EGU22-5743, updated on 13 Aug 2022
https://doi.org/10.5194/egusphere-egu22-5743
EGU General Assembly 2022

Making sense of urban DAS data with clustering of coherence-based array features

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Seismic noise monitoring in urban areas can yield valuable information about near-surface structures and noise sources like traffic activity. Distributed Acoustic Sensing (DAS) is ideal for this task due to its dense spatial resolution and the abundance of existing fiber-optic cables below cities.
A 15 km long dark fiber below the city of Grenoble was transformed into a dense seismic antenna by connecting it to a Febus A1-R interrogator unit. The DAS system acquired data continuosly for 11 days with a sampling frequency of 250 Hz and a channel spacing of 19.2 m, resulting in a total of 782 channels. The cable runs through the entirety of the city, crossing below streets, tram tracks and a river. Various noise sources are visible on the raw strain-rate data. A local earthquake (1.3 MLv) was also recorded during the acquisition period.
To characterize the wavefield, the data is divided into smaller sub-windows and coherence matrices at different frequency bands are computed for each sub-window. Clustering is then performed directly on the covariance matrices, with the goal of identifying repeating sub-structures in the covariance matrices (e.g. localized repeating noise sources). Finding underlying patterns in the complex dataset helps us to better understand the spatio-temporal distribution of the occurring signals.