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The crust and mantle heterogeneities beneath Japanese Islands investigated by the Hi-net and wave propagation simulation

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1. Background

Regional seismic wavefield observed in the Hi-net high-density seismic network deployed over Japanese Islands is investigated by comparison between compute simulation of seismic wave propagation using recent high-resolution velocity and attenuation tomography models. It is expected that the regional wavefield is strongly influenced by heterogeneities in the crust and upper-mantle structure along propagation path. For example, mantle Pn and Sn wave is very sensitive to the super/sub Moho structure, and the Rg wave is influenced by near-surface structure. Moreover, the crustally guided Lg wave is sensitive to the roughness of surface and Moho interface and heterogeneities in the crustal structure. Thus, by make full use of these regional phases, it is expecting to investigate the heterogeneities and regionalities of the crust and upper-mantle structure in Japan.

2. Data and Method

The Hi-net data for intermediate (M4-5) scale and shallow (H<40km) earthquakes was used in this study to investigate the regionalities of the seismic wave propagation in Japan especially the difference in the wavefidld between northeastern and south-western Japan where strong difference in the crust/mantle structure is expected. The FDM simulation of seismic wave propagation was conducted using the velocity (Matsubara et al., 2008) and attenuation tomography (Sekine, 2001; Nakamura, 2008) models. In order to examine the scattering of high-frequency (f>1 Hz) seismic wavefield, small-scale heterogeneities which is described by vonKarman distribution function with horizontal and vertical correlation length of Ax,y/Az=10/0.5 km and standard deviation of e=1-2% which is based on former studies (Furumura and Kennettt, 2005; Furumura et al., 2014) is superposed on the tomography model and made a *Hybrid heterogeneity model*.

3. Results

Based on the analysis of dense Hi-net seismic data over Japan and computer simulation of seismic wave propagation, it is obtained the following conclusions about the characteristics of the regional wavefield in Japan:

(1) The amplitude of the Sn wave is large in southwestern Japan (compared with northeastern Japan). This is because; 1) the velocity gradient in the sub-Moho structure push up S wave energy from the mantle to the crust which develop large Sn phase, 2) a larger Qs in the mantle develop large Sn phase for longer distances.

(2) The attenuation of the Lg wave is large in northeastern Japan (compared with southwestern Japan). This is because; 1) strong Lg-to-P conversion occurs in the low-wavespeed superficial layer remove Lg wave energy, 2) a larger Qs in the crust o northeastern Japan especially beneath volcano attenuate Lg very drastically, 3) a smaller velocity contrast across Moho leaks S wave energy into the mantle.

(3) A larger Pg is observed in northeastern Japan. This is because; 1) a low-wavespeed superficial layer suppressing generation of the P-to-S conversion and leasing large Pg wave propagating in the crust by multiple reflections.

(4) Attenuation of the short-period surface (Rg) wave is large in northeastern Japan. This is because; 1) strong dispersion and elongation of surface wave occurs in the surface wave due to the existence of low-velocity superficial layer in northeastern Japan, 2) strong attenuation occurs in the short-period surface waves as propagating in low-Q crust.