EGU2020-12055
https://doi.org/10.5194/egusphere-egu2020-12055
EGU General Assembly 2020
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Precise Distributed Acoustic Sensing measurements by using seafloor optical fiber cable system for seismic monitoring

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Distributed Acoustic Sensing (DAS) measurements which utilize an optical fiber itself as a sensor can be applied for various purposes. An observation of earthquakes using an optical fiber deployed on the seafloor with DAS technology is attractive because DAS measurements enable a dense seismic observation as a long linear array. Spatial resolution of the observation reaches a few meters. The length of the array is determined by the measurement range of the DAS interrogator deployed on the optical fiber, and a fine spatial sensor interval can be configured. DAS measurements have become increasingly accurate and the current state of technology exhibit high signal quality. Because DAS measurement is useful for earthquake observation, there were some trials for an observation of earthquakes using an optical fiber deployed on the land or the seafloor. However, There are few observations using DAS technology on seafloor until the present.

In 1996, a seafloor seismic tsunami observation system using an optical fiber cable was deployed off the coast of Sanriku by Earthquake Research Institute, the University of Tokyo. The system has three seismic stations and two tsunami-meters, and a length of the cable is approximately 115 km. The system has six spare (dark) optical fibers which are dispersion shifted single mode type, and have been incorporated for future extension of the observation system. We have started development of a seafloor seismic observation system utilizing DAS technology on the Sanriku cable observation system as a next generation of marine seismic observation system. In 2019, we performed DAS measurements using a dark fiber from Sanriku seafloor observation system three times. An interrogator was installed in the cable landing station temporarily. Data were recorded with various values of parameters, such as length of data collection (array aperture), gauge length, ping rate, acquisition offset, for evaluation of data quality and signal to noise ratios. The total recording period for three measurements was approximately three weeks. As a result, many earthquakes including micro-earthquakes were recorded. The obtained data will be used to develop data processing techniques for seismic observations utilizing DAS measurements.