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Slip mode segmentation of the megathrust beneath Nicoya Peninsula, Costa Rica

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The Nicoya Peninsula, Costa Rica, overlies a section of a subduction megathrust close to the Middle America Trench. This location allows terrestrial geodetic monitoring of the surface deformation above the seismogenic zone, a region that is often underwater in many subduction zones. A continuous Global Positioning System network has operated in the Nicoya peninsula of northern Costa Rica since 2002 observing a number of deep and shallow slow slip events (SSEs) with a recurrence interval of ∼21 months. On September 5th 2012, a Mw 7.6 nucleated just underneath the geodetic network. We explore the relationship between these recurrent SSEs and the large earthquake. We find that SSE recurrence interval appears constant before and after the earthquake. Using a modified version of the Extended Network Inversion Filter [e.g. McGuire and Segall, 2003] (ENIF) to identify time dependent characteristics of SSEs before and after the 2012 Nicoya earthquake, we find that slip starts updip prior to the earthquake in the shallow, 15 km depth, section of the subduction zone and then migrates to a deep patch beneath the Nicoya gulf. Following the earthquake, high slip rates initiate down dip (40 km depth) and remain downdip, a change from observations of SSEs prior to the earthquake. In this study, we also analyze the temporal and spatial evolution of the surface deformation at different temporal scales (from hours to years) after the earthquake to infer the aseismic slip due to postsiesmic response on the fault interface. We compare the portion of postseismic displacement interpreted as afterslip with our previous analysis of SSE. Our results show that the main rupture was followed by significant early afterslip for the first 3 hours after the main event followed by regular afterslip decaying exponentially. During the first few months, the afterslip has most likely filled gaps left by the coseismic rupture (in particular updip). We also show that afterslip seems to be bounded by regions affected by SSE. The temporal evolution of the slip on the fault underneath Nicoya suggests the presence of different patches activated by different slip mechanisms. This observation fits well with the notion of segmentation of the megthrust with asperities of different frictional properties.