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MODELING THE DYNAMIC TRACTION EVOLUTION DURING THE PROPAGATION OF AN EARTHQUAKE RUPTURE: CAN WE INFER THE FAULT CONSTITUTIVE LAW?

Several recent investigations examine the mechanical conditions of faults before and during a large earthquake with the ambition to constrain the fault constitutive behavior and to retrieve the dynamic traction evolution during the rupture propagation. The definition of the dynamic traction as a function of time or slip is commonly used to prescribe its evolution within the breakdown zone through a constitutive law. However, it is still a matter of debate the full understanding of the physical mechanisms controlling the breakdown process.

The analysis of dynamic traction as a function of slip allows the estimate of the critical slip weakening distance (D_c). Several methods have been proposed to measure D_c. The most recent suggests evaluating D_c as the slip value at the peak slip velocity, assuming that the latter occurs when the traction is at its minimum (i.e., the frictional stress level). The inferred values of the critical slip weakening distance can be extremely large (of the order of several meters), they seems to be correlated with the final slip and cover a wide interval of values (from few percent to 80% of the total slip). In this study we investigate the dynamic traction evolution either by modeling the spontaneous propagation of a crack through 2 - D and 3 - D dynamic algorithms or by using the rupture history on the fault plane as a boundary condition to constrain the instantaneous traction. We aim to discuss the variability of D_c estimates and the existing biases that limit its calculation. In particular, we will show that the possibility to estimate D_c from the slip velocity peak depends on the adopted constitutive law and on the assumed dynamic parameters.