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Seismic interferometry using dense seismic network data in south Niigata Prefecture, Japan

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We applied seismic interferometry to the data recorded by 15 seismic stations in south Niigata prefecture to estimate surface-wave group velocity between selected station pairs. 14 of the 15 stations each have one three-component broadband velocity seismometer (VSE-355JE by Tokyo Sokushin Co., Ltd.) at a depth of 5 m and the other has one seismometer (VSE-355EI) on the ground surface. The average distance between stations is 7.1 km and therefore the analysis makes it possible to evaluate detailed velocity structure in this region and to estimate group velocity in the higher frequency range (0.5-1 Hz). First we computed cross-correlation functions (CCFs) of long-term ambient noise at selected pairs of stations; (a) between all 14 stations and station GYK03 (Niigata Institue of Technology), (b) between stations on three northwest-southeast lines (31 pairs), and (c) between neighboring stations (35 pairs). Here we used 1 hour continuous data for the calculation, after the one bit normalization (Sabra et al., 2005). The shortest and longest distances between the pairs are 4.2 km (GYK04-GYK05) and 40.7 km (GYK01-GYK15), respectively. The stacked CCFs of ambient noise showed coherent and dispersive wave-trains in a wide frequency range (0.05-1.0 Hz). Especially, time-symmetric CCFs were derived in a frequency range between 0.01 and 0.25 Hz. On the other hand, asymmetric CCFs were clearly seen in the higher (0.5-1.0 Hz) and lower (0.05-0.125 Hz) frequencies. Next we compared observed group velocities with theoretically derived dispersion curves near the stations based on a seismic velocity structure model of the Niigata region (Sekiguchi et al., 2009). Observed group velocities correspond well to the dispersion curve at some stations pairs, while the agreements tend to be poor for station pairs where S/N value of the stacked cross-correlation function is low or where the velocity structure is spatially varying between the stations. Continued data acquisition and analysis is important to obtain more stable CCFs and to evaluate the effect of spatial structure change on the group velocity dispersions.

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Keywords: seismic interferometry, ambient noise, surface wave, velocity structure model, south Nigata Pref.