



Comparison of direct rotational-motion measurements and array-derived rotations during a 3D seismic-exploration campaign – the Rot3D experiment

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Six-component (6C) sensor data consisting of three components of translational and three components of rotational motion allow carrying out wavefield processing with a single station that conventionally requires sensor arrays (e.g., slowness estimation). Conventional sensor arrays need to be large, regular, and dense for standard processing (e.g., SPAC, f-k beamforming analysis). Alternatively, estimating the spatial gradients of the wavefield and, hence, rotational motion at the free-surface, by finite-difference approximation enables using substantially smaller arrays of closely-spaced conventional sensors. However, all arrays can suffer from limitations such as size requirements, as well as sensor coupling variations and subsurface inhomogeneity across an array that negatively affect the array-processing results. First portable, reliable, and highly sensitive broadband rotational motion sensors (i.e. blueSeis3A) allow us comparing array-derived rotational motion estimates with direct observations, and investigating how a single 6C station can be used to replace a sensor array.

We carried out a direct comparison of three blueSeis3A prototype rotational seismometers with three arrays of conventional 3C 4.5-Hz geophones placed approximately in the centre of a commercial 3D seismic-exploration survey. A total number of 86 3C geophones were laid out in four patches around 30 m apart. Three patches consisted of an areal hexagonal sensor pattern to optimally estimate the spatial gradients with different inter-sensor spacing. Additionally, four broadband 3C seismometers and groups and lines of conventional 1C (vertical-component) geophones were installed. During around three weeks, signals from several hundred vibroseis sweeps with up to 2-km distance to the sensor layout as well as ambient noise were continuously recorded. Even though synchronizing a total of 10 independently operating recording units, snow and low temperatures, as well as technical issues with the prototype instruments made this field campaign challenging, the recorded data allow, for example, comparing conventional slowness and dispersion-curve analyses with single 6C station processing.