aHomestake Array and Wiener Filtering

Michael Coughlin, Jan Harms

August 11, 2016

Introduction

With the original Homestake array (http://arxiv.org/abs/1403.7756):

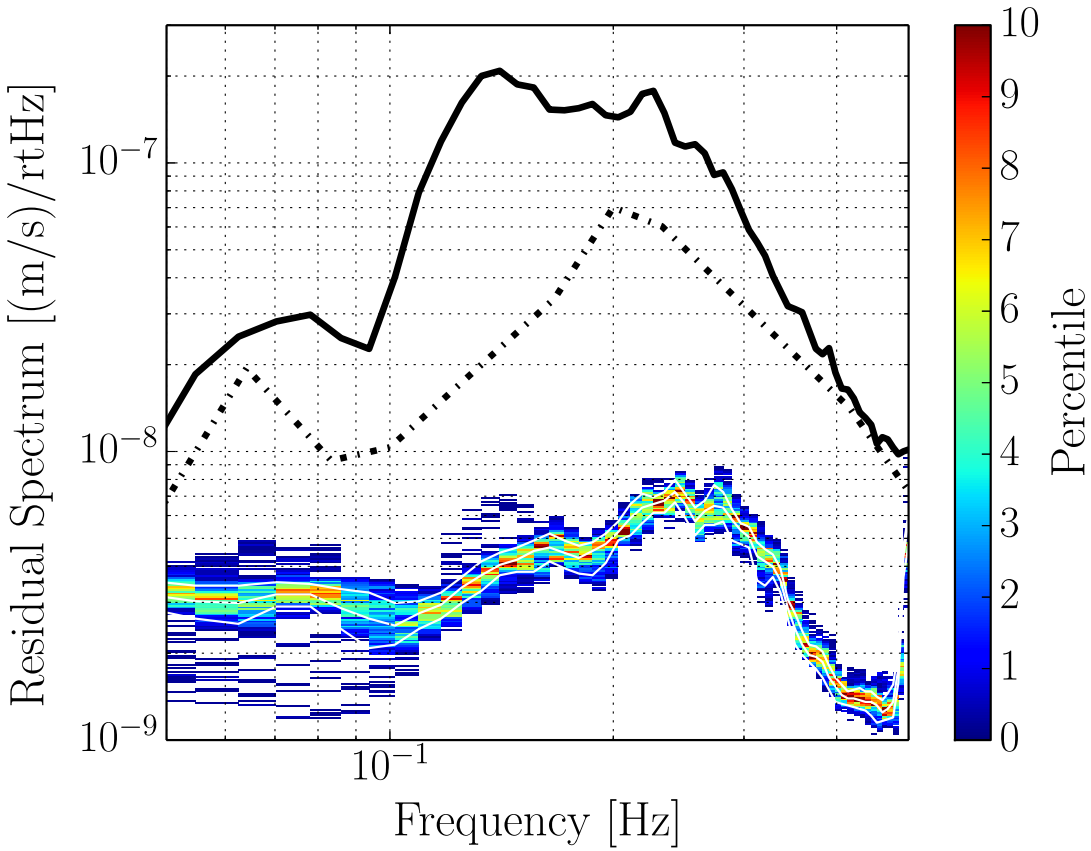
1. We demonstrated that we can achieve more than an order of magnitude seismic-noise cancellation between about 0.05-0.5 Hz using Wiener filters with only a few seismometers separated by a distance of order 500 m.
2. At least a factor 50 NN reduction should in principle be feasible at the Homestake site around 0.1 Hz (subject to assumptions about scattering).
3. We have showed that this subtraction performance can be achieved without regularly updating the filter, indicating that the average properties of seismic fields at Homestake do not change significantly over timescales of weeks in this frequency band.

Introduction (continued)

Caveats to the analysis:

1. Assumed that seismic scattering at the Homestake site is representative for seismic scattering of the entire region that needs to be included for NN estimates.
2. Array not large enough to explore optimal array design and the many technical issues associated with the calculation of Wiener filters based on a large number of reference channels
3. Residual spectra contained a microseismic peak ... why? (body waves and surface waves? scattering?)

