Very broadband strain-rate measurements along a submarine fiber-optic cable off Cape Muroto, Nankai subduction zone, Japan

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Distributed acoustic sensing (DAS) is a new method that measures the strain change along a fiber-optic cable and has emerged as a promising geophysical application across a wide range of research and monitoring. Here we present the results of DAS observations from a submarine cable offshore Cape Muroto, Nankai subduction zone, western Japan. The observed signal amplitude varies widely among the DAS channels, even over short distances of only ~100 m, which is likely attributed to the differences in cable-seafloor coupling due to complex bathymetry along the cable route. Nevertheless, the noise levels at the well-coupled channels of DAS are almost comparable to those observed at nearby permanent ocean-bottom seismometers, suggesting that the cable has the ability to detect nearby micro earthquakes and even tectonic tremors. Many earthquakes were observed during the five-day observation period, with the minimum and maximum detectable events being a local M1.1 event 30–50 km from the cable and a teleseismic Mw7.7 event that occurred in Cuba, respectively. Temperature appears to exert a greater control on the DAS signal than real strain in the quasi-static, sub-seismic range, where we can regard our DAS record as distributed temperature sensing (DTS) record, and detected many rapid temperature change events migrating along the cable: a small number of large migration events (up to 10 km in 6 hours) associated with rapid temperature decreases, and many small-scale events (both rising and falling temperatures). These events may reflect oceanic internal surface waves and deep-ocean water mixing processes that are the result of ocean current–tidal interactions along an irregular seafloor boundary.

Keywords: distributed acoustic sensing (DAS), Muroto submarine cable, broadband seismograms, water mixing process