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Spatial Variability of Near-field Ground Motions from Pseudo-Dynamic Rupture Simulations

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We analyze the effect of earthquake source parameters on ground-motion variability based on near-field wavefield simulations for large earthquakes. We quantify residuals in simulated ground motion intensities with respect to observed records, the associated variabilities are then quantified with respect to source-to-site distance and azimuth. Additionally, we compute the variabilities due to complexities in rupture models by considering variations in hypocenter location and slip distribution that are implemented a new Pseudo-Dynamic (PD) source parameterization.

In this study, we consider two past events – the Mw 6.9 Iwate Miyagi Earthquake (2008), Japan, and the Mw 6.5 Imperial Valley Earthquake, California (1979). Assuming for each case a 1D velocity structure, we first generate ensembles of rupture models using the pseudo-dynamic approach of Guatteri et.al (2004), by assuming different hypocenter and asperities locations (Mai and Beroza, 2002, Mai et al., 2005; Thingbaijam and Mai, 2016). In order to efficiently include variations in high-frequency radiation, we adopt a PD parameterization for rupture velocity and rise time distribution in our rupture model generator. Overall, we generate a database of rupture models with 50 scenarios for each source parameterization. Synthetic near-field waveforms (0.1-2.5Hz) are computed out to Joyner-Boore distances Rjb ~ 150km using a discrete-wavenumber finite-element method (Olson et al., 1984). Our results show that ground-motion variability is most sensitive to hypocenter locations on the fault plane. We also find that locations of asperities do not alter waveforms significantly for a given hypocenter, rupture velocity and rise time distribution. We compare the scenario-event simulated ground motions with simulations that use the rupture models from the SRCMOD database (Mai and Thingbaijam, 2014), and find that the PD method is capable of reducing the ground motion variability at high frequencies. The PD models are calibrated by comparing the mean residuals with the residuals from SRCMOD models. We present the variability due to each source parameterization as a function of Joyner-Boore distance and azimuth at different natural period.