WHAT DO DYNAMIC RUPTURE SIMULATIONS CONSTRAINED BY GMPEs TELL US ABOUT EARTHQUAKE SOURCE PARAMETERS?

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Dynamic source inversions of individual earthquakes provide constraints on frictional parameters, which are inherent to the studied event. However, general characteristics of the dynamic rupture parameters are not well known. Here we propose to constrain the dynamic rupture parameters by modeling events with waveforms compatible with ground motion prediction equations (GMPEs) using Bayesian inference.

We assume a vertical strike-slip fault governed by the slip-weakening friction law with heterogeneous distribution of dynamic parameters (initial stress, friction drop and characteristic slip-weakening distance). For the dynamic rupture propagation, we utilize finite-difference code FD3D_TSN after Madariaga et al. (1998), further developed by J. Premus. Synthetic waveforms are calculated for a regular grid of phantom stations considering a 1D velocity model. The misfit is evaluated in terms of spectral accelerations at various periods against GMPEs by Zhao et al (2006).

We employ Markov chain Monte Carlo sampling of the dynamic parameter space and obtain a large ensemble of dynamic rupture models with various dynamic parameter settings, whose waveforms statistically fit the observed GMPEs. The synthetic events exhibit various magnitudes and degrees of complexity (e.g., one or more asperities).

We compare stress drops estimated from the corner frequency or source-time-function duration (the so-called apparent stress drop) with stress drops evaluated directly from the dynamic models. We conclude that the empirical apparent stress drop variability is exaggerated by the variability of the corner frequency or duration even without any negative data-processing influence. The variability of the inherent source stress drop is much smaller.