Rayleigh-wave phase speed distribution beneath the Japanese islands: A multi-station approach

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Phase speed distributions of fundamental-mode Rayleigh waves in the Japanese islands are reconstructed by using a newly developed multi-station method with a regional broad-band seismic network, F-net, which has been deployed by the NIED (National Research Institute for Earth Sciences and Disaster Prevention, Japan). We estimate local phase speeds and arrival angles of the fundamental-mode Rayleigh waves from a group of stations using the multi-station method in a period range between 40 and 128 seconds. To avoid some unwanted effects caused by higher modes as well as ambient noise, we restrict seismic events at depth shallower than 50 km and with surface-wave magnitude greater than 6.0. In our multi-station analysis, we consider at first regular grids with a 1-degree interval in both longitude and latitude. Each grid point is supposed to be the center of a circle with radius of 150 km. F-net stations located in each circle are used as a group to measure local phase speed dispersion, and one of the stations in each group is set to be the reference station. We then measure phase differences for the rest of stations in the group with respect to the reference station. Perturbations of phase speeds and arrival angles are expanded in a set of B-spline functions, whose coefficients are determined by a least-squares inversion. The local phase speeds estimated by the multi-station analysis are then used to invert for phase speed maps in order to investigate the upper mantle structure beneath the Japanese islands.

The results show that the phase speeds in a period range between 40 and 50 seconds in the Chubu region are 6-15 % slower than those estimated from a model based on PREM with crustal correction using an average crust model in Japan, suggesting a thicker crust beneath this region. In addition, the phase speeds in the same period range are 3-10 % higher than the reference values in the Chugoku and the eastern Kyusyu regions, indicating the effect of the subducting Philippine Sea plate. In a period range longer than 60 seconds, the phase speeds in the eastern Japan (from Hokkaido to the northern Kanto) tend to be 2-6 % faster than the reference, suggesting the effect of the subducting Pacific plate with higher shear wave speeds beneath these regions.