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Velocity fluctuations of a slow crack front during slow propagation: an experimental approach, and comparison to large scale spatio temporal scaling law in fault slip dynamics

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Space and time fluctations of the slip distribution along major faults are nowadays more and more often evidenced. The origin of this variability is however very debated. Often fluids are invoked for the presence of several time scales during rupture processes or triggering. On the basis of an experimental approach, we study the propagation of a fracture front along a weak heterogeneous plane and show that a broad distribution of the crack front velocity is exhibited without the presence of fluid. We follow dynamically the quasi-2D fracture propagation in a transparent Plexiglas using a high speed camera and acoustic emissions. The dynamics of the fracture front exhibits irregular bursts with large velocity fluctuations because of spatial heterogeneities that are artificially randomly introduced. The local velocity distribution of the front line is observed to be very wide despite a global and well defined average velocity. The distribution is nicely fitted by a power law behavior for velocities larger than the average velocity with an exponent -2.7 for various average crack speeds (ranging from 0.35 μm/s to 40 μm/s). The spatial correlations of the velocity fluctuations also follow a power law behavior which indicates that velocity fluctuations are propagating over large length scales along the fracture front. Events are defined as clusters of large crack velocities. A seismic moment for each event is then estimated from an accurate

optical measurement of the crack area. The distribution of the seismic moments for a large set of events is shown to be consistent with statistics of natural faults even if the large scale crack speed is very constant which shows the large influence of the fault asperities at small scales. We also compare our experimental results to statistics of slip distributions measured from large events (e.g. Kokoxili, Sumatra) and continuous measurements of the slip distribution of normal faults from InSAR inversion in the Asal Rift.