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Three-dimensional seismic velocity structure beneath East Asia using adjoint tomography

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East Asia is the complicated region where tectonic plates meet. In many studies, travel-time tomography based on ray theory has clarified three-dimensional (3D) velocity structure of the Earth. On the other hand, the recent studies show waveform inversion based on wave theory can construct realistic 3D structure (e.g. Obayashi et al., 2010 SSJ; Miyoshi et al., 2013 SSJ). In the present study, we have inferred 3D heterogeneous structure precisely beneath the eastern Asia region by using adjoint tomography method. We selected 161 earthquakes (M >5.5, half duration <5 second) occurred in the region based on Global CMT catalog. Displacement seismograms used in this study were recorded at broadband seismic stations in the region. The average number of stations used in inversion is about 180. Theoretical waveforms were calculated using the spectral-element method (Komatitsch and Tromp, 2001). We used GAP-P2 mantle tomography model (Obayashi et al., 2009) as an initial 3D model of inversion. Both observed and theoretical waveforms were filtered between 12.5 and 100 second to extract time windows of P- and S-waves, and between 30 and 150 second to extract time windows of surface waves. We applied adjoint method (Liu and Tromp, 2006) for calculating the misfit kernel, which is related to velocities, and performed inversion by using the steepest descent method. The parallel computing of theoretical waveforms and misfit kernels were used 256 CPU cores of supercomputers, such as K computer at Riken. The computing time was required 0.1 million CPU hours in each iteration. We have iterated four times on inversion. The VR value was improved about 10% by using the revised model. The Vp and Vs of improved model showed a few percent slower than the initial model. The ratios of the velocity perturbation show slightly large value than the initial model at a depth of 100 km in a wide area of the eastern Asia region. Acknowledgements: We used F-net seismograms of the National Research Institute for Earth Science and Disaster Prevention. This study was supported by the strategic Programs for Innovative Research ”Field 3” Advanced prediction Researches for Natural Disaster Prevention and Reduction.

Keywords: adjoint method, tomography, velocity structure, East Asia