Performance of 3-Component Nodes in the IRIS Community Wavefield Demonstration Experiment

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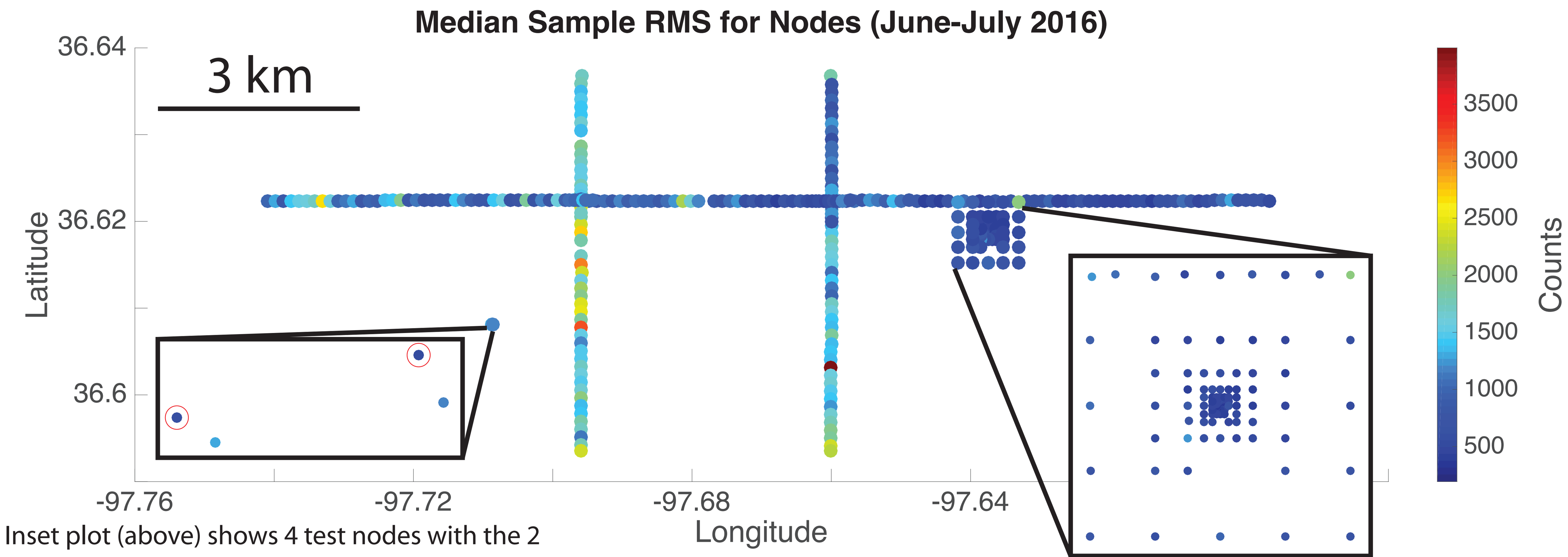
www.iris.edu/wavefields

