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Pseudo-dynamic source characterization accounting for rough-fault effects

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Broadband ground-motion simulations, ideally for frequencies up to ∼10Hz or higher, are important for earthquake engineering; for example, seismic hazard analysis for critical facilities. An issue with such simulations is realistic generation of radiated wave-field in the desired frequency range. Numerical simulations of dynamic ruptures propagating on rough faults suggest that fault roughness is necessary for realistic high-frequency radiation. However, simulations of dynamic ruptures are too expensive for routine applications. Therefore, simplified synthetic kinematic models are often used. They are usually based on rigorous statistical analysis of rupture models inferred by inversions of seismic and/or geodetic data. However, due to limited resolution of the inversions, these models are valid only for low-frequency range. In addition to the slip, parameters such as rupture-onset time, rise time and source time functions are needed for complete spatiotemporal characterization of the earthquake rupture. But these parameters are poorly resolved in the source inversions. To obtain a physically consistent quantification of these parameters, we simulate and analyze spontaneous dynamic ruptures on rough faults. First, by analyzing the impact of fault roughness on the rupture and seismic radiation, we develop equivalent planar-fault kinematic analogues of the dynamic ruptures. Next, we investigate the spatial interdependencies between the source parameters to allow consistent modeling that emulates the observed behavior of dynamic ruptures capturing the rough-fault effects. Based on these analyses, we formulate a framework for pseudo-dynamic source model, physically consistent with the dynamic ruptures on rough faults.