proposed to represent slow, precursory increases and fast concurrent decreases in fluid pressure within overpressured subducting oceanic crust during the SSE cycle.

These observations represent an exciting opportunity to improve forecasts of SSE occurrence via monitoring of R changes. Thus far, this cyclic behaviour has only been observed over a short time-period (9 months, 4 SSE cycles) when ocean-bottom seismographs were deployed.

Here we present the results of a waveform cross-correlation study that aims to extend the catalogue in time and reduce the magnitude of completeness for focal mechanisms of northern Hikurangi seismicity. This enables improved temporal coverage and statistical analysis of stress tensor changes across multiple SSE cycles. By using well constrained focal mechanisms of events recorded on >30 OBS and land stations as templates, we automatically assign correlation-derived relative polarities to waveforms and subsequently invert for focal mechanisms and R using many more earthquakes complete to a lower magnitude. This approach offers an important step towards accurate SSE forecasting and an improved understanding of the physical processes leading to slow rupture nucleation.

Keywords: slow slip, seismology, focal mechanisms, stress inversions, Hikurangi, fluid pressure

