Project Abstract

Many earthquake source models assume that slip occurs across a planar interface between identical linear elastic materials, for which the assumption that the walls of the fault do not open implies that the normal stress remains unaltered by the rupture. However, when we examine ruptures along rough, nonplanar faults, there will certainly be changes in normal stress. Both the noopening assumption and the assumption of an ideally elastic material response seem less reasonable. To better understand the validity of these assumption in rough fault models, it is useful to develop a model that assumes the noopening condition and elastic response, and then to investigate the magnitude of stress changes as a function of fault roughness. If normal stress on the fault ever becomes tensile, it would contradict the noopening assumption. Additionally, we would like to quantify the degree of roughness necessary to invoke an inelastic material response. We are developing a dynamic rupture model in which we can parameterize and adjust the roughness of the fault as desired. First we specify a smooth curve describing the shape of the fault. Next, we generate a curvilinear coordinate system that conforms to the fault and the other boundaries of the physical domain. We then construct a mapping that transforms between curvilinear coordinates in the irregular physical domain and Cartesian coordinates in a rectangular logical domain. A regularly spaced distribution of grid points in the logical domain maps to an irregularly spaced mesh that conforms to the boundaries of the physical domain; this mapping is obtained by numerically solving an elliptic partial differential equation given a control function that specifies grid spacing at every point in the domain, a feature that allows us to "zoom in" on certain regions. We transform the elastodynamic equation into the coordinate system of the logical domain, and numerically solve it there using secondorder finite differences. The particular numerical method used to integrate the system relies on generating an orthogonal grid, one in which all coordinate lines meet at right angles. The use of an orthogonal grid allows us to avoid troublesome cross terms that would couple adjacent points on the fault. The code exhibits secondorder convergence for specified traction boundary conditions on the fault, and we are implementing rate and statedependent friction laws that will permit us to model dynamic ruptures along rough faults.