Project Abstract

We present numerical solutions to several benchmark problems illustrating instantaneous and delayed deformation of the Earth's crust caused by large earthquakes. The first set of benchmarks describes visco-elastic relaxation due to a strike-slip fault. To facilitate comparisons between various numerical methods, we assume a geometrically simple source (a finite rectangular dislocation with a constant slip) in a semi-infinite medium. One of the major limitations of the finite element (FE) models is the treatment of the remote boundary conditions. We tackle this problem by simulating a visco-elastic response of a Maxwellian half-space underlying an elastic layer using meshes with an increasing node spacing away from the source, and infinite elements at the external boundaries of the computational domain. We use a menu-driven pre-processor APMODEL to specify the problem geometry, and generate the input files for the finite element codes. At present, APMODEL allows one to generate input files for the 3-D finite element codes ABAQUS and TEKTON. The fully relaxed solution for the strike-slip fault problem is also obtained using a boundary element (BE) approach. The BE solution uses an elastic half-space model with an imposed stress-free boundary condition at the brittle-ductile transition. The stress-free boundary condition is enforced by adding stress-controlled boundary elements at the brittle-ductile interface. The FE and BE solutions are in good agreement, indicating that our benchmark is robust. Other benchmark problems include the case of a dip-slip fault, effects of gravity, and poro-elasticity. We also compare the efficiency and accuracy of several BE codes, including DIS3D, Interact, and POLY3D. Our numerical benchmarks, and the pre-processing software (e.g., interactive mesh generators, converters of input files between different BE codes) may be of use for researchers studying the quantitative aspects of earthquake-induced deformation.