Retrieval of Green's function from cross-correlation of a wave field: Oblique incidence of SH waves on layered media

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Recently, an assertion has been verified experimentally and theoretically that the Green's function between two receivers can be reproduced by cross-correlating the records at the receivers. In this study, we have theoretically proved the assertion for cases that plane SH waves are obliquely incident from below on horizontally layered media by using the Thomson-Haskell matrix method. Strictly speaking, the Hilbert transform of the cross correlation between records at two receivers on the free surface is proportional to the convolution between the body-wave part of the Green's function and its time-reversed record and the autocorrelation function of the source wavelet.

It is notable that only the body-wave part of the Green's function can be retrieved from cross-correlation of seismograms for incident waves from a source inside a bedrock. The study offers a theoretical proof for cases which were numerically investigated by Rickett and Claerbout (1997), and is a special case of the proof by Wapenaar et al. (2004) which dealt with three-dimensional arbitrary inhomogeneous media. However, a simple geometry enables us to make an analytical proof and to better understand the physical background of the assertion. We should also note that we must take the Hilbert transform of the cross-correlation function between records, not the cross-correlation itself and its difference for the cases. Though for a little bit different model, Sanchez-Sesma and Campillo (2005) already pointed out the necessity of the Hilbert transform for two dimensional problems.