Toward Rapid, Robust Characterization of Subduction Zone Earthquakes: Application to the 2015 Illapel, Chile Earthquake

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Accurate and robust knowledge of earthquake source parameters is crucial for hazard assessment and disaster response. The short revisit interval and open and rapid data availability of the European Space Agency's Sentinel-1 synthetic aperture radar (SAR) mission mean that SAR interferometry (InSAR) can be a viable method for rapid characterization of major earthquakes, provided the tools for rapid data analysis are available. Thrust-faulting events in subduction zones are particularly damaging; they may generate devastating tsunami and trigger damaging aftershocks. In this study, we develop methods to rapidly model source parameters using InSAR data from the September 16, 2015, Mw 8.3, Illapel, Chile earthquake.

Subduction zone fault geometries have been characterized from seismicity and other data (e.g. the Slab 1.0 model). Since a priori knowledge of fault geometry would eliminate one of the more time-consuming aspects of source parameter modeling, we begin with the Slab 1.0 model of South America. We use a triangular fault mesh to accommodate the irregular fault geometry, then calculate Green's functions using analytical solutions for triangular dislocations. We then compare an interferogram downsampling schema using conventional quadtree decomposition to one based on the Green's functions and model resolution.

Preliminary results suggest that taking advantage of these a priori fault geometry and interferogram sampling models produces a slip model with maximum slip ~12 m and moment magnitude of 8.39, and which reproduces the observed surface displacements with a root mean square misfit of ~6 mm. Pre-event calculation of Green's functions and interferogram sampling schemes, combined with predetermined fault geometry and short satellite revisit intervals, will allow InSAR to play a complementary role to seismic waveform analysis in the rapid characterization of earthquakes.