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DEM Simulation of dynamic Slip on a heterogeneous Fault : Controls on Rupture Initiation and Velocity

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Heterogeneity on a wide range of scales has been recognized as an important factor determining the behaviour of earthquake faults, both for individual rupture events and for the long term dynamics of the fault. A discrete element (DEM) simulation is used to investigate the properties of the dynamic rupture of a heterogeneous fault. An intrinsic small scale roughness of the fault surface is present due to construction of the fault model from random spherical particles. Additionally, heterogeneity on a large length scale is introduced, generating asperity and non-asperity regions along the fault by varying the small-scale surface roughness. The intrinsic frictional parameters between the DEM particles forming the surface of the fault are kept constant. When the block of elastic material surrounding the fault is sheared, repeated dynamic rupture of the fault occurs. The size of the resulting slip events span several orders of magnitude. A number of the larger rupture events have been investigated in detail. The results show that the rupture velocities vary between 75% of the S-wave velocity and about 80% of the P-wave velocity. Most of the large events show a complicated distribution of the final displacement where the maximum slip is located within one of the asperity areas. The large slip events also nearly always initiate within or at the edge of the asperity areas.