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Analysis of the slow slip events of Guerrero, Mexico: implications for numerical modeling.

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Guerrero, in Mexico, is one of the subduction zones where long term slow slip events (SSEs) have been observed recurrently. Understanding the mechanics of these events is important to determine their role in the seismic cycle. SSEs in Guerrero have been found to have the same characteristics, along the interface of subduction, as classical earthquakes but with much longer slip time (around a year) and lower stress drop (0.1 MPa).
We investigate the slip models of the Guerrero SSEs of 2006 and 2009 (Radiguet et al., JGR 2012). The kinematic slip models have been determined by inversion of GPS time series using two different methods. From these slip histories, the constitutive relation between stress and slip (or slip rate) on each subfault is determined. Analytical Green functions are used to calculate the shear stress in a homogeneous, elastic, isotropic medium. Whatever the kinematic slip modeling method used, a clear slip weakening law can be retrieved over the whole slipping area. While some spatial variation in the parameters of the slip weakening law is observed, a mean value of about 0.1 m for the slip weakening distance and 2.5 kJ/m2 for the fracture energy can be extracted on each subfault. Moreover the slip-weakening rate seems quite homogeneous (around 1 MPa/m), and this is roughly the same as the value found in coseismic processes. The yield stress is of the order of 0.01 MPa, a low value compared to a stress drop of 0.1 MPa. The stress-slip rate relationship presents a loop trajectory coherent with the one observed in classical earthquakes.
The results of these analyses are used to numerically model the Guerrero SSEs. The aim is to reproduce the slip pattern using the mechanical laws determined in the study of the slip model. If a simple slip weakening law, with parameters found above, is used, we observe a rapid progress of the crack-like slip area. This is different from the observation of the migration of localized slip. So a slowing mechanism (healing) must be introduced in addition to the slip weakening law. A pseudo-dynamic model is developed, supposing a fully plastic fault strengthening with a prefixed slip distance.