Fault kinematic modeling using 3D finite element method

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We adopt a finite element method to investigate the effect of 3D variation of material properties in the subduction zone using the coseismic and postseismic deformation of the 2005 Mw 8.7 Nias-Simeulue, Sumatra earthquake. In this study, we construct a simple subduction model using the mesh generation software, Cubit, developed by Sandia National Lab., USA. The fine element code, PyLith, is used to compute Green’s function responses due to unit dislocation. Preliminary analysis shows the difference of surface displacement calculated from homogeneous and 3-D heterogeneous material models can be as large as 30%. Ignoring the spatial variation of material properties leads to systematic misfits in surface horizontal and vertical displacements. Inverting fault slip distributions with assumption of a homogeneous, isotropic earth, results in biased fault slip distributions and fault geometries in our synthetic tests. For the coseismic and postseismic deformation of the Nias-Simeulu earthquake, we infer a model with less up-dip slip and down-dip slip when using a more realistic 3-D elastic structure. The moment and Coulomb stress calculations may be biased by the assumption of elastic homogeneity. We find the spatial variation of coseismic and postseismic slip distribution in various models remains similar, while integrated potency along depth in 3-D elastic models are smaller comparing with that in an elastic half-space model. In addition, a trade-off exists between the elastic heterogeneity and fault geometry. We may not be able to distinguish which one affects more on surface displacements. The elastic half-space model seems to be more sensitive to the change of the fault geometry.