Simple physical model for the probability of a subduction-zone earthquake following slow slip events: Application to the Hikurangi megathrust, New Zealand

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Slow slip events have been widely documented in subduction zones worldwide, yet their implications for the occurrence of future large earthquakes are not well understood. In this study, we develop a relatively simple, simulation-based method for estimating the probability of a large subduction-zone earthquake following slow slip events in places where there are insufficient records of the timing and size of past large earthquakes. The method has been applied to a locked portion of the southern Hikurangi subduction megathrust, New Zealand, which is surrounded on all sides by the 2016 M7.8 Kaikoura earthquake source region, its afterslip, and triggered slow slip events further north. Our models accounting for uncertainties in the input parameters indicate that annual probability of a M>7.8 subduction earthquake over one year after the Kaikoura earthquake increases by 1.3 - 18 times relative to the pre-Kaikoura probability, while the absolute probability remains fairly low (0.6 - 7%). The annual probability decays to the pre-Kaikoura level once the slow slip events terminate. We find that probabilities of a large subduction earthquake are mainly controlled by the ratio of the total stressing rate to the mean stress drop of large earthquakes. The developed approach can be applied to evaluate the potential for triggering of a large earthquake following slow slip events in other subduction zones.

Keywords: Slow slip events, Earthquake triggering, Probability estimate

