Numerical simulation of earthquake sequence on rough faults

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Faults have geometric complexity at a wide range of spatial scales and forms; here we focus on fractal roughness of the fault surface (e.g., Candela et al., 2012). Slip on a nonplanar fault causes spatially heterogeneous stress field (Dieterich & Smith, 2009), modulating the style of the next slip event on the same fault. Thus, it is important to investigate rupture dynamics on rough faults using sequence simulations of multiple spontaneously nucleating and propagating events, instead of a single dynamic rupture simulation with artificial nucleation procedures.

In this study, we model earthquake sequences on rough faults, using a finite-difference model which captures inertial dynamics and plastic deformation during dynamic rupture and a quasi-dynamic boundary integral model which simulates the interseismic period and nucleation. We use rate and state friction with dynamic weakening on the fault and Drucker-Prager off-fault plasticity.

Our numerical simulations show that the stress field becomes more heterogeneous with accumulating slip. Stress heterogeneity makes the rupture process of subsequent events increasingly more complicated (in terms of slip and rupture velocity fluctuations). Later events are more sensitive to the local geometry of the fault due to accumulated stress heterogeneity. The place of nucleation is highly sensitive to subtle changes in fault geometry and used parameters. Furthermore, we are going to show some preliminary results which account for viscoelastic relaxation during the interseismic period in the presentation.