Wiener Filter (iHomestake)



(a) Wiener Filter

Introduction (continued)

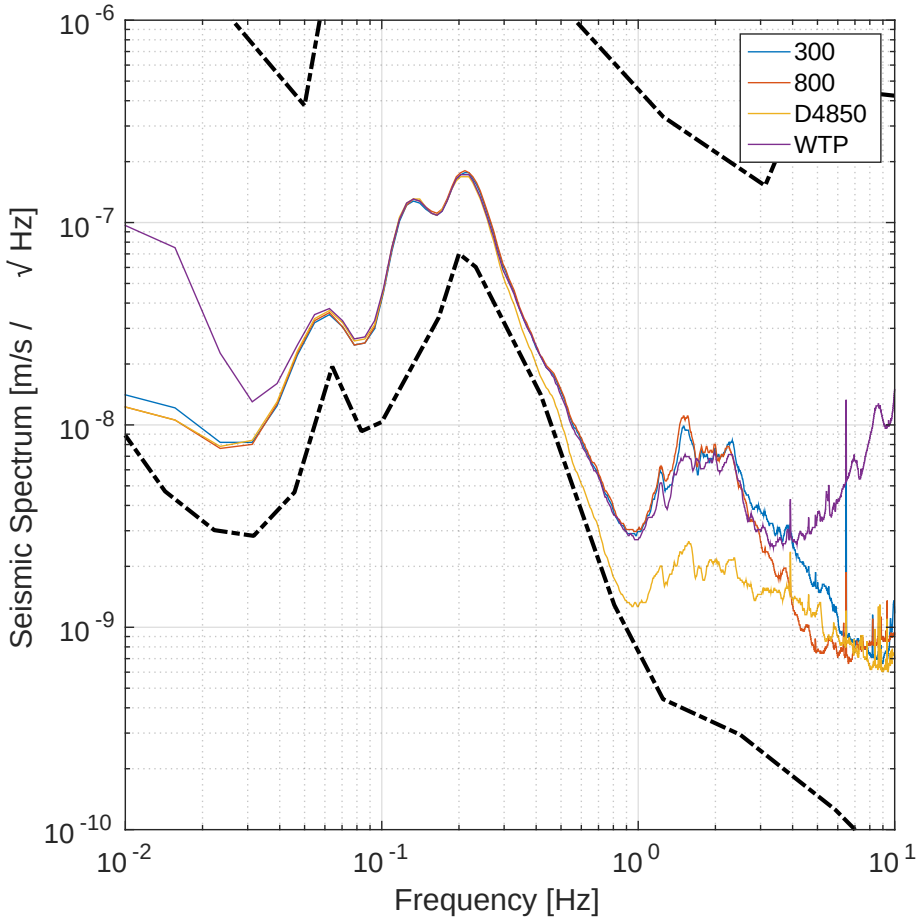
Benefits of aHomestake array:

1. The array has significantly larger horizontal spacing than used in the iHomestake analysis.
2. Significantly more channels!

We can try to use the larger aHomestake array to test these:

