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Detection of velocity discontinuities beneath the Japan Trench revealed from seismic interferometry

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The distribution of hypocenters clearly shows the configuration of a shallow double-planed seismic zone as well as a deeper one beneath the northeastern Japan subduction zone. For understanding the cause of the configuration of a shallow double-planed seismic zone, we need to estimate the velocity structure of the Pacific plate. Seismic interferometry is a one of techniques used to estimate the detailed properties of the Earth by analyzing velocity boundary of seismic waves. These patterns are constructed by correlating and summing pairs of seismic traces with one another to estimate a Green's functions as a response of subsurface elastic properties. Here we evaluate the detectability of subsurface velocity discontinuities of the Pacific plate around the Japan Trench by using data from Ocean Bottom Seismometers.
We calculate autocorrelation functions (ACFs) or cross-correlation functions (CCFs) of noise with time-window length of 60 s at ocean bottom seismometers deployed around the Japan Trench in the northeastern Japan. Filtered one-hour trace at the frequency band of 1?4 Hz is used to calculated correlation by one-bit correlation technique. By taking ensemble average of ACFs or CCFs among 24 hours, the one-day ACFs or CCFs are calculated during about 60 days at each station.
We assumed that the ACF is now derived for a random wavefield excited by a stochastic distribution of sources or scatterers; these are assumed to have random excitation times and random phases and amplitude characteristics. A plane wave from the stochastic sources or scatterers is vertically incident on a seismic station. Then the body wave reflects at a surface, and the refection reflects a subsurface velocity boundary again. The reflection could be observed as PxP reflection at the station. We considered that the typical phases in the ACFs correspond to the PxP reflections from subsurface velocity boundary. Some typical phases are consistent with those from the Moho discontinuity. The result suggests that seismic interferometry is effective in evaluating the detectability of subsurface velocity discontinuities. The other typical phase is possibly consistent with those from the depth of the lower plane of a double-planed seismic zone.

Keywords: seismic interferometry, Ocean Bottom Seismometer, ACF