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Deep seismic images revealed by autocorrelation analysis of ambient noise beneath the northeastern Japan subduction zone

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We obtain seismic reflection images using autocorrelation functions (ACFs) of the ambient noise in the northeastern Japan subduction zone. ACFs with a time-window length of 120 s are calculated from the continuous seismic records obtained at each seismic station during an analysis period of 300 days. The ACFs show some distinct signals with relatively large amplitude without any significant temporal variations during the analysis period. The ACFs show the signals at a large lag time of 20?50 s as well as a small lag time of 10 s. The lag time of 10 s corresponds to the travel time of the PP reflection arrival from the continental Moho discontinuity. The signals with the large lag times between 30 and 50 s corresponding to the back-scattered signals from the mantle wedge or the plate boundary are identified clearly at stations located in the back-arc side. In the ACF records from the fore-arc side stations, weak signals interpreted as the reflection from the plate boundary are apparent in a lag time range from 20 to 30 s. These results suggest that it is possible to retrieve Green's functions reflecting seismic velocity heterogeneity related to the subducting Pacific slab from the ACFs. We construct depth migrated images using the ACFs to obtain the reflectivity profile by assuming that the ACFs represent Green's functions composed of a random wavefield excited by a stochastic sources or scatterers distributed in the vertical or near-vertical direction from stations and that they can be treated as zero-offset seismic traces recorded at each of the stations. The depth migration images show a relatively transparent structure within the subducting pacific slab, whereas a reflective structure within the mantle wedge characterized by the low velocity zones corresponding to the wedge flow imaged by 3-D seismic velocity tomography.

Keywords: Seismic interferometry, ambient noise, autocorrelation, reflection profile, subduction zone