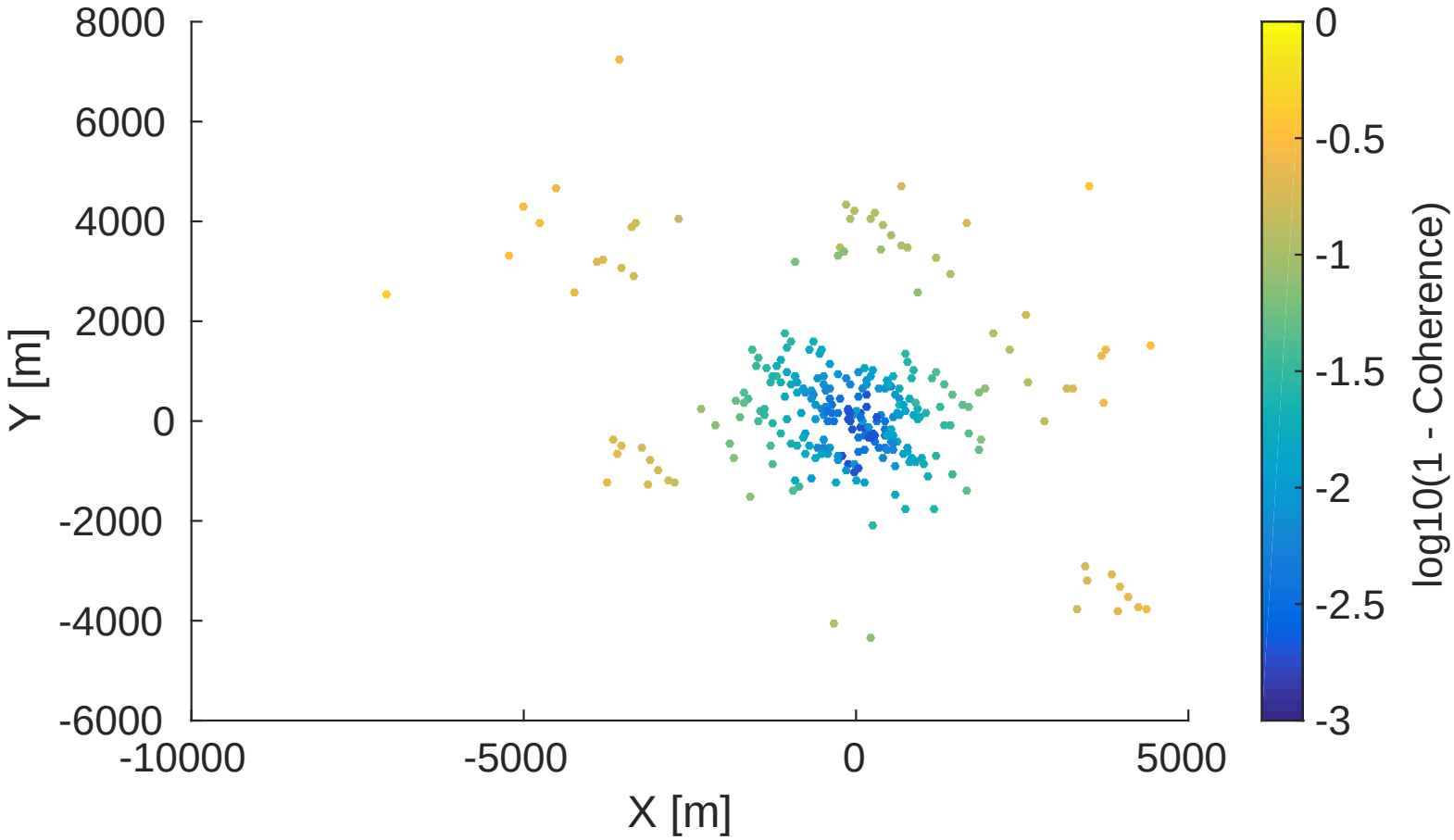
1. Distinguishing between body and surface waves
2. Whether a larger array with greater variation in station distances would yield even better subtraction over a broader range of frequencies

