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Linking short- and long-term deformation along an active margin: regional tectono-geomorphic patterns in light of the 2010 Maule Chile earthquake (M8.8)

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Strongly coupled subduction zones are known to have generated some of the largest earthquakes on Earth (megathrust earthquakes). These regions are also associated with an array of tectonic landforms, including multiple marine and fluvial terraces, which are intimately coupled with the long-term effects of seismogenic processes. Thus understanding the parameters that control the along-strike propagation of megathrust earthquake ruptures combined with the analysis of tectonic landforms is fundamental for the assessment of seismic hazards and risk mitigation. Here we report on the 2010 Maule earthquake that ruptured $\sim$500 km of the central Chile margin. Modeling of GPS data during the interseismic and co-seismic periods have revealed segmentation in two main areas of high slip release and coupling. However, the spatiotemporal persistence of these segments and their relation with mechanical properties of the forearc is still poorly understood. To elucidate the relationships between short-term rupture segments and long-term tectono-geomorphic entities of the forearc we quantified permanent, long-term deformation using marine terraces in the Maule rupture zone and evaluate its relation with inter- and co-seismic patterns. We used the MIS-5 marine terrace, an ubiquitous geomorphic reference surface along the coast of central Chile, which we correlated with LiDAR images, field observations and new OSL ages. Furthermore, we evaluated the mechanisms of uplift by forward modeling of plate boundary slip. Coeval terraces are sharply offset across discrete crustal faults and also deformed in areas of broad crustal warping with wavelengths of $\sim$100 km, reflecting activity of deep-seated structures within the interplate zone, both at the southern and northern sectors of the Maule rupture, where uplift rates reach 1.8 mm/yr. The central part, in turn, is characterized by a lesser degree of permanent uplift. Based on the similarities between seismic-cycle deformation and historical earthquake ruptures we propose that the southern sector of the Maule rupture zone constitutes a stable, discrete seismotectonic boundary. In contrast, the northern sector constitutes a rather diffuse boundary that may prevent rupture propagation of some earthquakes. Our modeling results suggest that in the north slip at the plate interface must be deeper than that inferred for the 2010 event to uplift the coast.