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Are seismic and aseismic slip patches influenced by the late-interseismic physical state of a megathrust? Results from the southern end of the 2010 Maule Chile earthquake

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Spatial and temporal variations of Earth's surface deformation through different phases of seismic cycles provide key information for understanding processes controlling megathrust earthquakes (>Mw 8.5). Theoretical and observational advances have suggested that megathrust zones heterogeneously undergo seismic and aseismic slip, as a consequence of different frictional properties. To what extent, however, the physical mechanism of a forearc controls the temporal evolution and spatial patchwork of slip during a seismic cycle is an insufficiently understood topic. Here, we integrate geodetic and geophysical data to explore the possible control of the late-interseismic physical state of the megathrust on pre-, co- and post-seismic slip patterns at the southern end of the 2010 Maule earthquake (Mw 8.8) rupture zone. This area has been monitored with a dense space-geodetic network in the final few years of an earthquake cycle and the beginning of the next. Furthermore, state-of-the-art seismic experiments provide a unique dataset to study deformation processes related to the structure at depth and its elastic properties. Plate-locking degree, coseismic slip and afterslip distributions have been inferred from joint inversions of GPS (from survey and continuous modes) and InSAR data. A high-resolution tomography that images the Vp/Vs ratio before the Maule earthquake was used to estimate the changes of the Poisson's ratio on the interface of the megathrust event. Tomographic inversions of synthetic data indicate that large scale lateral variations of the Vp/Vs ratio in the upper part of the slab are well resolved making a comparison with other physical parameters possible. Interestingly enough, a comparison of areas with low locking degree reveals that they correlate with areas of high Poisson's ratio. We speculate that these are areas where the fluid content in the interface is high and possibly overpressured. The southern end of the Maule rupture zone overlaps a low locked area, which may have arrested further southward propagation of the rupture. The low locked area also shows a concentration of afterslip in the updip part of the megathrust, which may also be related to a high Poisson's ratio that possibly reflect high fluid content. Though still speculative, we hypothesize that the distribution of fluids along the interface can be estimated under certain assumptions from changes of Vp- and Vs velocities and that these fluids control the distribution of seismic and aseismic slip patterns and the locking degree.