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Rupture process and coseismic deformations of the 27 February 2010 Maule Earthquake, Chile

Nelson Pulido[1*], Yuji Yagi[2], Hiroyuki Kumagai[1], Naoki Nishimura[2]

[1]Nat. Res. Inst. Earth Sc. and Dis. Prev, [2]University of Tsukuba

We estimated the spatial and temporal slip distribution for the 27 February 2010 Maule earthquake from teleseismic body wave data. To obtain a stable inversion solution, we used the data covariance matrix from the observation and modeling errors, and incorporated smoothing constraints by using ABIC. The fault rupture can be divided into three stages. For the first 30 s the rupture started as an elliptical crack elongated in the in-plane direction along dip. After 30 s the rupture propagated bi-laterally along the strike reaching the maximum moment release at around 50 s near the hypocenter. Finally the rupture propagated mainly to the north reaching another peak of moment release at 80 s and 130 km north-east from the hypocenter. Main rupture lasted for about 110 s. To evaluate our source model, we calculated the coseismic vertical displacements and compare them with observed uplift/subsidence values measured along the coastline, as well as displacements obtained from strong ground motion and high-sampling GPS records in Concepcion. Our model provides good estimations of the static displacements in the northern source region, but under-estimates the observed coseismic uplifts in the southern region. This result suggests that more coseismic fault slip is required beneath the Arauco peninsula.The main slip in our source model is located in a region near the coastline. This feature is in good agreement with the source model of Delouis et al. (GRL, 2010), but differs from the source model of Lay et al. (GRL, 2010), in which the main moment release is located near the trench. A recent tomographic study conducted in the source area of the Maule earthquake suggests that the updip limit of the rupture zone might be located 30-40 km away from the trench (Contreras-Reyes et al., Tectonics, 2010), in agreement with our source model. On the other hand, the high-frequency radiated seismic energy suggests that the Maule earthquake may be identified as a normal megathrust event having the coseismic slip within the normal seismogenic zone (Newman and Convers, 2010), supporting the rupture near the coast as indicated by our results. The largest slip area of our source model is located near the hypocenter in a region of strong pre-seismic locking as derived from GPS measurements (Moreno et al., Nature 2010). This result supports the idea that slip of future earthquakes in subduction regions might be correlated to inter-seismic coupling.

Keywords: 2010 Chile earthquake, source process, coseismic displacement, strong motion, seismic coupling