Coseismic deformation of the M9 Sumatra-Andaman earthquake: Accounting for tectonic structure via FEMs

1 Summary.
The slip distribution of the M9 Sumatra-Andaman earthquake is estimated from 3D finite element models (FEMs), GPS data, and inverse methods. The estimated slip distribution loads an FEM to predict regional-scale seafloor deformation. The FEMs are constructed to simulate rupture along the interface separating the weak overriding forearc wedge and the stiff down-going slab. Both estimated slip (inverse models) and seafloor deformation (forward models) are sensitive to the simulated tectonic structure.

2 Geology 101: Which model best represents a subduction zone?
The reliability of both forward model predictions (surface deformation) and inverse model estimates (slip distribution) depend on how well the model represents the natural system.

3 Inverse models: Calculating impulse response functions.
FEMs calculate the impulse response function (IRF) for each fault patch. The IRFs are assembled into a matrix, which is used in standard inverse methods to estimate the slip distribution based on GPS data.

4 Inverse models: Estimating the coseismic slip distribution.
The slip distribution is estimated via least-squares inverse methods, using FEM-generated IRFs and GPS data. Separate Laplacian operators smooth the down-dip and along-strike slip components.

5 Seafloor deformation.
The coseismic slip distribution drives a forward model to predict deformation throughout the problem domain.

6 Conclusions.
1. FEM configurations can represent the tectonic structure of the SASZ.
2. Coseismic slip distributions are readily calculated from FEM-based inverse analyses.
3. Both estimated slip (inverse models) and seafloor deformation (forward models) are sensitive to model configurations of tectonic structures.
4. Results of this study have implications for all SASZ processes driven by the coseismic load, such as stress-coupling, postseismic deformation, and tsunami genesis.

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References.

Timothy Masterlark
Department of Geological Sciences, The University of Alabama, Tuscaloosa, AL 35487
masterlark@geo.ua.edu