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Three dimensional seismic wave-speed structure beneath the Kanto Plain based on adjoint tomography

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We have obtained the preliminary model of three dimensional (3D) structure beneath the Kanto Plain, metropolitan area of Japan. We applied the spectral-element method (e.g. Peter et al. 2011) and adjoint method (Liu and Tromp 2006) to infer 3D velocity model and to reproduce the observed waveform bandpass filtered between 5 and 20 second. We used the travel-time tomography result (Matsubara and Obara 2011) as an initial 3D model and used broadband records obtained at the NIED F-net stations. We selected 147 earthquakes based on the earthquake catalog by the F-net and the S/N ratio of their seismograms. The 3D model used for the forward and adjoint simulations is represented as a region of approximately 500 by 450 km in horizontal and 120 km in depth. Minimum period was 4 sec. The initial 3D model reproduced P-wave seismograms well, however it could not really explain S-waves and later arrivals. For the adjoint inversion, we picked up the windows of the body waves from the observed and theoretical seismograms. The forward and adjoint simulations were implemented by K computer in RIKEN. The performance of the original application was 5% of the peak performance of the K computer, however the modified code achieved 10% by optimization. One iteration requires about 0.1 million CPU hours at least. The model parameters of Vp and Vs were updated by using the steepest descent method. The revised model reproduces observed waveforms better than the initial model.
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Keywords: Kanto Plain, seismic wave-speed structure, adjoint tomography