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Tectonic control on the Mw 8.8 2010 Maule Chile earthquake

M. Moreno (1), D. Melnick (2), M. Rosenau (1), J. C. Baez (3), J. Klotz (1), O. Oncken (1), A. Tassara (3), J. Chen (1,4), K. Bataille (3), M. Bevis (5), A. Socquet (6), C. Vigny (7), B. Brooks (8), I. Ryder (9), B. Smalley (10), M. Bartsch (1), V. Grund (11), and H. Hase (12)

(1) Helmholtz-Zentrum Potsdam, Germany, (2) Universität Potsdam, Germany, (3) Universidad de Concepción, Chile, (4) Shanghai Astronomical Observatory, China, (5) Ohio State University, USA, (6) Université Joseph Fourier, Grenoble, France, (7) Ecole Normale Supérieure, Paris, France, (8) University of Hawai'i, USA, (9) University of Liverpool, UK, (10) University of Memphis, USA, (11) Sogeti High Tech GmbH, Hamburg, Germany, (12) Geodetic Observatory TIGO, Concepción, Chile

The Maule earthquake of 27th February 2010 (Mw=8.8) affected about 500 km of the Nazca-South America plate boundary in south-central Chile producing spectacular crustal deformation. This earthquake occurred on a mature seismic gap, which presented a high degree of plate locking in the decade preceding the event. Shaking, tsunami inundation and coastal uplift patterns show similarities with its predecessor in 1825, suggesting that both events ruptured an analogous segment of the plate boundary. Here, we present estimates of static coseismic surface displacements measured by a dense GPS network and used them in conjunction with published geodetic data to obtain an updated, higher-resolution slip model of the 2010 Maule earthquake. The use of a finite element model that introduced the main geometrical complexities of the Chile subduction zone allowed us to compare the spatial relation of slip patterns before and during the 2010 Maule earthquake with tectonic features of the forearc. The combination of the data sets provided a good resolution, indicating that most of the slip was well resolved. Coseismic slip was concentrated north of the epicenter with up to 16 m of slip, whereas to the south it reached over 10 m within two minor patches. The theoretical accumulated slip deficit including the 1960 earthquake slip that overlapped $\sim$150 km of the 2010 rupture; the 1928 and 1985 events; as well as heterogeneous plate locking suggests that the 2010 event closed the seismic gap. Slip deficit distribution shows an apparent local overshoot that highlight cycle-to-cycle variability, which has to be taken into account when anticipating future events from interseismic observations. Rupture propagation was obviously not affected by bathymetric features of the incoming plate. Instead, splay faults in the upper plate seem to have limited rupture propagation in the updip and along-strike directions. Additionally, we found that along-strike gradients in slip are spatially correlated with geometrical inflections of the megathrust. Our study suggests that persistent tectonic features may control strain accumulation and release along subduction megathrusts inducing a seismotectonic segmentation persistent over several seismic cycles.