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Variability of high frequency seismic noise and implications for interferometric methods : a case study of deep geothermal reservoirs in northern Alsace, France.

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The ambient noise correlation technique allows the determination of the Green's function between a pair of receivers. Theoretically, convergence to the complete Green's function requires that the source distribution is uniform in space and time or that the medium is diffusive. Although these conditions are rarely meet in reality, many studies have shown the efficiency of such method at periods longer than a few seconds where the noise is very energetic, stable and propagates over long distances. In this study we intend to apply ambient noise correlation approach to image the first 3km of the crust around the deep geothermal reservoirs of Rittershoffen and Soultz-sous-Fôrets, located in northern Alsace, a densely populated part of the Rhine graben. Using a network of permanent short-period velocimeters associated with temporary arrays, we characterize the spatial and temporal signature of the noise recorded in the area. The frequency range of interest extends from 0.2 to 5 Hz and includes two kinds of seismic noise. Below 1 Hz, the noise is dominated by the second micro seismic peak and appears very homogeneous both in time and space. Above 1 Hz, the noise is dominated by local anthropogenic sources characterized by a time dependent and highly heterogeneous spatial distribution which reduces the efficiency of the method. First, the convergence of the stacked correlation function toward the Green's function is much slower. Secondly, localized sources can be responsible for biases on the dispersion curve measurements. Finally, the temporal heterogeneity of the noise sources reduces the stability of the coda of the correlation functions and the ability to recover temporal variability of the medium. We take advantage of two small aperture arrays to perform a selection of the wave fields depending on their propagation direction. This method is applied on both real and synthetic data sets and is shown to overcome some of the issues induced by the spatio-temporal heterogeneity of the high frequency seismic noise sources.