Seismic Spectra



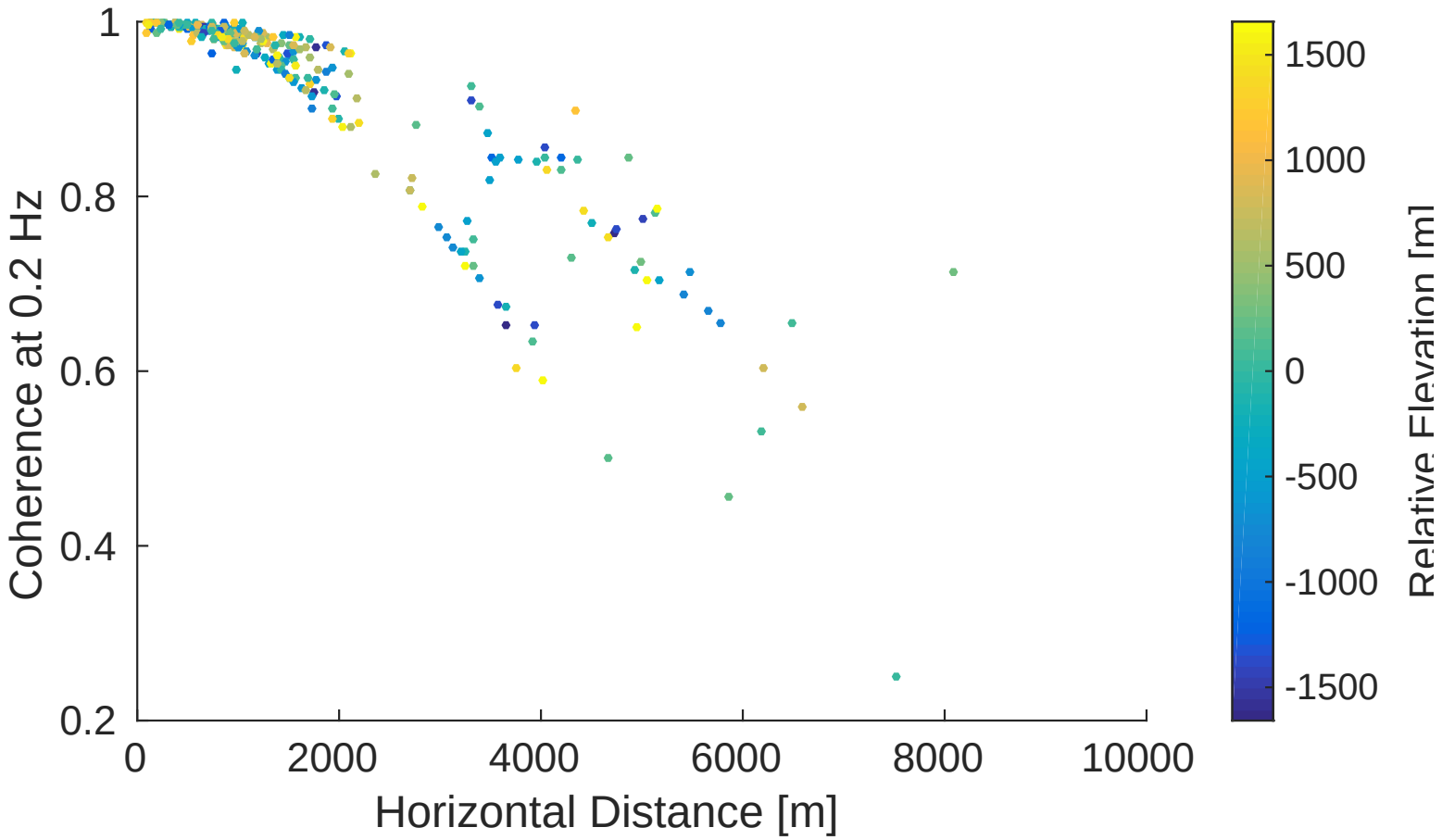
(b) Seismic Spectra

Coherence vs. Relative Location (0.2 Hz)



