Towards a Robust Slip Inversion Through Bootstrapping: Application of 4 Very Large Earthquakes

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The study of finite fault slip inversion has been developed comprehensively for several tens of years, and has now became more of a routine analysis. However, the robustness of slip models is neither well understood nor widely-discussed. In this study, we applied the empirical Green’ s function (EGF) method, which has its advantage of being able to remove the complex path and site effects that is difficult to model theoretically. Inversions were conducted with far-field broadband data, using non-negative-least-squares method, and taking EGF selection primarily from Baltay et al. (2014).

To tackle the issue of result robustness, bootstrap is performed in the station selection process, randomly selecting waveforms from P or SH components in various stations, for the model error is specific to inclusion of stations. Averaged results indicating the stable features, together with standard deviation of each features can thus be obtained. With bootstrapping as regularization, results also became smoother without the requirement to explicitly apply the smoothing constraint.

This approach has been applied to 4 megathrust earthquakes, including M_W 8.7 2005 Nias, Indonesia; M_W 8.5 2007 Bengkulu, Indonesia; M_W 8.8 2010 Maule, Chile; and M_W 9.0 2011 Tohoku-Oki, Japan earthquakes. Results comparable to previous studies can be acquired, though the slip is very concentrated as it represents the upper boundary of concentrated slip given by the bootstrapping. Nevertheless, one can clearly observe the difference in rupture pattern across various very large earthquakes as demonstrated in this study.

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