Global Seismic Tomography: Ehime-2006 model

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Our GRC of Ehime University has been developing a series of Evolving High-resolution Image Models of Earth (Ehime) using global seismic tomography. In our Ehime models, the three-dimensional (3-D) Earth structure is expressed with a grid parameterization instead of blocks or spherical harmonics, depth variations of the Moho, 410 and 660 km discontinuities are taken into account in the inversion, and an efficient 3-D ray tracing technique is used to calculate ray paths and travel times (Zhao, 2001, 2004). However, one drawback of the previous Ehime models is that regular grid nodes are arranged in the latitude and longitude directions, which leads to excessive grid nodes in the polar regions and thus the mantle structures under the Arctic and Antarctic regions were not resolved well.

In this study (Ehime-2006 model) we adopt an irregular grid approach to express the Earth structure. In the longitude direction more grid nodes are set up in and around the equator while fewer grid nodes are arranged in the polar regions. The spacing between grid nodes is flexible to change to adapt to the heterogeneous ray coverage in the mantle. Another advantage of this new parameterization is that, for the same grid spacing, the total number of nodes in the irregular grid model is reduced by 1/3 as compared with the regular grid model. Thus with the same computer resources more data can be used to determine a higher-resolution tomographic model.

We applied this new approach to arrival times of P, pP, PP, PcP, and Pdiff phases extracted from the ISC data set (1964-2003) and about 20,000 data we newly collected from seismograms. The resulting Ehime-2006 model has a higher spatial resolution with a grid spacing of 3 to 4 degrees as compared with the Ehime 2001 and 2004 models that have a grid spacing of 5 degrees. Our Ehime-2006 model shows some new features of lateral velocity variations in the mantle such as subducting slabs and mantle plumes, in particular, in and around the Arctic and Antarctic regions.

Zhao, D. (2001) Seismic structure and origin of hotspots and mantle plumes. Earth Planet. Sci. Lett. 192, 251-265.

Zhao, D. (2004) Global tomographic images of mantle plumes and subducting slabs: insight into deep Earth dynamics. Phys. Earth Planet. Inter. 146, 3-34.