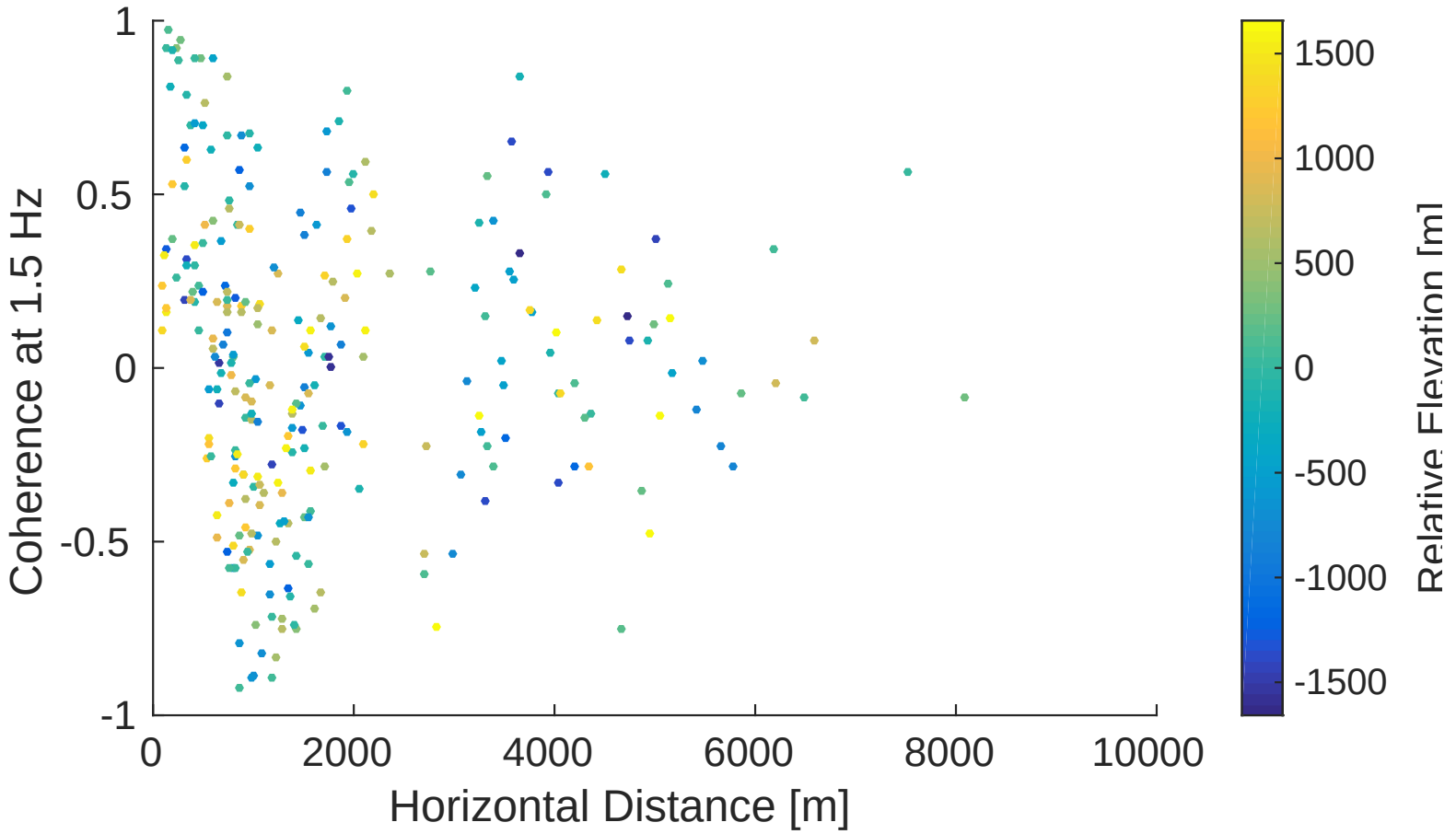
(c) Coherence vs. Relative Location

Coherence as a function of distance (0.2 Hz)



(d) Coherence as a function of distance (0.2 Hz)

Coherence as a function of distance (1.5 Hz)

