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Distance and azimuthal dependence of ground-motion variability

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We investigate the near-field ground-motion variability by computing the seismic wavefield for five previously published kinematic rupture models of the M 7.3 1992 Landers earthquake, several simplified rupture models based on the Landers event, and a large M 7.8 scenario earthquake in Southern California. The ground motion simulations are accomplished by solving the elasto-dynamic equations of motion using a generalized finite-difference method. The simulated waveforms are calibrated against near-field strong-motion recordings for the Landers earthquake. We then analyze our simulation-based data-set of ground-motions, binned with respect to distance and azimuth to compute mean and standard deviation of peak ground velocity (PGV). We consider different 1D-velocity-density profiles for the Landers simulations, and a 3D heterogeneous Earth structure for the ShakeOut scenario, and for both cases we honor geometrical fault complexity.

The ground-motion variability, $\sigma_{ln(PGV)}$, estimated from numerical simulations is higher in the near-field (Joyner-Boore distance R_{JB} <20 km) compared to that associated with standard ground-motion prediction equations. We find that $\sigma_{ln(PGV)}$decreases with increasing distance from the fault as a power law. The physical explanation of a large near-field $\sigma_{ln(PGV)}$is the presence of strong directivity and rupture complexity. We also show that intra-event ground-motion variability is high in the rupture-propagation direction (both forward and backward directivity regions), but low in the direction perpendicular to rupture propagation for unilateral ruptures. We observe that the power-law decay of $\sigma_{ln(PGV)}$ is primarily controlled by slip heterogeneity. In addition, $\sigma_{ln(PGV)}$ as function of azimuth is sensitive to variations in both rupture speed and slip heterogeneity. We also find that the azimuthal dependence of mean, $\mu_{ln(PGV)}$, can be approximated by a Cauchy-Lorentz function, which may potentially help in estimation of ground motion for directive ruptures.