Separation of the temporal variation of the ACROSS signal using independent component analysis

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Transfer functions of the artificial seismic source ACROSS change due to various effects such as stress change before and after earthquakes, barometric pressure, and precipitation. Since the observed temporal variations are influenced by various factors, it is important to separate variations by various factors.

In this study, we performed independent component analysis (ICA) to extract independent variations from the observed transfer function. ICA is a method of extracting statistically independent signal from the records in which multiple signals are mixed. The mixed signal needs to be a linear addition of multiple signals. Assuming that the observed temporal variation of transfer function is a linear addition of independent variations due to several factors, we can extract each variation by ICA.

In this study, we used the ACROSS source installed at Mikawa Observatory of Nagoya University in Toyohashi City, Aichi Prefecture. We used fourteen-month long data for monitoring temporal variation of transfer function at stations around the source. There are six components in the transfer function: up-down, north-west, and east-west components by vertical excitation (Uv, Nv, and Ev component) and those components by horizontal excitation (Uh, Nh, and Eh component). For analysis, we used the transfer function in the frequency domain. We performed preprocessing in which data whitening and dimension compression are made. Data whitening maximizes the performance of signal separation by ICA. Dimension compression is made by principal component analysis to reduce noise that may be included less important components. We applied ICA to the preprocessed transfer function and succeeded to obtain five independent components. Among many methods of ICA, we adopted AMUSE method that is often applied to time series signals.

As a result, we obtained independent components with annual and biannual variations and short-term changes. These independent components were correlated with different kinds of fluid movement, such as ground water level change and rainfall.

Keywords: Artificial source, Seismic wave, Independent component analysis

