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Sources of high frequency seismic noise: insights from a dense network of ∼250 stations in northern Alsace (France)

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Monitoring local or regional seismic activity requires stations having a low level of background seismic noise at frequencies higher than few tenths of Hertz. Network operators are well aware that the seismic quality of a site depends on several aspects, among them its geological setting and the proximity of roads, railways, industries or trees. Often, the impact of each noise source is only qualitatively known which precludes estimating the quality of potential future sites before they are tested or installed.

Here, we want to take advantage of a very dense temporary network deployed in Northern Alsace (France) to assess the effect of various kinds of potential sources on the level of seismic noise observed in the frequency range 0.2-50 Hz. In September 2014, more than 250 seismic stations (FairfieldNodal@ Zland nodes with 10Hz vertical geophone) have been installed every 1.5 km over a ∼25km diameter disc centred on the deep geothermal sites of Soultz-sous-Forêts and Rittershoffen. This region exhibits variable degrees of human imprints from quite remote areas to sectors with high traffic roads and big villages. It also encompasses both the deep sedimentary basin of the Rhine graben and the piedmont of the Vosges massif with exposed bedrock. For each site we processed the continuous data to estimate probability density functions of the power spectral densities. At frequencies higher than 1 Hz most sites show a clear temporal modulation of seismic noise related to human activity with the well-known variations between day and night and between weekdays and weekends. Moreover we observe a clear evolution of the spatial distribution of seismic noise levels with frequency. Basically, between 0.5 and 4 Hz the geological setting modulates the level of seismic noise. At higher frequencies, the amplitude of seismic noise appears mostly related to the distance to nearby roads. Based on road maps and traffic estimation, a forward approach is performed to model the induced seismic noise. Effects of other types of seismic sources, such as industries or wind, are also observed but usually have a more limited spatial extension and a specific signature in the spectrograms.