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Towards 3D Noise Source Location using Matched Field Processing

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The Matched Field Processing (MFP), initially developed in ocean acoustics, is an array-processing and beamforming method, that locates noise sources in range, depth and azimuth. In this study, we analyze the sensitivity of MFP for 3D source location on the exploration scale in applied geophysics and discuss its "acoustic" approximation compared to the "elastic/ correct" one in an heterogeneous Earth.
Since MFP is based upon the correlation of a measured noise field with a synthetic field, the definition of the Green's function (Replica) plays an important role for the source location and requires previous knowledge about the source. To improve the MFP resolution, we tested and developed Replicas for different environmental conditions and source types. Therefore, we computed synthetic array data sets in homogeneous and heterogeneous media with changing source distributions, source mechanisms, signal characteristics and array configurations using Finite Difference modelling and inverted them with MFP. This allows to test the influence of amplitude terms within the Replicas and to quantify the location uncertainties of the method.
We present the application of MFP on the Gornerglacier (Switzerland) using a small-scale, dense aperture array (7 stations, Ø < 500 m), that was installed on ice. The located noise source forms a distinct 3-dimensional zone and channel-like structure down to 400 m depth, which could be linked to a meltwater channel (glacier moulin).