Rayleigh wave eigenfunctions

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Overview

- Analyzing 14 local events from Gary's database (May 20-28, 2015).
- Extracting Rayleigh wave amplitudes at different depths and frequencies.
- Fitting biexponential functional form to data and doing parameter estimation.

$$r_1(z,k,\omega) = C_1 e^{-a_1 kz} + C_2 e^{-a_2 kz}$$

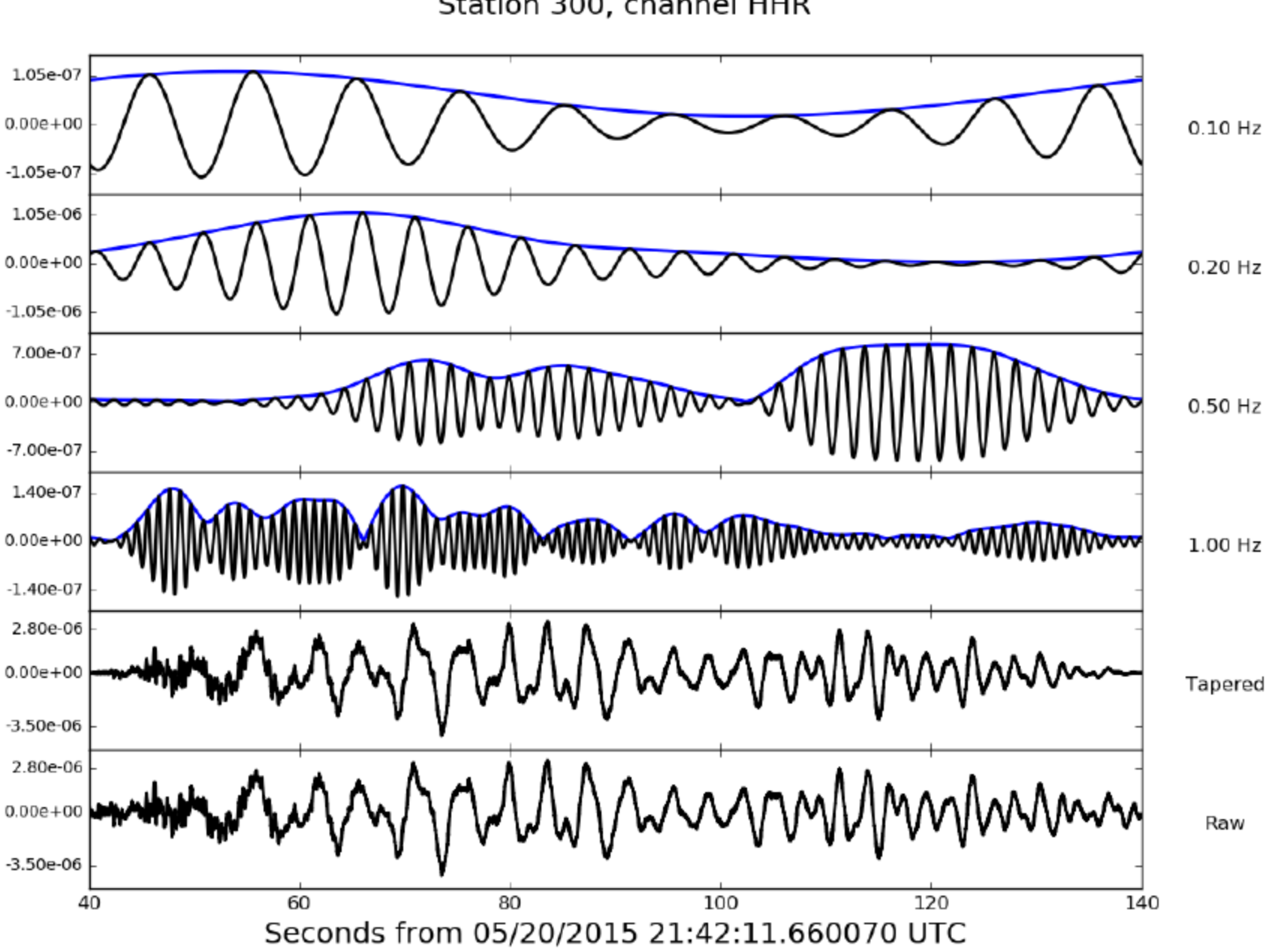
$$r_2(z,k,\omega) = C_3 e^{-a_3 kz} + C_4 e^{-a_4 kz}$$

