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Initiation of the 2014 Mw7.3 Papanoa, Mexico earthquake induced by a proceeding slow slip event

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Slow slip events (SSEs) are defined as transient quasi-static fault slip in convergent plate boundaries. Such "silent earthquakes" accommodate a fraction of the long-term geological loading at the depth of the brittle-ductile transition, separating inter-seismically locked from continuous creeping parts of the megathrust. On the other hand, transient SSEs may also promote failure of over-pressurized fault segments in subduction zones and thus trigger megathrust earthquakes.

A recent geodetic analysis reveals that a slow slip event occurred just before the mainshock of the 2014 Mw7.3 Papanoa, Mexico earthquake [Radiguet et al., 2016]. This preceding SSE is thought to have caused substantially enough Coulomb stress changes in the hypocentral region to eventually trigger the mainshock. However, geodetic inversions lack resolution at depth and may only provide limited information on the dynamic stress evolution leading from slow slip to spontaneous dynamic earthquake rupture.

Here, we couple a quasi-dynamic slow slip cycle model with dynamic rupture and seismic wave propagation simulations to investigate potential triggering mechanisms linking the preceding SSEs and megathrust earthquakes exemplary for the Papanoa earthquake. The quasi-dynamic slow slip model utilizes the Boundary Element Method (BEM) in the framework of laboratory-derived rate-and-state friction [Li and Liu, 2016; 2017] and is specifically suitable for complex 3D fault geometries. In our model, SSEs spontaneously appear at 50 km depth close to a pronounced fault kink of the subducting Cocos plate. A maximum slip of $\sim$30 cm is accumulated in between 20 and 50 km depth across the subduction interface. This indicates that slab geometry significantly affects the nucleation of SSEs in the Guerrero region. In a next step, we will export the transient shear stress perturbations generated by the deep SSEs as initial conditions for dynamic earthquake rupture simulations using the openly available software SeisSol (www.seissol.org). Importantly, the same curved 3D fault geometry and rheology will be used in both methods. Based on the coupled approach, we will discuss if megathrust dynamic rupture can be constrained by fault stress perturbations generated by models of preceding SSEs.