EGU24-10604, updated on 07 Feb 2025
https://doi.org/10.5194/egusphere-egu24-10604
EGU General Assembly 2024

On DAS-recorded strain amplitude

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The power of distributed acoustic sensing (DAS) lies in its ability to sample deformation signals along an optical fiber at hundreds of locations with one interrogator only. While the interrogator is calibrated to record 'fiber strain', the properties of the cable and its coupling to the rock control the 'strain transfer rate' and hence how much of 'rock strain' is represented in the recorded signal.

We use DAS recordings carried out with a Febus A1-R interrogator in an underground installation colocated with an array of strainmeters in order to measure the 'strain transfer rate' in situ. A tight-buffered cable and a standard loose-tube telecommunication cable (running in parallel) are used, where a section of both cables covered by sand and sandbags is compared to a section, where cables are just unreeled on the floor.

Signals from the Mw 7.7 and Mw 7.6 earthquakes that took place on the East Anatolian Fault on February 6th 2023 allow us a proper comparison of signals in the frequency-band between 50 mHz and 0.2 Hz. At lower frequencies the DAS signal-to-noise ratio is insufficient. At higher frequencies the invar-wire strainmeters show a parasitic response to vertical ground motion. For frequencies up to 1 Hz we use seismometer recordings to estimate strain for an incoming plane wave, based on the ray parameter and in this way extend the bandwidth of the comparison. The ray parameter varies along the recording but is sufficiently well known and can be validated against the strainmeter recording.

The 'strain transfer rate' is largely independent of frequency in the band from 0.05 Hz to 1 Hz and varies between 0.15 and 0.55 depending on cable and installation type. The sandbags show no obvious effect and the tight-buffered cable generally provides a larger 'strain transfer rate'. The noise background for 'rock strain' in the investigated band is found at about an rms-amplitude of 0.1 nstrain in 1/6 decade for the tight-buffered cable. This allows a detection of the marine microseisms at times of high microseism amplitude.