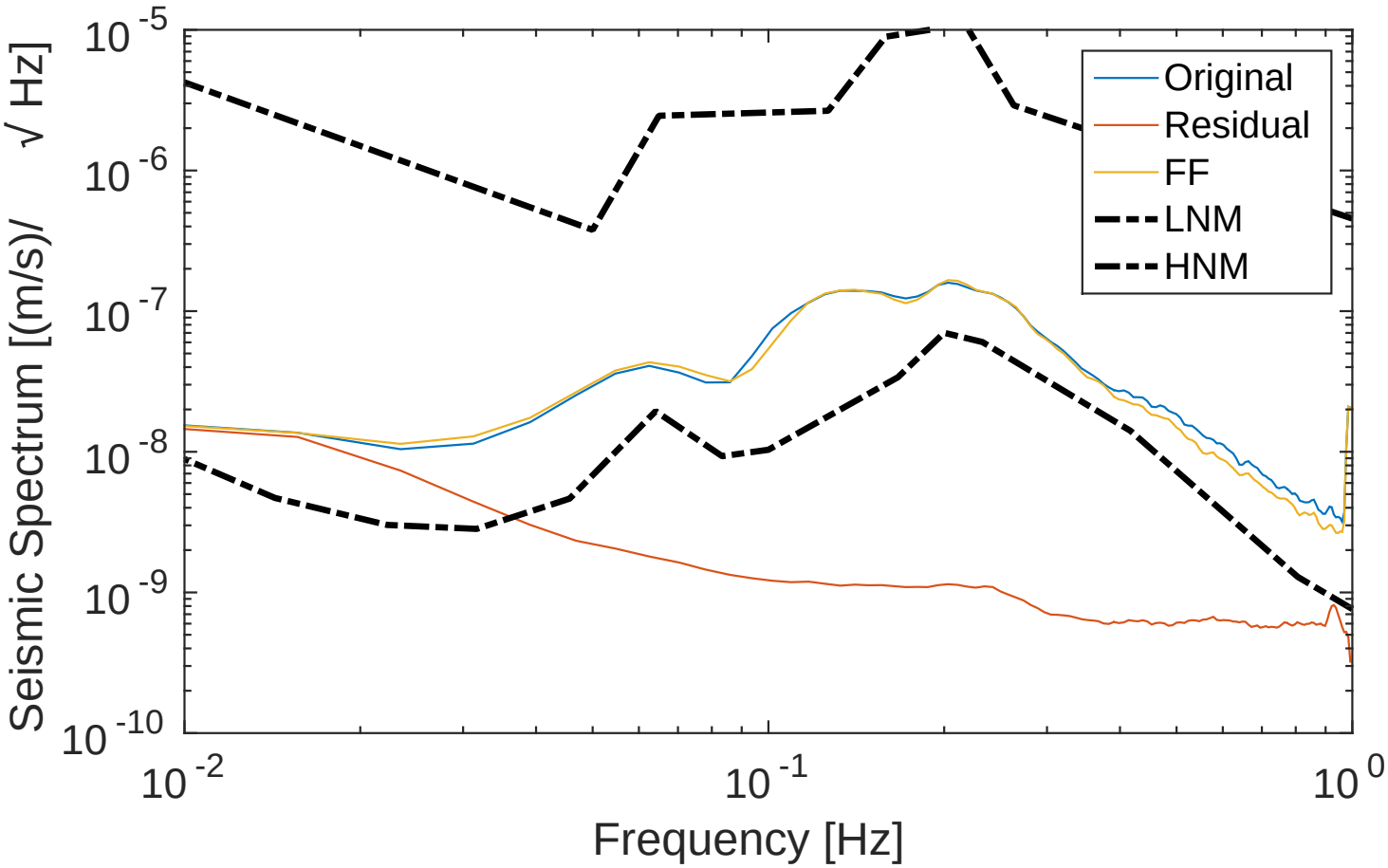


(e) Coherence as a function of distance (1.5 Hz)

Parameters

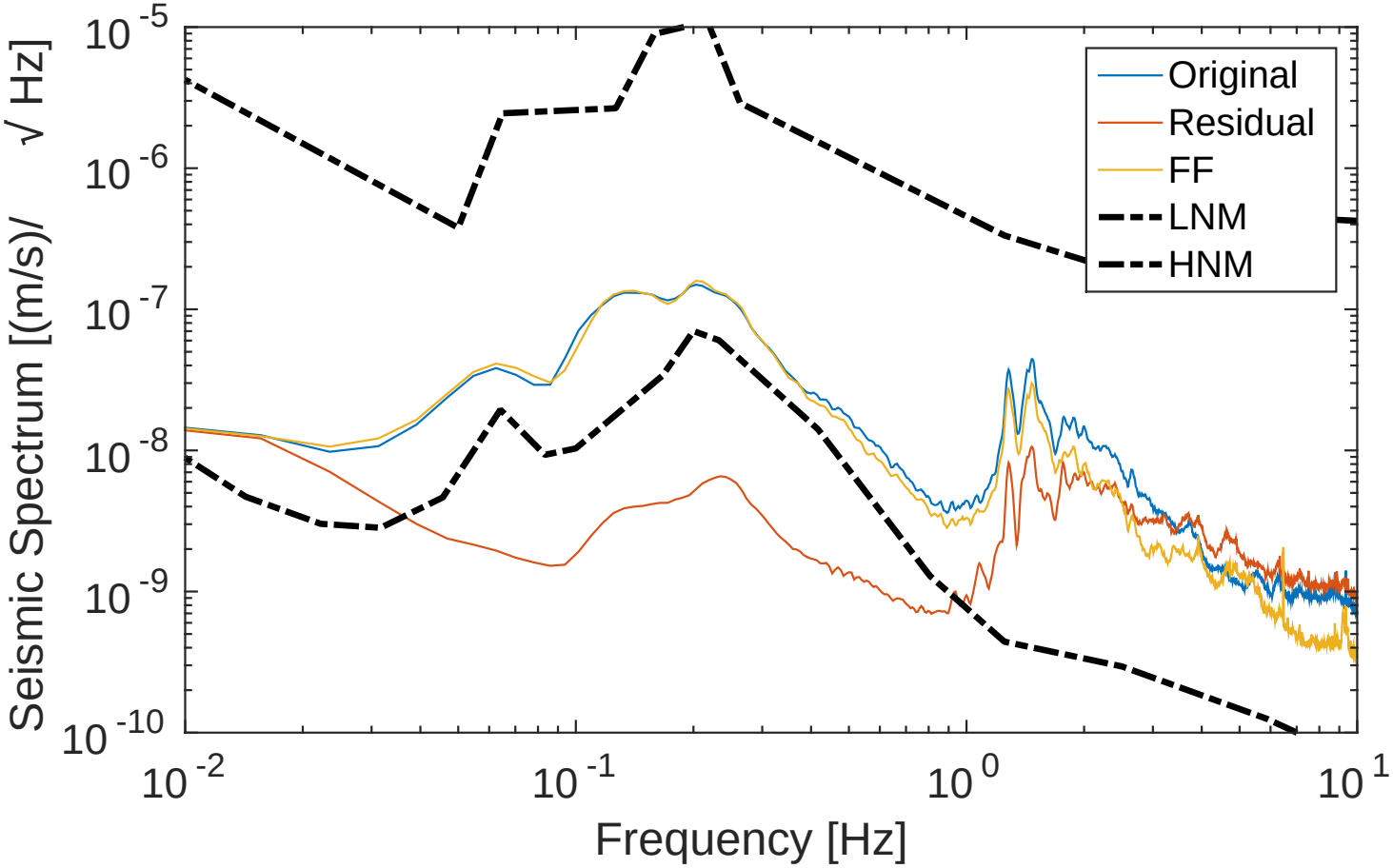
1. Target: 800:HHZ
2. Used all sub-surface seismometers (8)
3. Vertical channels only
4. 1 Hour filter, 23 Hour subtraction

