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Imaging of a deep geothermal reservoir using ambient noise cross correlation

Maximilien Lehujeur (1,2), Jérôme Vergne (2), Alessia Maggi (2), and Jean Schmittbuhl (2)

(1) Groupe Electricité de Strasbourg, 26 Boulevard du Président Wilson, 67000 Strasboug, France, (2) Institut de Physique du Globe de Strasbourg IPGS (CNRS, Université. de Strasbourg I), 5 rue René Descartes, 67084 Strasbourg Cedex, France

The ambient noise cross correlation technique is a method which was initiated about 20 years ago in helioseismology. It was demonstrated that cross-correlating Sun's surface motion recorded at two distinct points could lead to an estimation of the medium properties in-between the recording points. Nowadays this method is widely used in seismology and many applications can be found in the literature. This method allows determining the Green's function between a pair of receivers only by correlating sufficiently long noise records. Thanks to this, it is now possible to perform tomographic studies without any deterministic sources. Nowadays, this method is widely applied at regional and continental scales using coherent seismic noise at periods larger than $\sim$5s. In contrary, few applications of this method have been performed at a more local scale and at periods lower than 5s, where the seismic noise is mostly dominated by anthropogenic sources. This represents the context of our study in the area of Soultz-sous-forêts and the closeby region of Rittershoffen (North-East of France) where a geothermal plant is about to be installed (ECOGI project). The aim of this study is to build an image of the geothermal reservoir using ambient noise cross-correlation in a high frequency range (0.2 to 5 Hz) and to develop tools in order to follow the evolution of the reservoir during the production period. Indeed, some studies have shown that a small perturbation of the medium results in a stretching of the correlation functions. Therefore computing the correlations over the time and determining the stretching coefficients allows conducting 4D tomography. We applied the ambient noise cross-correlation technique using about 3 years of continuous data recorded by short-period permanent stations in this region. Various classical processing schemes have been tested. At periods lower than 0.5s, the dispersion curves are poorly constrained and the correlation functions are less stable over time. Based on synthetics tests and a statistical analysis of the seismic noise we propose smarter data processing methods associated with careful noise selection to improve the quality of the correlations in this frequency range.