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What can Finite-Source Rupture Models Tell About the Scaling of Dynamic Source Properties?

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We analyze the scaling of average dynamic source properties (fracture energy, static stress drop and dynamic stress drop) from a suite of 31 kinematic inversion models from 21 crustal earthquakes. Shear-stress histories are first computed solving the elastodynamic equations by imposing slip velocity, obtained from kinematic inversion, as a boundary condition on the fault plane. This is achieved by means of a 3D finite difference method in which the rupture kinematics are modeled with the Staggered-Grid-Split-Node (SGSN) fault representation method of Dalguer and Day (2007). Dynamic parameters are then estimated from the calculated stress-slip curves and averaged over the fault plane.

An uncertainty analysis reveals that despite the poor resolution of kinematic inversion models, our dynamic parameter estimations are rather stable. Our results indicate that: (2) fracture energy, stress drop and apparent stress drop increase with magnitude; (2) stress drop and apparent stress drop seems to decraese with the amount of cumulative slip on the fault plane.

The new scaling relations proposed may be useful to constrain the initial conditions in spontaneous dynamic rupture calculations for earthquake source studies and physics-based near-source ground-motion prediction for seismic hazard and risk mitigation.