Estimation of fracture energy of large earthquakes based on heterogeneous fault rupture process

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Fracture energy (G) is a fundamental physical property of earthquakes governing its nucleation, rupture growth and arrest. The most widely used approach to estimate fracture energy is based on the seismic energy budget (usually referred to the “seismological” fracture energy). To that purpose average values of displacement and stress on the fault plane have to be assumed. However these values can be highly variable for large earthquakes. To estimate fracture energy I use the linear elastic fracture mechanics approach (LEFM), and assume that heterogeneous fault rupture can be described as the superposition of anti-plane and in-plane fault rupture modes. I systematically calculated fracture energy of large earthquakes (M>7) based on variable fault rupture velocities and stress drops, for an extensive database of slip models of NEIC. I first calculate the stress drops and local rupture velocity distributions using the slip models and sub-faults rupture times in the database. My results show highly heterogeneous distributions of stress drops and local fault rupture velocities. Fault ruptures largely take place in the sub-shear domain for the majority of slip models but can locally become super-shear. My results indicate that fracture energy *G* is highly correlated with fault slip. However the rate of growth of *G* with increasing slip for large earthquakes is weaker compared to the growth for small earthquakes. Finally, I calculated D_c values based on my estimations of *G* and *S* for all the slip models in this study, and show that D_c accounts for a significant fraction of the final fault slip.