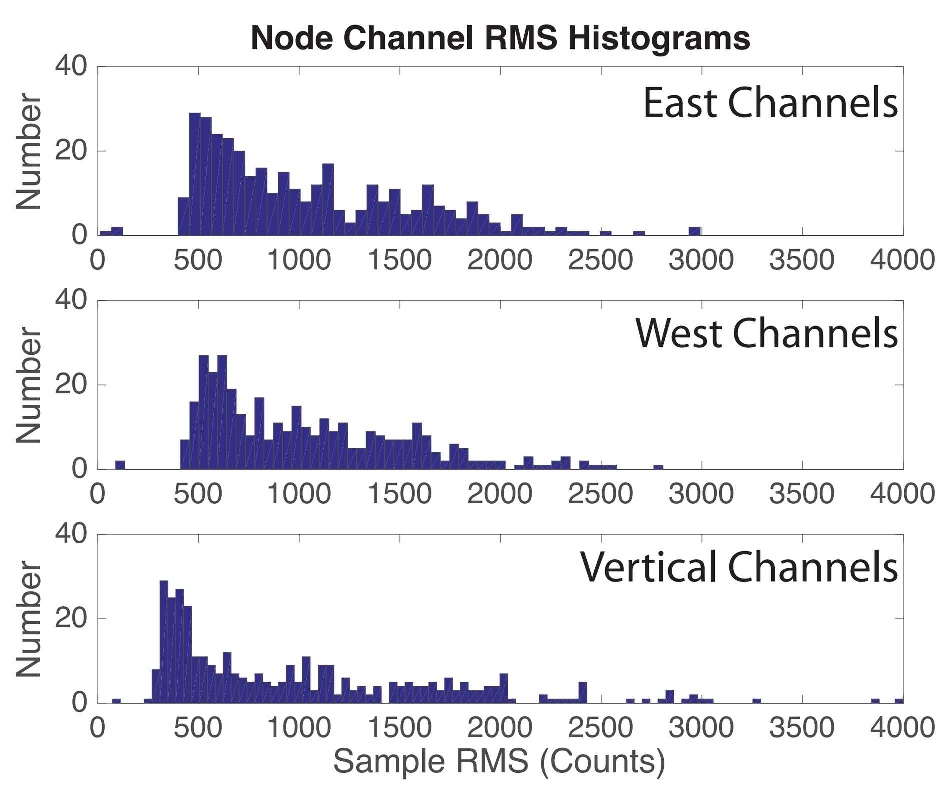
Instrumentation

In June of 2016, IRIS facilitated a community-designed experiment to demonstrate the feasibility and usefulness of recording the full seismic wavefield. The experiment made use of **363 FairfieldNodal ZLAND 3-component 5Hz nodal systems** recorded at 250 samples/sec to deploy 3 seismic lines and a 7-layer nested gradiometer for 30 days. In addition to nodes, **18 Guralp CMG-3T 3-component BB sensors** recorded on a Reftek RT-130 DAS at 100 samples/sec were deployed in a "Golay" array design, along with **9 Hyperion Microbarometers** recorded on a Reftek RT-130 DAS at 100 samples/second co-located with 9 of the broadband stations. The broadband and infrasound stations were deployed for 5 months.

Using MUSTANG to Evaluate Network Performance



Inset plot (above) shows 4 test nodes with the 2 buried nodes circled in red. Note that the 2 surface nodes (not circled) have higher SAMPLE RMS values.



In an effort to quantify how well the nodes performed during the deployment, we turned to data metrics calculcated by MUSTANG (service.iris.edu/mustang).

The plot above shows how the SAMPLE RMS metric varies for nodes across the network. SAMPLE RMS is a metric that quantifies the variance of raw trace amplitudes (in counts) within a 24-hour window. For the above plot, median SAMPLE RMS values are shown for the period June-July 2016 and have been averaged across the 3 components at each station. These data have not been corrected for instrument response.

Lower values tend to indicate node stations that were quieter, while higher values show stations with higher noise. Variation across the network can arise from differences in site conditions, installation techniques, local noise (cars, wind turbines, etc.).

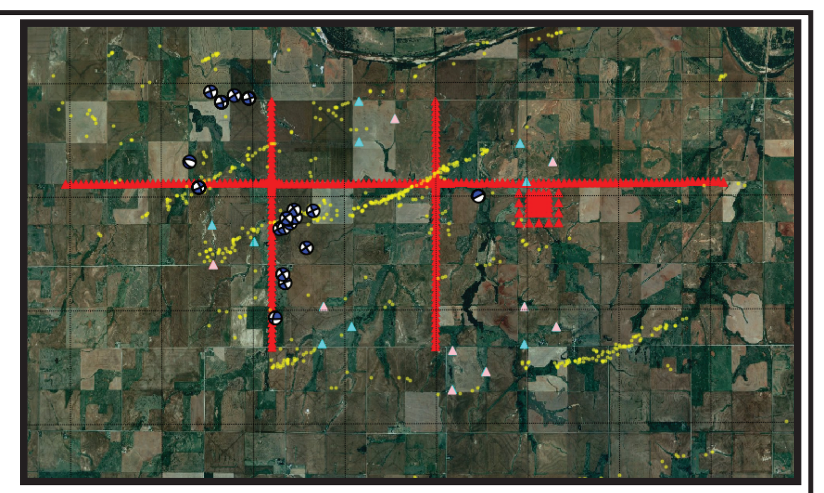
Histograms of median SAMPLE RMS values (left) show how SAMPLE RMS values vary by channel.

