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Uncertainty Quantification in Earthquake Source Inversions: The Source Inversion Validation (SIV) Project

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Finite-fault source inversions estimate kinematic rupture parameters of earthquakes using a variety of available data sets and inversion approaches. Rupture models are obtained by solving an inherently ill-posed inverse problem, subject to numerous a priori assumptions, noisy observations, and imperfect Green's functions. Despite these limitations, near real-time source inversions are becoming increasingly popular, while we still face the dilemma that uncertainties in source inversions are essentially unknown. Yet, the accurate estimation of earthquake rupture properties, including proper uncertainty quantification, is critically important for earthquake seismology and seismic hazard analysis, as they help to adequately characterize earthquake complexity across all scales.
The collaborative project "Source Inversion Validation" (SIV) attempts to quantify the intra-event variability in rupture models (evidenced in the SRCMOD database, http://equake-rc.info/srcmod), and to propose robust uncertainty metrics for earthquake source inversions. The SIV efforts include a rigorous testing platform to examine the current state-of-the-art in earthquake source inversion, and to develop and test novel source inversion approaches. In this presentation, we will summarize initial SIV results related to previous benchmark exercises, discuss the latest findings for a test case of a complex rupture embedded in a 3D heterogeneous Earth model, and propose metrics to quantify rupture-model variability, quality of data fitting, and model robustness.