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Testing equi-partition in S-wave coda using borehole seismograms

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Equi-partition is a state in which energy of all possible wave modes becomes equal due to multiple scattering among the modes. This is important to identify the scattering regime (e.g. Shapiro et al., 2000) and constitutes the basic principle underlying seismic interferometry (e.g. Sanchez-Sesma and Campillo, 2006).

In this study, we calculate relative contributions of the horizontal and vertical components to the kinetic energy, similar to horizontal to vertical (H/V) ratio, for S-wave coda of 60 local earthquake records at three borehole stations in Japan. S-wave coda in lapse times of 40-80sec and 2-16 Hz band is used. On the surface receivers of the two rock sites of IWTH13 and IWTH17, contribution of horizontal components is dominant and gradually increases with frequency. At a softer site of IWTH02, the contributions show much stronger variations with frequencies reflecting low velocity layers. Subsurface receivers at a depth of about 100m show larger contribution in horizontal components irrespective of site conditions.

We quantitatively explain the observations by synthesizing wavefields under equi-partition in horizontally layered structures estimated from well-logging. Through the modeling, we test there different assumptions on the equi-partition. Subsurface receivers play a critically important role to distinguish the assumptions. For S-wave coda in frequencies lower than about 5Hz, equi-partition holds among both body and surface waves. For higher frequencies, equi-partition holds among only body waves. The results suggests that the contribution of horizontal and vertical kinetic energies serves as a useful tool for estimating subsurface layered velocity structures as an alternative to or in conjunction with the H/V method using ambient noise.

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Keywords: equi-partition, coda, borehole seismograms