Using joint DAS-Nodal array to better understand local seismicity and shallow structure in Northern Oklahoma

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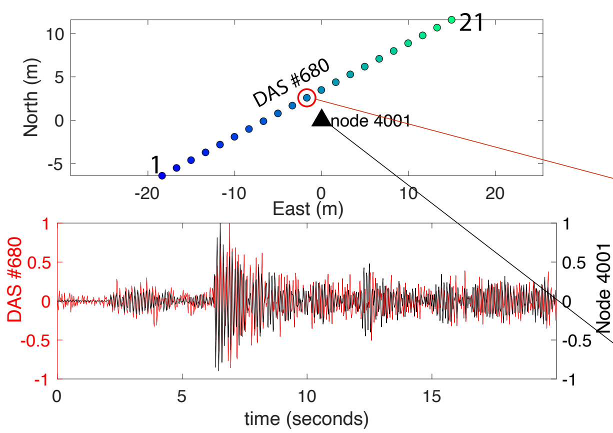
Distributed acoustic sensing (DAS) converts fiber cables into densely spaced seismic channels, proving high-resolution ground vibration recording. However, the sensitivity and signal quality are highly variable due to different fiber installation and coupling. In summer 2021, we conducted a field experiment with joint DAS and seismic nodal arrays in northern Oklahoma with a goal to better understand the fiber response.

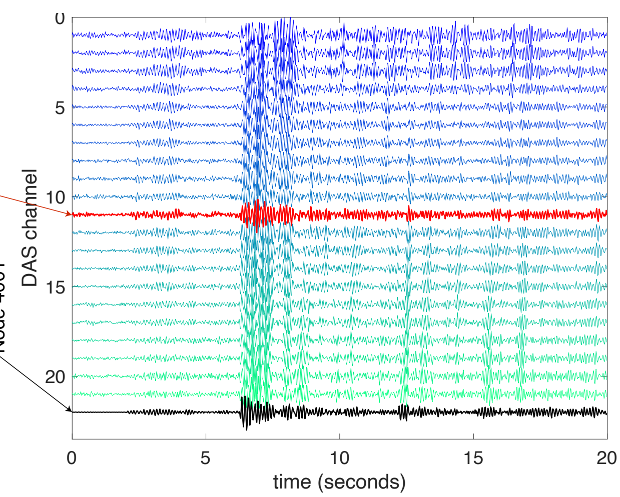
We analyzed 47 local seismic events within 30 km of the array from Oklahoma Geological Survey catalog. These events are distributed within 8 distinct clusters. For the array that extends east from Enid, only one (out of 12) cataloged earthquake (M2.13) is visually identified. Some of the cataloged events are detectable via waveform cross-correlation. On the contrary, the array that extends west from Enid had 26 out of 35 cataloged events visually identified.

The difference in sensitivity could be due to coupling or subsurface structure. Using the collocated Nodal arrays, we derived shallow tomographic image from ambient noise cross-correlation, and found variations in shallow velocity that could contribute to different amplitude response of the DAS array. Preliminary analysis found correlation between shallow velocity structure and horizontal-to-vertical (HV) ratio using Nodal array.

Comparing waveforms recorded by DAS array with collocated node, the DAS wavefield shows high-resolution scattered waves and secondary arrivals following S-wave, illustrating the advantage of high spatial sampling in DAS arrays. Updated analysis of earthquake detection via matched filter and subsurface structure will be discussed.



Left column: Top: UTM coordinate of DAS channels within 20m of Node 4001 for a M2.13 earthquake on May 2nd, 2021. Bottom: Waveforms of the DAS #680 (red) and rotated waveform of Node 4001 (black) (the DAS line strike is 61 degree, rotate using combinations of E and N components).



Right column: Waveforms for DAS channels and rotated Node 4001, bandpass filtered 0.5 to 20 Hz and downsampled to 50 Hz. Even within 50 m, the waveform shows gradual changes, and secondary phases are clear. DAS data is integrated to strain.