SCALING RUPTURE CHARACTERISTICS ACROSS EARTHQUAKE SIZES: INSIGHTS FROM 3D DYNAMIC AND KINEMATIC SIMULATIONS

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Earthquake rupture dynamics exhibit complexity across various spatial and temporal scales, which significantly differ for different rupture sizes. This complexity influences seismic energy radiation and ground-shaking patterns. In this study, we explore how rupture characteristics scale with earthquake size using 3D dynamic and kinematic rupture simulations. Slip-velocity time-histories from 3D dynamic simulations of events with magnitudes approximately 6.9, incorporating fault roughness are utilized based on previous work by Mai et al., (2017). These simulations serve as the basis for generating down-scaled kinematic rupture models that replicate smaller earthquake sizes (Mw 5.0, 3.0 and 1.0) from which we then compute seismic waveforms.

We propose a three-step algorithm to rescale kinematic rupture properties derived from dynamic simulations to smaller events. First, the spatial discretization (dx) is adjusted based on the ratio of the ruptured fault areas of the target and reference events. Second, the temporal discretization (dt) is scaled while maintaining the ratio of spatial to temporal discretization. This ensures coherence of energy radiation during rescaling from large to small earthquakes. Third, the slip-velocity amplitudes are rescaled based on the ratios of seismic moments and rupture areas of target and reference events. The resulting peak ground accelerations for the rescaled small-magnitude events align with estimates derived from ground-motion prediction equations (Boore and Atkinson, 2008). Our study outlines an efficient method for calculating physics-based ground motions for small earthquakes in induced-seismicity environments.