Low Frequency



(f) PSD

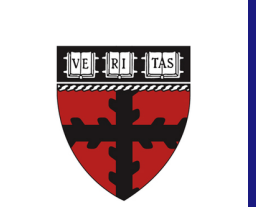
High frequency



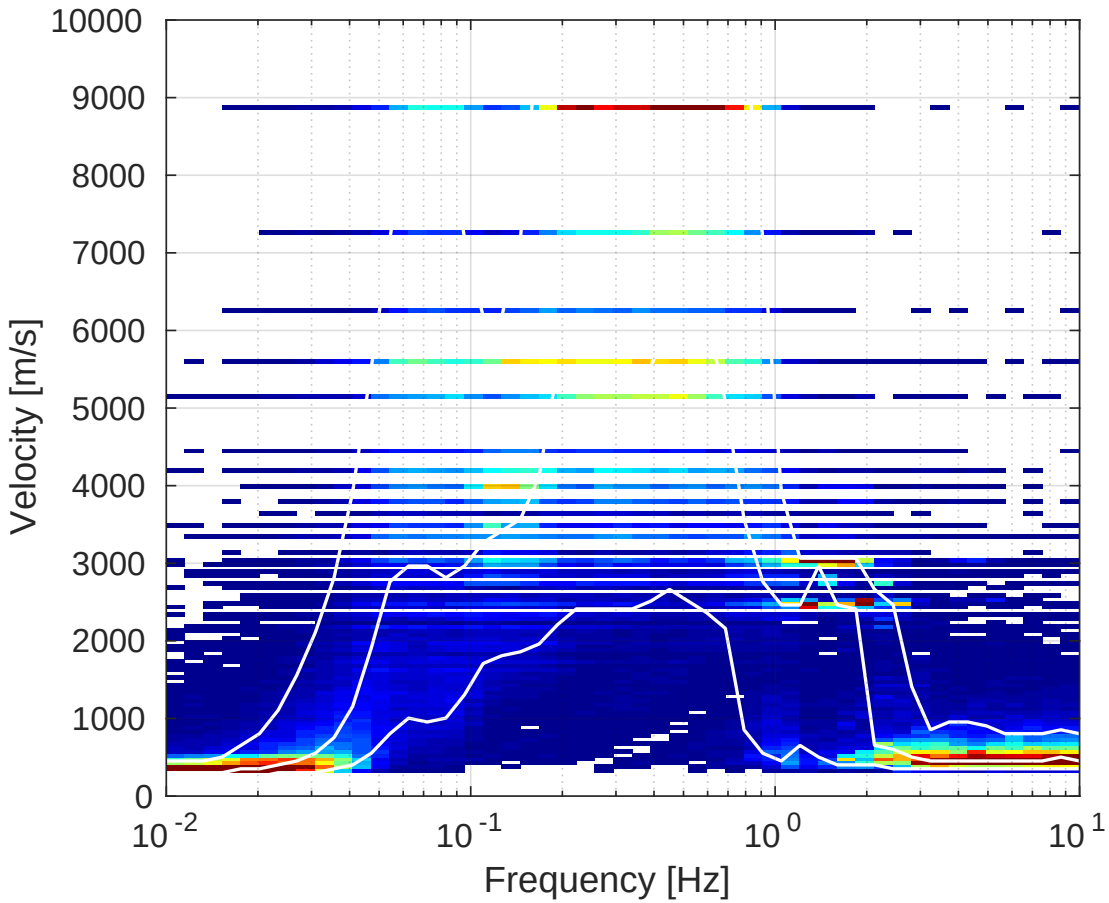
(g) PSD

Parameters

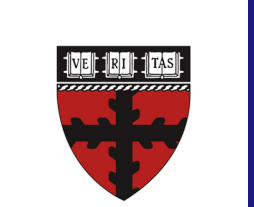
1. 3D KF-map decomposition
   ($\vec{k} = (k_x, k_y, k_z) \rightarrow \vec{k} = (k_r, k_\theta, k_\phi) \rightarrow v = \frac{2\pi f}{k_r}$.)
2. Used all seismometers
3. Vertical channels only
4. 1 week of data



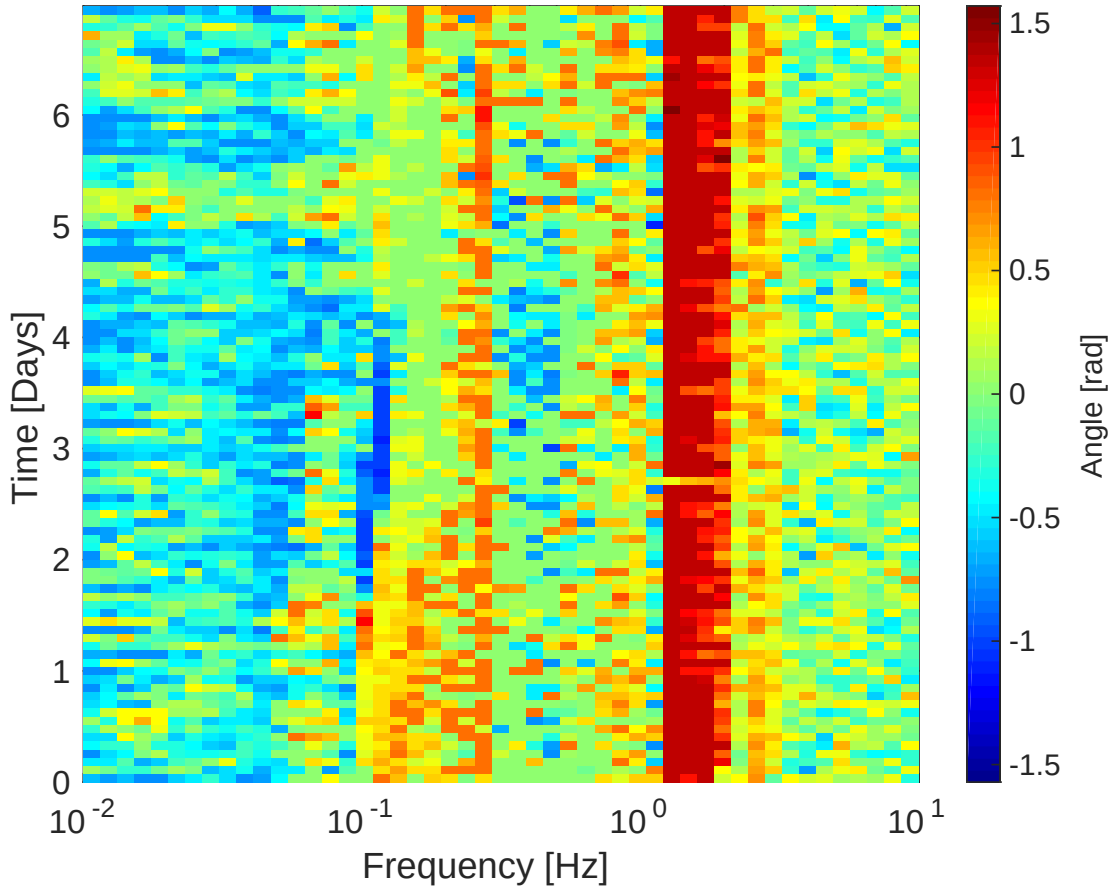
Velocity vs. frequency



(h) Velocity vs. frequency



Angle $(\tan^{-1}(y/x))$ vs. frequency vs. time



(i) Angle $(\tan^{-1}(y/x))$ vs. frequency vs. time

Conclusions

1. The aHomestake array covers a wider aperture than that of the original Homestake array
2. We can use the aHomestake array to explore the effects of the assumptions of the original analysis
3. Numerical issues seem to be limiting the efficacy of the Wiener filters