Broadband modeling of the 2003 Tokachi-Oki earthquake on the Earth Simulator

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We use a Spectral-Element Method implemented on the Earth Simulator in Japan, to simulate broadband seismic waves generated by the 2003 Tokachi-Oki earthquake (Mw 8.0). To use the finite fault model in our numerical simulations we approximate it by a set of 745 sub-events of size 6 km X 5 km, which are constrained by both teleseismic body waves and strong motion seismograms (Ji et al, 2004).

The earthquake was initiated by a small thrust event, and is well characterized by a 2-segment fault geometry dominated by rupture along 180 km of the subducting Pacific plate. These sub-events represent the distribution of the moment-density tensor. We perform three-dimensional numerical simulations, which incorporate 3D variations in compressional-wave speed, shear-wave speed and density, attenuation, anisotropy, ellipticity, topography and bathymetry, and crustal thickness. We use model S20RTS of the mantle (Ritsema et al., 1999), model CRUST2.0 of the crust (Basin et al., 2000), and topography and bathymetry model ETOPO5. The simulations are performed on 1944 processors, which require 243 out of 640 nodes of the Earth Simulator. We use a mesh with 82 million spectral-elements, for a total of 5467 million global integration grid points (i.e., almost 15 billion degrees of freedom). This translates into an approximate grid spacing of 2.9 km along the Earth"s surface. On this number of nodes, a simulation of 60 minutes of wave propagation accurate at periods of 5 seconds and longer requires about 15 hours of CPU time. We have compared the results of our simulation with both teleseismic broadband seismograms and strong motion records in Hokkaido Island and have confirmed that the source rupture history is well modeled by our fully 3-D synthetic seismograms.