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Evaluating earthquake and tsunami potential from interseismic locking distribution along the subduction megathrust

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Although interseismic locking distributions have been used in qualitatively evaluating the future earthquake potential, quantitatively estimating how an earthquake may rupture through the locked interface is a more useful tool for quantifying both seismic and tsunami hazards. Here, we investigate rupture scenarios from interseismic locking models along the megathrust interface below Nicoya peninsula, Costa Rica using spontaneous rupture simulations. We first estimate initial stress from locking, then initiate spontaneous ruptures at different nucleation points and observe the eventual earthquake magnitudes and slip distribution. We find that $\sim$40% of nucleations tested develop into large earthquakes of Mw>7.2 based on present interseismic locking models. Of these events, those nucleated from deeper depths have a tendency for larger-amplitude shallow slip, suggesting increased tsunami potential. Furthermore, irrespective of the input locking models we do not observe rupture scenarios of earthquakes with intermediate magnitudes between 6 and 7, a result consistent with observations outside of the aftershock period in Nicoya. The results of hypocentre-dependent earthquake magnitudes and tsunamigenic potential not only pose challenges in estimating rupture extents from locking models, but also underscore the significance of quantitatively evaluating seismic and tsunami hazard in subduction zones.