Student Projects from IRIS Wavefields Short Course

Group photo of student participants and instructors from the IRIS Wavefields Short Course at Indiana University in August 2017

In August 2017, IRIS hosted a student short course at Indiana University focused on the Wavefields dataset. Over 5 days, the 29 graduate student and post-doc participants learned about instrumentation, array seismology, infrasound, data formats, high performance computing and parallel processing, and ambient noise cross-correlation, among other topics.

Students ended the week with group projects including event detection using template matching (upper right) and comparison of local and regional events (lower right).



Above image by: Nate Stevens, Colin Pennington, Yuwei Li, John Aiken

A big thank you to the following instructors for helping to make the short course a success:

- Marianne Karplus (UTEP)
- Chuck Langston (Memphis)
- Heather DeShon (SMU)
- Brian Stump (SMU)
- Gary Pavlis (Indiana)
- Rob Mellors (Livermore)
- Fan-Chi Lin (Utah)

Scan the QR code to check out all of the student projects from the Wavefields Short Course

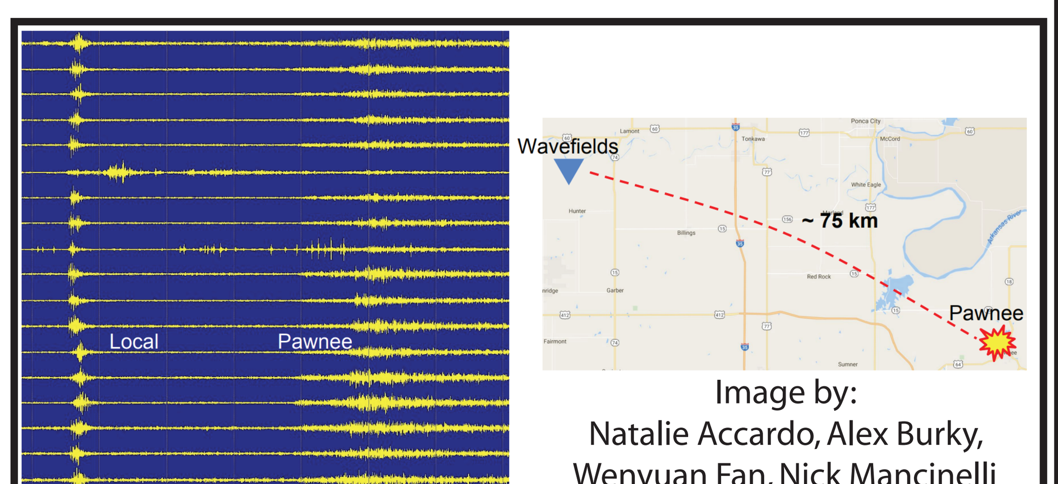
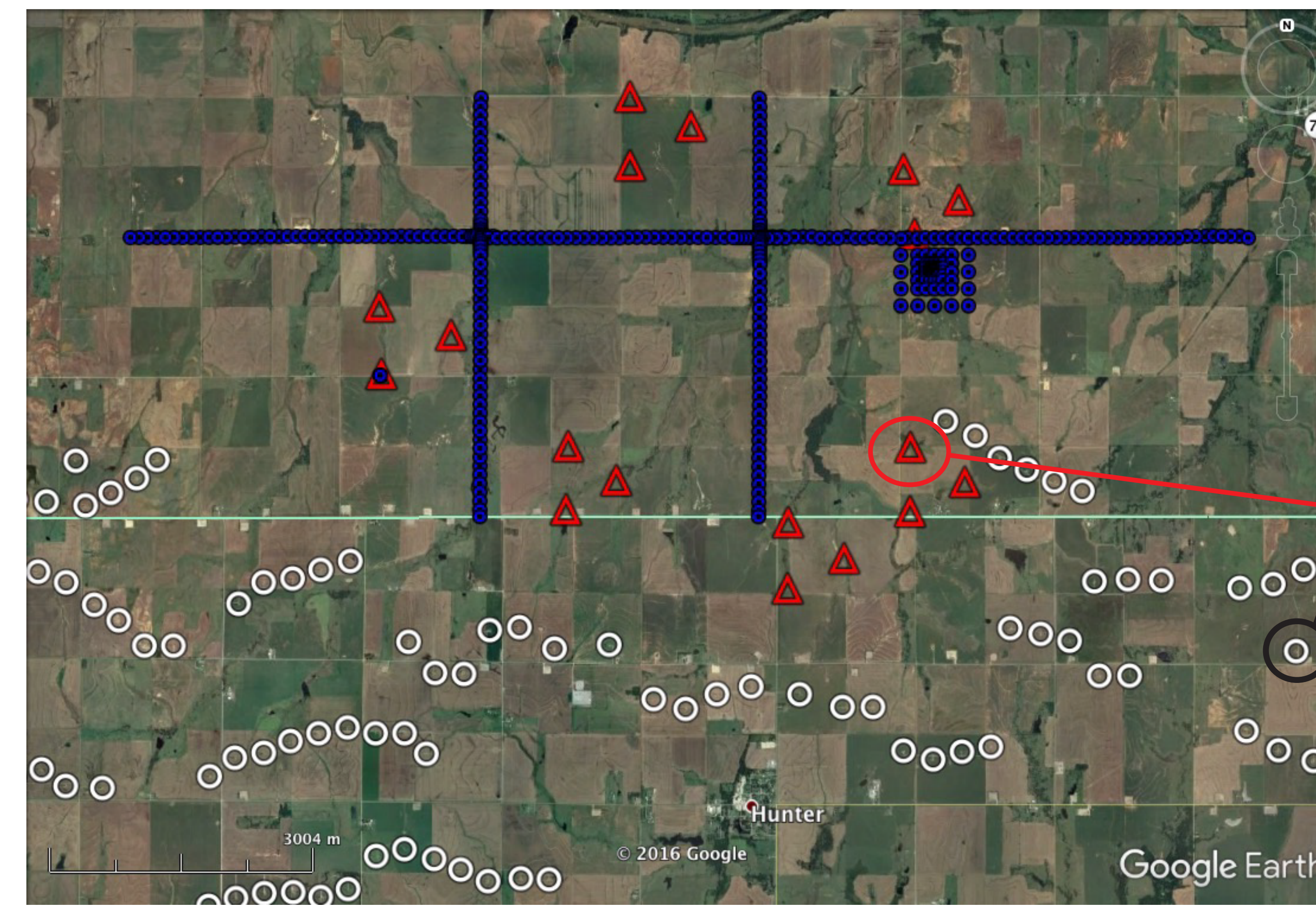


