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Evidence for locally lower friction within the high slip area of the 2010 Maule earthquake: dynamic weakening as an explanation of low apparent fault friction.

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Some recent studies have pointed out to a possible correlation between forearc morphology and seismic asperities on megathrust. A possible cause for this correlation would be that the average effective friction along megathrust depends on the mode of slip. One hypothesis is that it would be lower in seismic asperities area due to dynamic weakening during seismic rupture, and higher in area dominated by rate-strengthening friction. We test successfully this hypothesis based on the study of the South Chile subduction zone where the 2010 Maule earthquake (Mw 8.8) occurred. The accretionary prism, which lies updip of the portion of the megathrust which ruptured seismically, as well as the Arauco peninsula, where the rupture stopped, appear to be at a critical mechanical state. The critical taper theory thus applies there, requiring relatively high basal frictions ($\mu \sim 0.35$ - 0.5). By contrast, the seismogenic zone appears to be over-critical and the critical taper theory requires a lower basal friction. We used the limit analysis theory to further constrain the frictional properties. This theory allows predicting forearc deformation based on the megathrust geometry, forearc topography and frictional properties. It can thus be used to estimate the effective basal friction, and its eventual variation in space from the modeling of structural cross-sections. We analyzed the Santa Maria island cross-section where a backthrust splays from the megathrust marking the updip transition from unstable to stable sliding. The modeling implies a low basal friction ($\mu \leq 0.15$) in the seismogenic zone and a higher basal friction in the aseismic zone ($\mu \sim 0.35$). The Arauco peninsula known to be a recurrent barrier to earthquake propagation and characterized by a very high basal friction ($\mu \sim 0.5$) could be interpreted as a velocity-strengthening barrier.