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# Uncertainty Quantification of Kinematic Source Parameters using a Bayesian Approach

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Ground-motion simulations for seismic hazard analysis and dynamic rupture modeling suffer not only from the non-uniqueness of kinematic source models but also from the unknown robustness of source-inversion solutions. Therefore, adequate uncertainty analysis of kinematic source model parameters is critical to better understand the main factors that lead to rupture model variability, and to explore the robustness of kinematic source model parameters. Thanks to large improvements in computational tools, Bayesian techniques have become feasible to estimate comprehensive model uncertainties by producing the probability density functions (PDF) of model parameters.

In this study, we use a Bayesian technique to infer the ensemble of all possible source models that are consistent with seismological data and the available prior information. Two different procedures are followed. In the first one, we use a two-step procedure that initially explores the parameter space in search for the best fitting model (using a non-linear optimization algorithm) and then applies a Markov Chain Monte Carlo (MCMC) method for Bayesian inference on the kinematic rupture parameters. The second procedure is a one-step procedure that immediately applies MCMC by assuming Gaussian uncertainty for the seismological data. This second technique is computationally cheaper and explores the full parameter space, but does not provide a best-fitting "reference solution".

Our study presents synthetic tests based on the "Source Inversion Validation" (SIV) exercise. We analyze the performance of those two approaches in terms of efficiency, and their ability to image the known kinematic rupture details. For the two-step procedure, we additionally perform jackknife tests to examine the robust and sensitive features of the best-fitting model. Our results indicate that the well-resolved part of the fault is conserved through all the delete-one jackknife tests, and that the posterior PDF follows a Gaussian like distribution only within the well-resolved regions of the fault.