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Rupture parameters of dynamic source models compatible with NGA-West2 GMPEs

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Dynamic source inversions of individual earthquakes provide constraints on stress and frictional parameters, which are inherent to the studied event. However, general characteristics of both kinematic and dynamic rupture parameters are not well known, especially in terms of their variability. Here we constrain them by creating and analyzing a synthetic event database of dynamic rupture models that generate waveforms compatible with strong ground motions in a statistical sense.

We employ a framework that is similar to the Bayesian dynamic source inversion by Gallovič et al. (2019). Instead of waveforms of a single event, the data are represented by Ground Motion Prediction Equations (GMPEs), namely NGA-West2 (Boore et al., 2014). The Markov chain Monte Carlo technique produces samples of the dynamic source parameters with heterogeneous distribution on a fault. For all simulations, we assume a vertical 36x20km strike-slip fault, which limits our maximum magnitude to Mw<7. For dynamic rupture calculations, we employ upgraded finite-difference code FD3D_TSN (Premus et al., 2020) with linear slip-weakening friction law. Seismograms are calculated on a regular grid of phantom stations assuming a 1D velocity model using precalculated full wavefield Green's functions. The procedure results in a database with those dynamic rupture models that generate ground motions compatible with the GMPEs (acceleration response spectra in period band 0.5-5s) in terms of both median and variability.

The events exhibit various magnitudes and degrees of complexity (e.g. one or more asperities). We inspect seismologically determinable parameters, such as duration, moment rate spectrum, stress drop, size of the ruptured area, and energy budget, including their variabilities. Comparison with empirically derived values and scaling relations suggests that the events are compatible with real earthquakes (Brune, 1970, Kanamori and Brodsky, 2004). Moreover, we investigate the stress and frictional parameters in terms of their scaling, power spectral densities, and possible correlations. The inferred statistical properties of the dynamic source parameters can be used for physics-based strong-motion modeling in seismic hazard assessment.