Suppressing the influence of weak incoherent noises using records obtained simultaneously at two points for SPAC method

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Incoherent noises due to traffic etc. that invade into observed records of microtremor array measurement give undesirable influence on the result of analysis for SPAC method.

In the usual or conventional SPAC method, the SPAC coefficient is given by the azimuthal average of the real part of the cross-spectra of the records obtained at a pair of stations that is normalized by the square root of the product of the power spectra at these ones, and fitted with the zero-order Bessel function of the first kind in order to determine the phase velocity of the surface wave for each frequency (e. g. Okada(2003)). The integrand of the above mentioned azimuthal average is called the complex coherence function (e. g. Shiraishi & Matsuoka(2005)).

The formulation on which the SPAC method is based (Aki(1957), Okada(2003)) is derived by modeling microtremor with stack of coherent signals. Therefore, careful detection of incoherent noises and elimination of contaminated data are necessary for direct application to the observed records. In reality, it is not always easy to prevent contamination especially in urban area and to detect and eliminate the contaminated ones.

Assuming that observed records are the sum of coherent signal and incoherent noise, and that the cross-spectra between incoherent noises and those between coherent signal and incoherent noise are much smaller than the power-spectra of incoherent noises, it can be said that the power spectra of observed records is the sum of the power spectra of coherent signal and those of incoherent noise. Then, it is clear that the denominator of the above mentioned complex coherence function is over-estimated. The numerator becomes the cross-spectra of coherent signals. This means that the influence of incoherent noise appears as under-estimation of the complex coherence function, SPAC coefficient and the phase velocity of surface wave.

This difficulty can be solved by replacing the denominator of the above mentioned complex coherence function with the absolute value of the cross-spectra of the observed records, because the square of the absolute value of the cross-spectra of the observed records give the product of the power spectra of coherent signals under the above mentioned assumption. Hereafter, this corrected one is called ACCF (Alternative Complex Coherence Function), the usual one CCCF (Conventional Complex Coherence Function) to make typing easier.

In the presentation, SPAC coefficients and the phase velocities of surface wave calculated using ACCF are compared those obtained using CCCF for microtremor records obtained in Tsukuba city. As mentioned above theoretically, those calculated with CCCF give always smaller values than those with ACCF. This implies that the correction using ACCF to them under-estimated systematically by using CCCF is reasonable and efficient.