Image by: Natalie Accardo, Alex Burky, Wenyuan Fan, Nick Mancinelli

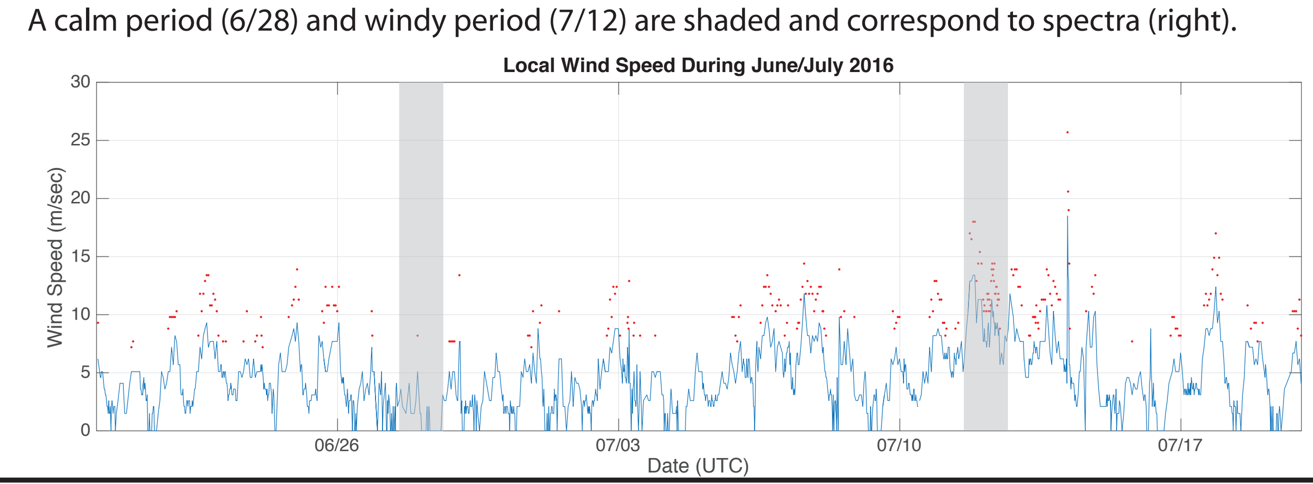
Wind Turbine Signals



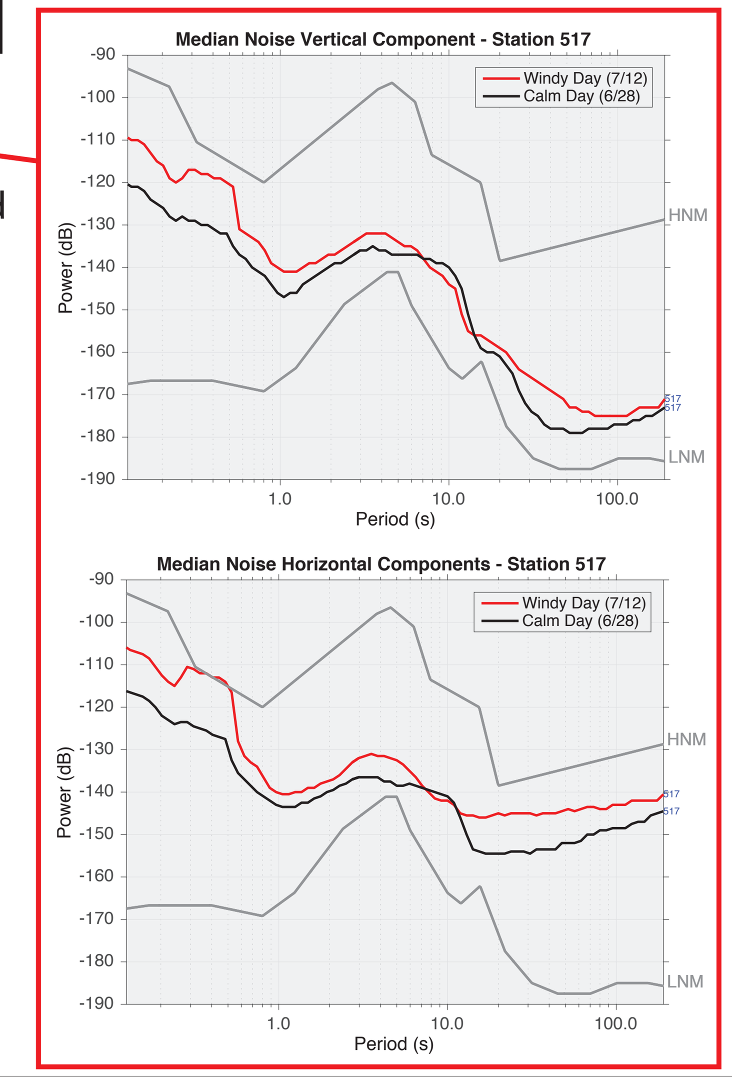
Location of deployment in north-central Oklahoma

Our array was deployed within a few miles of a large wind farm.

