DETERMINISTIC PHYSICS-BASED EARTHQUAKE SEQUENCE SIMULATORS MATCH EMPIRICAL GROUND MOTION MODELS AND ENABLE EXTRAPOLATION TO DATA POOR REGIMES: APPLICATION TO MULTIFAULT MULTIMECHANISM RUPTURES

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We use the deterministic earthquake simulator RSQSim to generate complex sequences of ruptures on fault systems used for hazard assessment. We show that the source motions combined with a wave-propagation code create surface ground motions that fall within the range of epistemic uncertainties for the NGA-West2 set of empirical models. We show the model is well calibrated where there are good data constraints and has good correspondence in regions with fewer data constraints. We show magnitude, distance, and mechanism dependence all arising naturally from the same underlying friction. The deterministic physics-based approach provides an opportunity for better understanding the physical origins of ground motions. For example, we find that reduced stress drops in shallow layers relative to constant stress drop with depth lead to peak ground velocities in the near field that better match empirical models. The simulators may also provide better extrapolations into regimes that are poorly empirically constrained by data, because physics, rather than data parameterizations, is underlying the extrapolations. Having shown the model is credible, we apply it to a problem where observations are lacking. We examine the case of crustal faults above a shallow subduction interface seen to break coseismically in simulations of the New Zealand fault system. Here, we show that in the model, by breaking up the coseismic crustal and interface rupturing fault motions into two separate subevents, and then recombining the resulting ground motion measures in a square-root-of-sum-of-squares incoherent manner, we reproduce well the ground motion measures from the full event rupture. This provides a new method for extrapolating ground motion models to more complex multifault ruptures.