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The Source Inversion Validation (SIV) Initiative: A Collaborative Study on Uncertainty Quantification in Earthquake Source Inversions

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Earthquake source inversions image the spatio-temporal rupture evolution on one or more fault planes using seismic and/or geodetic data. Such studies are critically important for earthquake seismology in general, and for advancing seismic hazard analysis in particular, as they reveal earthquake source complexity and help (i) to investigate earthquake mechanics; (ii) to develop spontaneous dynamic rupture models; (iii) to build models for generating rupture realizations for ground-motion simulations. In applications (i – iii), the underlying finite-fault source models are regarded as "data" (input information), but their uncertainties are essentially unknown. After all, source models are obtained from solving an inherently ill-posed inverse problem to which many a priori assumptions and uncertain observations are applied.

The Source Inversion Validation (SIV) project is a collaborative effort to better understand the variability between rupture models for a single earthquake (as manifested in the finite-source rupture model database) and to develop robust uncertainty quantification for earthquake source inversions. The SIV project highlights the need to develop a long-standing and rigorous testing platform to examine the current state-of-the-art in earthquake source inversion, and to develop and test novel source inversion approaches.
We will review the current status of the SIV project, and report the findings and conclusions of the recent workshops. We will briefly discuss several source-inversion methods, how they treat uncertainties in data, and assess the posterior model uncertainty. Case studies include initial forward-modeling tests on Green's function calculations, and inversion results for synthetic data from spontaneous dynamic crack-like strike-slip earthquake on steeply dipping fault, embedded in a layered crustal velocity-density structure.