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Using geophysical data inversion to constrain earthquake dynamics: supporting and conflicting evidence

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Earthquake kinematic models are often used to retrieve the main parameters of the causative dynamic rupture process. These models are usually obtained through the inversion of seismograms and geodetic data and they can be used as boundary conditions in pseudo-dynamic modeling to calculate the traction evolution on the fault. Once traction and slip time histories are inferred at each point on the fault plane, it is feasible to estimate the dynamic and breakdown stress drop, the strength excess and the slip weakening distance (Dc). Different papers in the recent literature emphasized that the measure of these quantities can be biased by the adopted parameterization of kinematic source models. Here we propose that, in order to make this task achievable, suitable inversion schemes and appropriate choices of the kinematic parameters must be adopted. We focus our attention on the a priori assumption of the source time function and on the uncertainties of the inverted kinematic models. We use a two-stages global search algorithm to invert strong motions data (Piatanesi et al., 2007): this technique performs a statistical analysis of the model ensemble, allowing the extraction of the most stable features of the earthquake rupture that are consistent with the data and giving an estimate of the variability of each model parameter. We have quantitatively verified that the choice of source time function affects ground motion time histories within the frequency band commonly used in waveforms inversion and that the inferred peak slip velocity and rise time strongly change among the inverted models. The choice of the source time function has a dramatic impact on the dynamic traction evolution inferred from kinematic models. The shape of the slip-weakening curve, the ratio between Dc and final slip and the dynamic stress drop distribution are remarkably affected by the adopted source time functions. We recommend the adoption

in kinematic inversions of source time functions that are compatible with earthquake dynamics.