

Ground Motion Prediction Derived from Interseismic Locking Models for the Subduction Zone in Nicoya, Costa Rica

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Seismic hazard evaluation demands accurate ground motion prediction. Dynamic rupture simulation is an effective approach in estimating near-source ground motion. However, the reliability of predictions from dynamic rupture simulations is controversial due to the unknowns and uncertainties in model inputs such as the initial stress distribution on faults. In recent decades, interseismic locking models derived from geodetic data have significantly advanced our understanding of loading on faults, which reveals the stress accumulation pattern on fault planes to some degree. Here, we probe the feasibility of ground motion prediction from rupture scenarios derived from interseismic locking models. We conduct spontaneous rupture simulations with initial stress derived from interseismic locking models on the megathrust beneath Nicoya Peninsula, Costa Rica, with different nucleation sites. According to simulation results, nucleation site significantly impacts rupture process, eventual slip distribution, and ground motions. To validate the ground motion predictions from those rupture scenarios, we compare the synthetics with high-rate GPS data during the 2012 Nicoya M7.6 earthquake. The average peak ground velocity (PGV) predictions from scenarios derived from Feng's locking model (Feng et al., 2012) are well consistent with GPS data with misfit <15%; variations ~ 50% are found in PGV predictions among scenarios due to the hypocenter-dependent rupture process and eventual slip distribution. By comparing the model predictions with GPS observations, our study demonstrates the feasibility to predict ground motion in future earthquakes by conducting dynamic rupture simulations with constraints from interseismic locking models. Such approach can be applied in seismic hazard assessment.

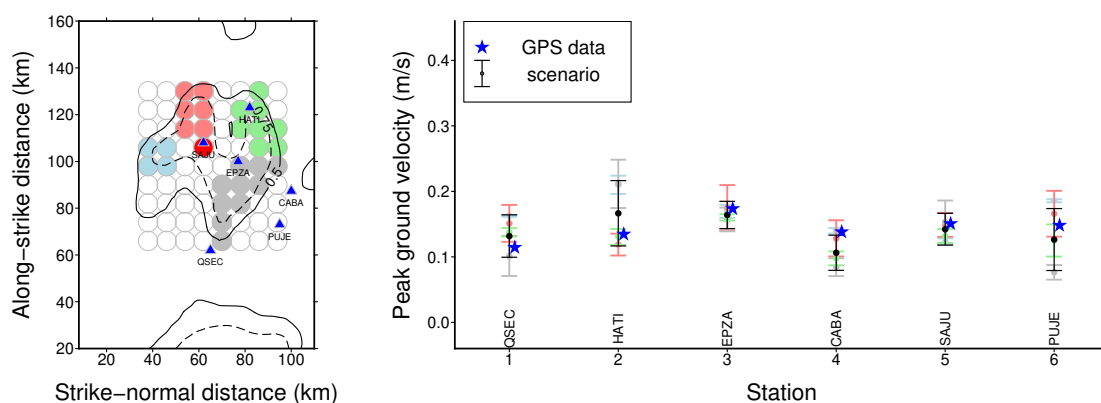


Figure 1. (left): The interseismic locking model from Feng et al., 2012 and nucleation sites clustered by locations (colored circles). Blue triangles are projections of GPS stations. (right): PGV predictions from rupture scenarios. Blue stars indicate PGV records at GPS stations. Colored dots and error bars represent average PGV predictions and standard deviations from rupture scenarios in four clusters. Black dots and error bars are the average predictions and standard deviations from all rupture scenarios.