

Modeling various slow slip events along the Hikurangi subduction zone

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Recent high-resolution seismic and geodetic observations have revealed the occurrence of slow slip events (SSEs) along various subduction plate interfaces. Long-term SSEs with a duration of 1.5 years (e.g., Manawatu SSEs) occur at the deeper portion (25–60 km) of the Hikurangi subduction zone, and shallow (5–15 km) SSEs with a duration of 1–3 weeks occur along the northern and central parts of the subduction zone. Wallace et al. (2012) reported a sequence of simultaneous short-term and long-term SSEs at the Hikurangi subduction zone during 2010–2011.

We modeled short-term and long-term SSEs along the Hikurangi subduction zone using a rate- and state-dependent friction law and considered realistic configurations of the plate interface. We set the coupling region where $a-b$ is negative based on the study of interseismic coupling by Wallace et al. (2009). By setting the effective stress and the critical displacement of shallow short-term SSEs to approximately 1.5 MPa and 2.4 mm, respectively, we could reproduce SSEs with a duration of 1–3 weeks and recurrence interval of 3 years. Additionally, by setting the effective stress and the critical displacement of the Manawatu long-term SSEs to approximately 3.0 MPa and 7.2 mm, respectively, we were able to reproduce SSEs with a duration of 0.5 years and recurrence interval of 5 years. The effective stress of the Manawatu SSE zone is two times larger than that of the short-term SSE zones. However, the ratio of the effective stress to the critical displacement of the Manawatu SSE zone is smaller than that of the short-term SSE zones. We could also reproduce a sequence of simultaneous short-term SSEs and a long-term Manawatu SSE as observed by Wallace et al. (2009). The occurrence of the various slow slip events suggests heterogeneous distributions of constitutive law parameters along the Hikurangi subduction zone.

Keywords: modeling, slow slip events, Hikurangi subduction zone, a rate- and state-dependent friction law, shallow short-term SSEs, Manawatu long-term SSEs