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On the Multi-component Information of DAS for Near-Surface Seismic: A Pilot Field Experiment in the Groningen Area

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In a surface-seismic setting, Distributed Acoustic Sensing (DAS) is still not a widely adopted method for near-surface characterisation, especially for reflection seismic imaging, despite the dense spatial sampling it provides over long distances. This is mainly due to the decreased broadside sensitivity that DAS suffers from when buried horizontally in the ground (that is when the upgoing wavefield (e.g. reflected wavefield) is perpendicular to the optical fibre). This is unlike borehole settings (e.g. zero-offset Vertical Seismic Profiling), where DAS has been widely adopted for many monitoring applications. Advancements in the field, like shaping the fibre to a helix, commonly known as helically wound fibre, allow better sensitivity for the reflections.

The promise of spatially dense seismic data over long distances is an attractive prospect for retrieving the local variations of near-surface properties. This is particularly valuable for areas impacted by induced seismicity, as is the case in the Groningen Province in the north of The Netherlands, where near-surface properties, mostly composed of clays and peats, play an essential role on the amount of damage on the very near-surface and the structures built on it. Installing fibre-optic cables for passive and active measurements is valuable in this situation. We installed multiple cables containing different fibre configurations of straight and helically wound fibres, buried in a 2-m deep trench. The combination of the different fibre configurations allows us to obtain multi-component information. We observe differences in the amplitude and phase information, suggesting that these differences can be used for separating the different components of the wave motion. We also see that using enhanced backscatter fibres, reflection images can be obtained for the helically wound fibre as well as the straight fibre, despite the decreased broadside sensitivity for the latter.