Three-dimensional seismic imaging of Baikal and Amur regions of eastern Russian using the double-difference tomography method

Haijiang Zhang, Yunfeng Liu, and Clifford Thurber (Department of Geology and Geophysics, University of Wisconsin-Madison)

Lee Steck, Charlotte Rowe (Los Alamos National Laboratory)

Kevin G. Mackey, Kazuya Fujita (Department of Geological Sciences, Michigan State University)

Steven Roecker (Department of Earth and Environmental Sciences Rensselaer Polytechnic Institute)

Eastern Russia is composed of a series of allochthonous terranes which have accreted to the Precambrian Siberian (North Asian) craton. In the southern part (Baikal and Amur regions), the terranes form a suture zone between the Siberian and North China cratons. The complexities of intracontinental deformation have resulted in the development of several microplates (or blocks) and broad zones of deformation. We assembled catalog picks from ~13000 events and ~140 stations for the Baikal and Amur regions in the period of 1970 to 2005. Out study will for the first time provide a detailed seismic velocity model of the crust and upper mantle for this complicated area.

We adopted the strategy of quality control of this data set using event-pair and station-pair differential times. The idea is to set up a linear system of equations using these differential times to check for possible outliers in the analyst picks by evaluating their internal consistency. For example, for a given station, the differential times among any three earthquakes should, in principle, satisfy dt12 (C dt23 = dt13, where dt!/s are the differential times and the subscripts represent event pairs. In practice, this will not be exactly satisfied, due to noise, cycle skipping, etc. After this step, we jointly use the absolute and differential times to solve for a velocity model in the region by double-difference tomography.

In our tomography algorithm, we will use a Spherical-Earth Finite-Difference (SEFD) travel time method to calculate travel times and trace rays. The basic concept is the extension of a standard Cartesian FD travel time algorithm (Vidale, 1990) to the spherical case by developing a mesh in radius, co-latitude, and longitude, expression of the FD derivatives in a form appropriate to the spherical mesh, and the construction of !0stencils!1 to calculate extrapolated travel times. We benchmark the SEFD method against the !0sphere-in-a-box!1 Cartesian FD travel time algorithm (Flanagan et al., 2006).