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Influence of the damage zone non-elastic deformation on rupture dynamics: 2D and 3D numerical modeling

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Including a damage zone surrounding the fault can produce visible effects on 2D in-plane rupture dynamics [see Andews, 2005 and BenZion & Shi, 2005], and hence on ground motion properties. Our work extends these studies to 2D anti-plane and 3D rupture dynamics. Damaging occurs when the absolute shear stress in the bulk exceeds the shear stress resistance, prescribed by a Mohr-Coulomb criterion, mimicking small fault failure in the medium surrounding the main fault. Thus, the absolute shear stress in the bulk is limited. First, we calculate ruptures in 2D mode II (in-plane) that reproduce exactly results from previous studies. Secondly, we study 2D mode III (anti-plane) rupture properties, and finally three-dimensional ruptures. In-plane calculations show that damage occurs asymmetrically, on the extensional side of the fault. Damage zone width increases linearly with rupture front propagation distance. Limiting shear stress in the bulk leads to limit peak slip velocity on the fault. Rupture propagation velocity is slightly decreased. Anti-plane calculations show a symmetrical pattern of the damage zone around the fault. Width is still increasing linearly with propagation distance. As mode II and Mode III ruptures are different (rupture is easier to propagate in mode III), we cannot compare directly the times or distances achieved when off-fault yielding starts. Nevertheless, peak slip velocity is also limited, but at a slightly higher value (with same initial conditions), and rupture propagation velocity also decreased. 3D calculations show similar patterns, such as linear increase of damage zone width in in-plane direction, limited peak slip velocity, and decreasing of rupture propagation velocity. This work is still in progress, and a systematic parameter space study is needed to better understand these features.