The Effects of Material Heterogeneity and Topography on the Predicted Slip Distributions for Hikurangi Slow Slip Events

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Slow slip events (SSEs) at the Hikurangi subduction margin adjacent to the North Island, New Zealand, display a bimodal distribution of characteristics. Long duration (1-2 years), deep (40-60 km depth), large events (equivalent to Mw 7.0) occur at the southern Hikurangi margin, while shallow (10-15 km depth), short (1-2 weeks), smaller events (equivalent to Mw 6.5) occur at the northern and central Hikurangi margin. Since 2000, three major slow slip events have been identified at the southern Hikurangi margin; the 2003 Kapiti SSE, the 2004/2005 Manawatu SSE, and the 2007/2008 Kapiti SSE (which ended in early 2009). In some cases, these SSEs may have triggered moderate seismicity within the subducting Pacific plate (e.g., Reyners and Bannister, 2007).

To date, all of the inferred slip distributions for the SSEs have been obtained using elastic half-space dislocation models. Numerous recent studies of coseismic displacement fields have shown that variations in elastic properties and surface topography can influence the predicted deformation. In our initial work, we used a finite element model to evaluate the influence of material property variations on the predicted surface deformation field. Elastic properties were assigned based on a seismic velocity model, and slip distributions inferred from an elastic half-space model were applied. When compared to the elastic half-space model, we found that the heterogeneous models generally predict larger amounts of surface deformation, indicating that the half-space models may be overestimating the amount of slip.

As the next phase in our study, we are using finite element models that include both topography and material property variations to generate Greens functions for use in an inversion. We isolate the influences of topography and material property variations by considering each factor separately. Then, by considering both effects together, we are able to place better constraints on SSEs along the Hikurangi margin. Using these improved slip distributions, we then look at changes in Coulomb stress along the margin due to the different SSEs.