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The effect of viscoelastic rheology on the stress accumulation pattern along fault zones

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Recent geophysical observations from large subduction zone earthquakes have revealed the depth dependent nature of seismic radiation, suggesting that the heterogeneous stress distribution along subduction plate boundaries varies with depth (Lay et al., 2012). We investigate the possibility that this is caused by the variation in mechanical properties along the megathrust. Previous finite element studies showed that stress concentrations caused by a geometrical asperity relaxes in magnitude, but can also diffuse spatially due to viscous deformation, suggesting the possibility that asperity size evolve over time. Here, a generic two dimensional fault zone model is studied in a finite element code, to investigate the possible effect of viscoelastic deformation to modify the stress heterogeneity along fault zones during steady loading.

The model consists of a viscoelastic medium with finite thickness, representing a fault zone, embedded in an elastic medium representing the host rock. Geometrical irregularities are introduced along the interface between the fault zone and host rock to simulate a rough surface. The roughness of the interface is varied in frequency and magnitude, as well as the dimensions of the model. Various viscoelastic models are also tested. Preliminary results suggest that the stress heterogeneity resulting from steady tectonic loading is influenced by the constitutive parameters and the loading rate. Thus the interplay between tectonic loading and fault zone viscoelastic response is also suggested to have control on the stress distribution along fault zones.