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Small-scale resistance heterogeneities influence on earthquake rupture dynamics

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Small-scale heterogeneities may be relevant to explain natural earthquakes features. Kinematics show the spatial complexity of both slip and rupture propagation. These spatial complexities may come from geometry of the fault, connectivity between fault segments, past history of the fault (residual stresses), frictional properties, etc. We choose to include small patches of strong static resistance in a homogeneous dynamic model. These patches are randomly and uniformly localized on the fault plane. We run several hundreds of independent numerical simulation, each simulation having a different random localization of small strong resistance patches. In every simulation, the rupture front is stopping spontaneously within the fault, between the small highly resistant patches. Hence, earthquake size is not prescribed as an a priori. We obtain a frequency-size distribution of the events. The small earthquakes are more likely obtained. Large earthquakes, that break the whole fault plane, are exceptions. We compare our frequency-size distribution with a power law distribution, such as the Gutenberg-Richter law. We study the way earthquakes are stopping. Self-propagation of the rupture front obeys to a balance between unbroken fault resistance and increase of stress induced by the deformation of the broken zone (size and stress drop). Thus, we compare stopping places with the value of a critical parameter, like kappa, that can be calculated at every point on the fault plane. The presence of these small barriers can stabilize the rupture up to prevent the supershear transition.