Map of deployment (above) with nodes (blue), broadband stations (red) and wind turbines (white). Below is a plot of local wind speeds and gusts as measured at a nearby airport during the deployment. A calm period (6/28) and windy period (7/12) are shaded and correspond to spectra (right).



We analysed noise spectra for one station on a windy day (red, right) and a calm day (black, right). We observe a large peak in both vertical and horizontal spectra between 6-8 Hz that is likely a result of noise from the turbines.

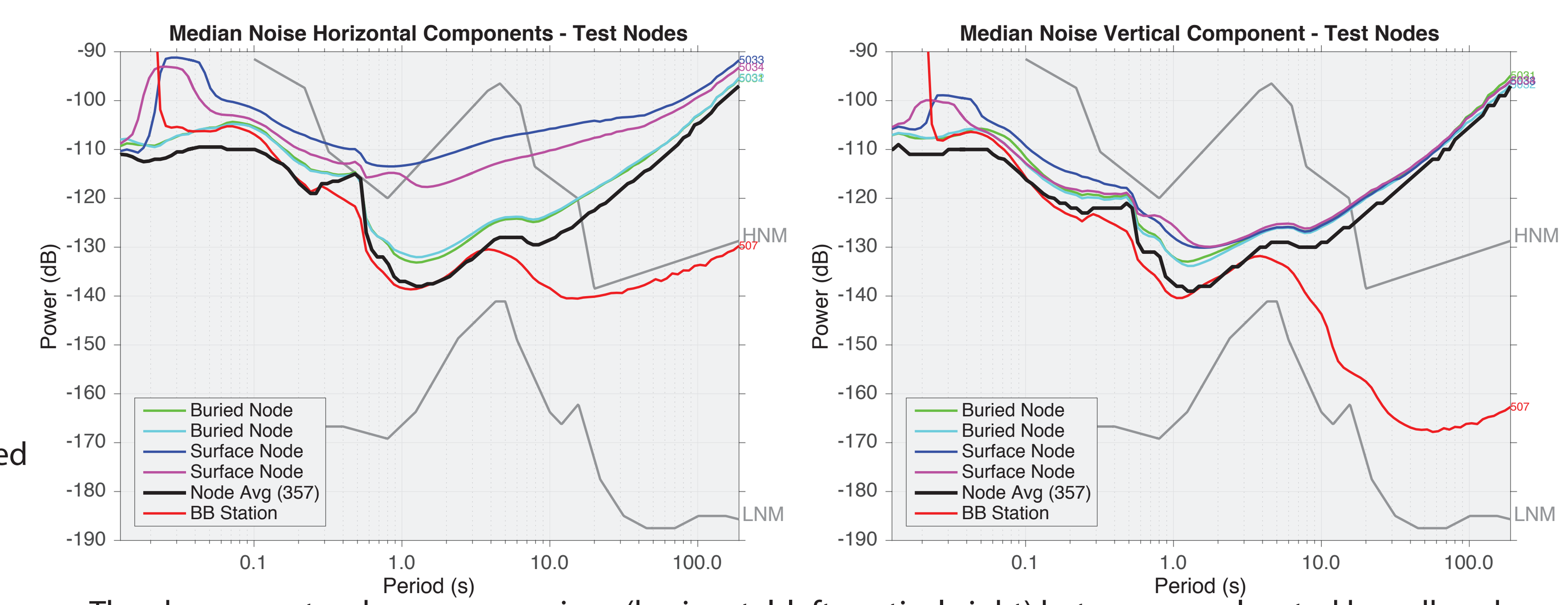


Buried vs Surface Nodes

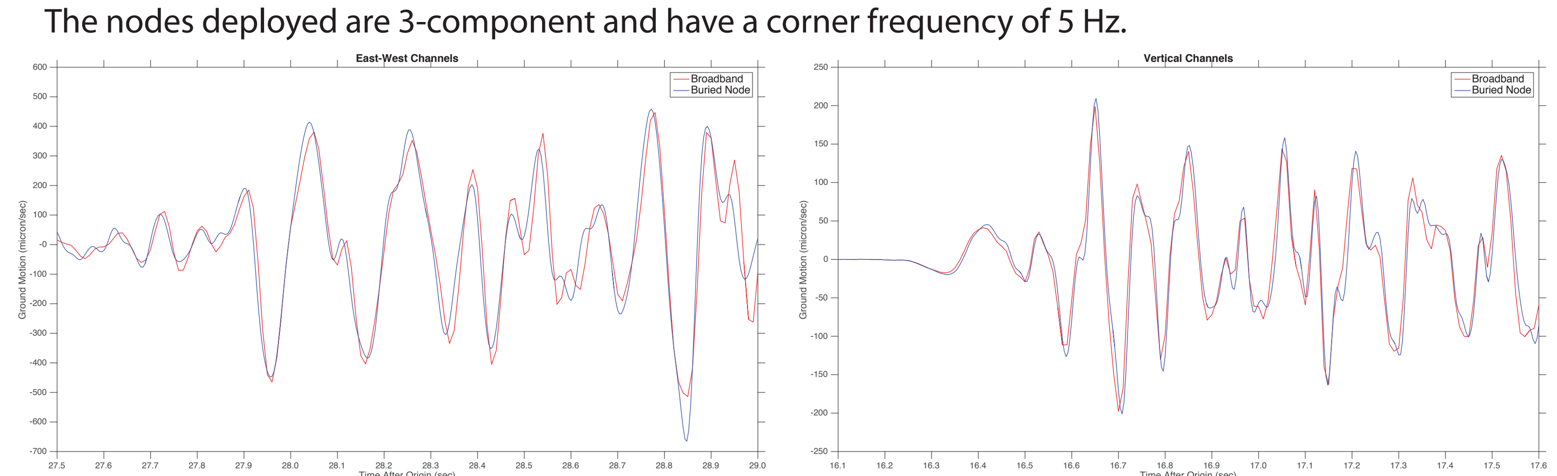
In an attempt to determine the difference between buried and surface nodes, we set up 2 pairs of test nodes ~20 feet apart near a broadband station (red circles below).

Horizontal and vertical spectra (right) show how the 4 test nodes compared. The 2 surface nodes exhibit significantly higher noise levels across the board, with a prominent peak seen between about 50-100 Hz.

With the exception of 2 test nodes, all the 3-C nodes deployed for this project were buried so that the top of the node was just below the surface. This was done to ensure better coupling and lower noise.



The above spectra show a comparison (horizontal, left; vertical, right) between a co-located broadband, 2 buried nodes, 2 surface nodes, an average spectra for all 357 nodes deployed during the experiment. The nodes deployed are 3-component and have a corner frequency of 5 Hz.



Here we show a comparison between our co-located broadband station (pictured, left) and one of the buried nodes at the same site. These data are from a nearby M4.4 event on 7/9/16 and have been band-pass filtered between 5 and 40 Hz.

To learn more about the Wavefields experiment, or to access the dataset, scan the QR code or head over to www.iris.edu/wavefields

Acknowledgements

This work was funded by the National Science Foundation through the IRIS SAGE award. IRIS procured a small set of evaluation nodes for this experiment that remain in our pool, but the bulk of the 363 nodes were leased from FairfieldNodal, the University of Utah and the University of Texas, El Paso. Broadband station installations and data processing/archiving were led by personnel from the IRIS PASSCAL Instrument Center - New Mexico Tech. The Okalahoma Geological Survey provided excellent field support during the installation and demobilization of the equipment. Road access was approved and granted by the Garfield County Commission and Broadband and Gradiometer permits were granted by 7 different and welcoming landowners from the area. Most important is the hard work of the 30+ graduate students from 20 different institutions who braved the Oklahoma heat to help install these arrays.