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An improved velocity model of the 2010 Maule earthquake rupture zone using a combined on- and off-shore network

Stephen Hicks (1), Andreas Rietbrock (1), Isabelle Ryder (1), Matthew Miller (2), and Chao-Shing Lee (3)

(1) School of Environmental Sciences, University of Liverpool, Liverpool, United Kingdom (s.hicks@liverpool.ac.uk), (2) Departamento de Geofísica, Universidad de Concepción, Concepción, Chile, (3) Institute of Applied Geosciences, National Taiwan Ocean University, Taiwan

Knowledge of the spatial distribution of seismic properties within an earthquake rupture zone is essential to our understanding of rupture mechanics. Following the Maule earthquake, there was an international collaborative effort to deploy a dense network of seismic instruments in order to record the aftershock sequence; this means a large dataset is available to perform seismic velocity tomography in the area of the rupture zone. Since most co-seismic slip occurred in the offshore region, it is important to interpret the velocity structure of the marine forearc and the underlying oceanic crust. However, since many aftershocks are located offshore, and thus outside of the land network, both the offshore velocity structure and the location of these aftershocks are inherently poorly resolved. During the period July - December 2010, The National Taiwan Ocean University and The University of Liverpool each deployed ocean-bottom seismometer (OBS) networks in the northern and southern ends of the rupture zone, respectively, comprising a total of 43 stations.

We use a catalogue of ∼500 seismic events recorded at both land and OBS stations, containing ∼60000 hand-picked P- and S-wave travel-times. We use a staggered 1D inversion scheme, which initially incorporates a separate velocity model for the marine forearc in order to form better hypocentral locations for the offshore events. Based on previous estimates for slab geometry, we find that the location of offshore seismicity is more tightly constrained along and above the interface. Taking these improved locations into account, we then re-invert for a new 1D model with station corrections. We present a 3D local earthquake tomography model based on manually-picked arrival times. The incorporation of OBS picks into the inversion elucidates better both the up-dip geometry of the subducting plate and the structure of the marine forearc. Beneath the low vp marine forearc (vp < 6.0 km/s), at depths of 7-15 km, we infer the presence of a high velocity structure (vp > 7.0 km/s); the upper interface of which dips at 10-15°, interpreted as the top of the downgoing oceanic crust. These first-order features are in accordance with results from previous active source studies in the region. We continue to analyse the nature and geometry of velocity anomalies along and around the megathrust, and their relation to rupture models and aftershock distribution.