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Relation between velocity changes, strain rate and non-volcanic tremors during the 2009-2010 slow slip event in Guerrero, Mexico

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We use ambient noise cross correlations to monitor slight changes in seismic velocities during the slow slip event (SSE) of 2009-2010 in Guerrero. This is a test of the sensitivity of the seismic velocity to variations of deformation, in absence of strong motions. The 2009-2010 event presents a complex slip sequence with two subevents occurring in two distinctive slipping patches (Walpersdorf et al., 2011). From a seismic array of 59 seismometers, consisting mostly of short-period sensors, we detect a velocity drop with a maximum of amplitude at the time of the first subevent. We analyze the velocity change at different period band and we observe that the perturbation associated to the SSE maximizes for periods longer than 12s. To determine the depth of the portion of the crust affected by this perturbation, we performed a linearized inversion of the velocity change measured at different period band. We detect no perturbation in the upper crust (first 10km), while the velocity perturbation increases with depth, affecting the middle and lower crust. Besides, we compute the deformation produced by the SSE in an elastic model using the slip evolution recovered from the inversion of continuous GPS. The comparison of the velocity changes and the deformation suggests that the velocity change is related with the strain rate. This result is similar to what was observed during a SSE in 2006 (Rivet et al., 2011).

The velocity changes can be interpreted together with other observables such as non-volcanic tremors. During the 2009-2010 SSE we measured non-volcanic tremors activity using continuous seismic record filtered between 2 and 8 Hz. We observed a correlation between velocity changes (measured at long period) and tremors activity whereas no correlation exists between velocity changes and seismic noise at long periods. This suggests that the over-riding plate exhibits a nonlinear mechanical behavior in response to the slight deformation produced by the SSE.