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Systematic Changes Of Earthquake Rupture With Depth: A Case Study From The 2010 Mw 8.8 Maule, Chile, Earthquake Aftershock Sequence

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The very shallow part of subduction megathrusts occasionally hosts tsunami earthquakes, with unusually slow rupture propagation. The aftershock sequence of the 2010 M_W8.8 Maule earthquake, offshore Chile, provides us with the opportunity to study systematic changes in source properties for smaller earthquakes within a single segment of a subduction zone. We invert amplitude spectra for double couple moment tensors and centroid depths of 71 aftershocks of the Maule earthquake down to magnitudes M_W 4.0 and 6.8. In addition, we also derive average source durations. Depending on the availability of data from a 130 broadband station temporary array, we employ two modelling schemes optimised for regional and teleseismic data. The resulting focal mechanisms highlight the correlation of the fault planes thrust earthquakes with the 3D slab model geometry in the area, and the occurrence of normal faulting earthquakes on a crustal fault system in the northernmost part of the study area. We find that shallower earthquakes tend to have longer normalized source durations on average, similar to the pattern observed previously for larger magnitude events. The normalised source durations of normal faulting earthquakes are at the lower end of those for thrust earthquakes, probably because of the higher stress drops of intraplate earthquakes compared to interplate earthquakes. Notably, a similar depth dependence is observable for thrust and normal earthquakes. We tentatively conclude from the similarity of the depth dependence of normal and thrust events and between smaller and larger magnitude earthquakes that the depth-dependent variation of rigidity is primarily responsible for the observed pattern rather than frictional conditional stability at the plate interface Tsunami earthquakes probably require both low rigidity and conditionally stable frictional conditions; the presence of long duration moderate magnitude events is therefore a helpful but not sufficient indicator for areas at risk of tsunami earthquakes.