Ambient noise wavefield characterized by polarization analysis

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The polarization of seismic waves can be used to infer the directionality of the ambient noise wavefield. We demonstrate a simple relationship between the vertical–horizontal cross-spectra at a single station and the azimuthal energy distribution of incident waves. The imaginary parts of the cross-spectra are related to the azimuthal energy distribution of elliptically polarized waves (Rayleigh waves), and the real parts are related to linearly polarized waves (P waves). The relationship can be used to estimate the dominant back-azimuth and directional intensity of the incident waves. We apply our polarization method to one-year-long records observed by Hi-net to investigate the characteristics of the ambient noise wavefield in Japan. Rayleigh waves in secondary microseisms in the period range 4–8 s are sensitive to ocean wave activity in the adjacent sea, showing seasonal variations in directionality that are related to a pressure source region estimated by an ocean wave model. Source locations estimated by the observed back azimuths are distributed in regions that contain strong source site effects. Rayleigh waves are exited effectively in the regions where resonance frequency determined by ocean depth matches the Rayleigh wave frequency. Compared with Rayleigh waves, the sources of the *P* wave energy are distant. The relative contribution of *P* wave energy in ambient noise increases when the adjacent sea is calm. At periods of 2-4 s, the directionality of the ambient noise wavefield seems to correspond to major tectonic boundaries, which is attributed to significant propagation effects associated with strong crustal heterogeneities along tectonic boundaries. Trapping and scattering in thick sediments and around those boundaries may reduce the directionality of the ambient noise. Shorter-period Rayleigh waves attenuate within shorter distances, and back-azimuths at 1-2 s periods point toward the nearest coasts from each station without remarkable seasonal variations. Our polarization technique characterizes the broadband ambient noise wavefield, as polarization analysis is applicable throughout a wide frequency range.

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