A. Bizzarri (1,2), M. Cocco (1)

(1) I.N.G.V. – Roma
(2) Università degli Studi di Bologna, Dipartimento di Fisica, Settore di Geofisica

WHAT CONTROLS SLIP-WEAKENING IN RATE AND STATE DEPENDENT FRICTION LAWS?

We study the dynamic traction behavior within the cohesive zone during the propagation of earthquake ruptures adopting rate- and state-dependent constitutive laws. We solve the elastodynamic equation for a 2-D in-plane crack using a finite difference algorithm. The investigation of the breakdown processes occurring within the cohesive zone requires an accurate control of the stability and convergence criteria as well as of the available resolution.

The resulting slip weakening curves are very similar to the classic laws proposed in the literature and show a nearly constant weakening rate. They displays an equivalent slip weakening distance d_0, which is different from the parameter L controlling the state variable evolution. Our simulations show that the state variable evolution within the cohesive zone controls the slip acceleration and the fast approaching to the peak slip velocity. The equivalent slip weakening distance, characteristic of the rate and state formulations, depends on the adopted constitutive parameters and on the evolution equation. While the dependence on the characteristic length L is simple, the dependence on the parameter A and B is much more complex since they also control the yield stress and the kinetic friction level.

The equivalent slip weakening values resulting from an ageing evolution equation are different from those calculated from a slowness law, but still remain larger than the adopted L values. We propose a scaling relation between these two length parameters (L and d_0). We emphasize that the nucleation patch scales with L and not with d_0, while fracture energy scales with d_0.