EGU22-11869
https://doi.org/10.5194/egusphere-egu22-11869
EGU General Assembly 2022

Long range distributed acoustic sensing technology for subsea geophysical applications

Erlend Rønnekleiv, Ole Henrik Waagaard, **Jan Petter Morten**, and Jan Kristoffer Brenne
ASN Norway, R&D, Tiller, Norway (erlend.ronnekleiv@asn.com)

Recent advances in range and performance of distributed acoustic sensing (DAS) enable new geophysical applications by measuring fiber strain in existing telecom cables and subsea power cables that incorporate optical fibers. We will present new field data showing the usability of DAS for environmental and geophysical applications, focusing especially on seabed surface waves and the sub-Hz domain. These examples show that highly sensitive DAS technology can be a valuable tool within seismology and oceanography.

The sensitive range along the fiber for DAS was previously limited to about 50 km. We will demonstrate a newly developed system (named OptoDAS) that allows for launching several orders of more optical power into the fiber, and thereby significantly improving the range beyond 150 km.

This new interrogation approach allows for high degree of flexibility optimizing the interrogation parameters to optimize the noise floor, spatial and temporal resolution according to the application. The gauge length (spatial resolution) can be set from 2 to 40 m. For interrogation of 10 km fiber, we achieve a record low noise floor of 1.4 pε/√Hz with 10 m spatial resolution. For interrogation of fibers beyond 150 km, we achieve a noise floor below 50 pε/√Hz up to 100 km. Above 100 km, the noise is limited by the level of reflected optical power, and the noise increases by ~0.3-0.4 dB/km, corresponding to the dual path optical loss in the fiber.

A modern instrument control interface allows for automatic optimalization of interrogation parameters based on application parameters in a few minutes. The instrument computer provides a flexible platform for different applications. The high-capacity storage system can store recorded time-series of several weeks to support e.g., geophysical investigations where extensive post-processing is required. The computational capacity can also be used for real-time visualization and advanced signal processing, for example for event detection and direct reporting of estimated parameters.

The OptoDAS system can convert a submarine cable into a 100 km+ densely sampled array. From the recordings on a telecom cable in the North Sea, we will show examples of propagating Rayleigh and Love acoustical modes bounded to the seafloor surface. These modes can be excited by acoustic sources on or above the seafloor, such as trawls and anchors. The dense spatial sampling allows for accurate estimates of the location of these sources. The system also allows for

applications in seismology and earthquake monitoring. When attached to a cable with non-straight geometry, the measurements have substantial information to determine the location of seismic events. This will be demonstrated using field data from the North Sea telecom cable.

From recordings on a submarine cable between Norway and Denmark, we present the DAS response in the frequency range 0.1 mHz-10Hz across a cable span of 120 km. The response in this frequency range will be a combination of temperature changes, ocean swells and tides. We show that increasing the gauge length in post-processing allows for improving the sensitivity for detecting ultra-low frequency signals.