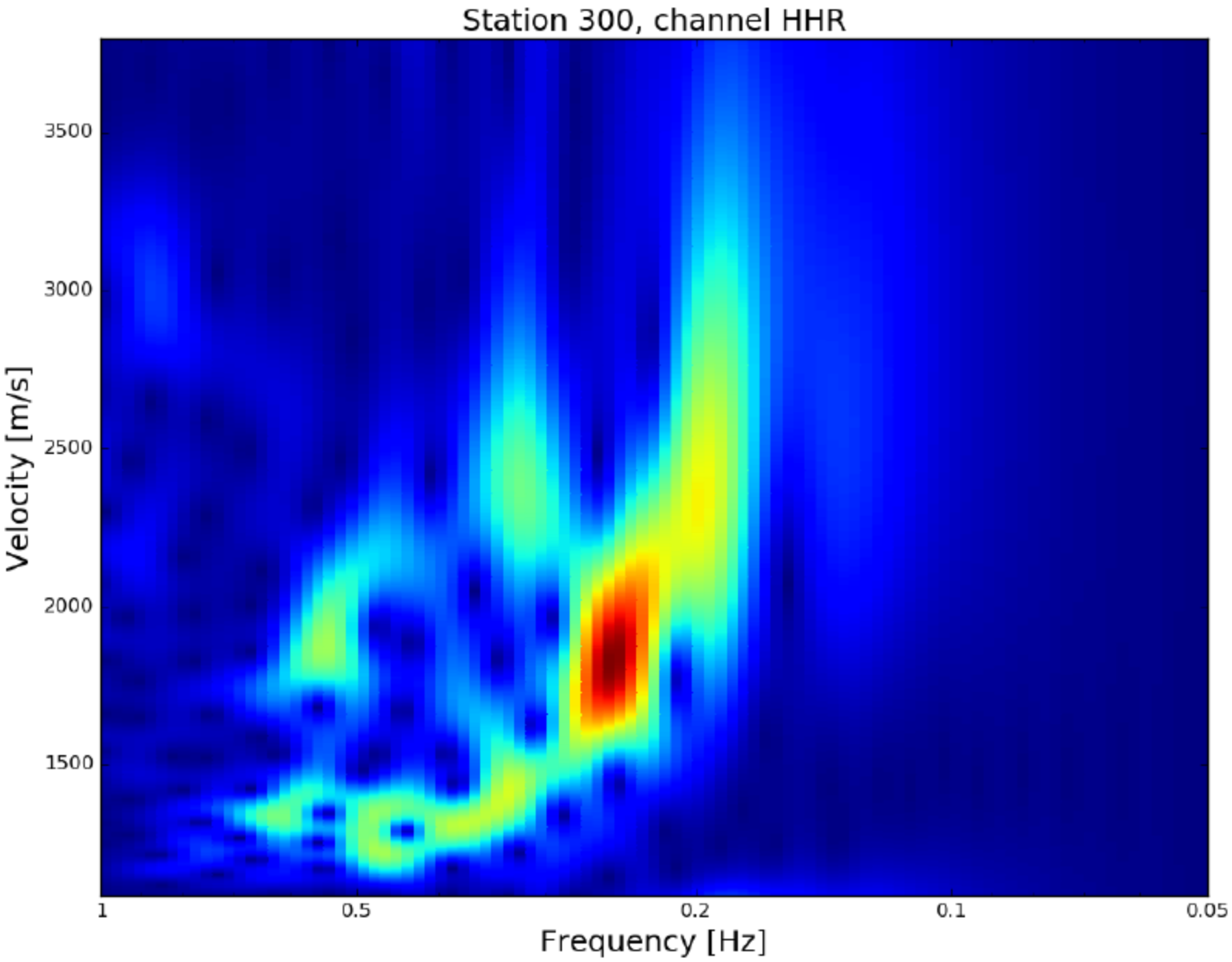
Method

- Rotate into radial, transverse, vertical coordinate system.
- Filter at a given frequency.
- Fit amplitude envelope with Hilbert transform.
- Extract maximum amplitude at each station for radial and vertical channels.
- Normalize by average vertical amplitude from surface stations.

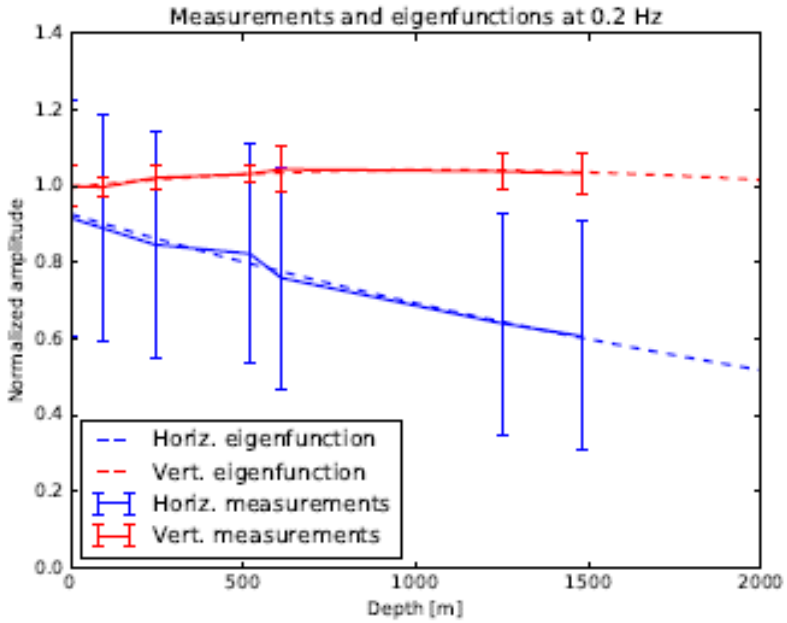
Method, cont.

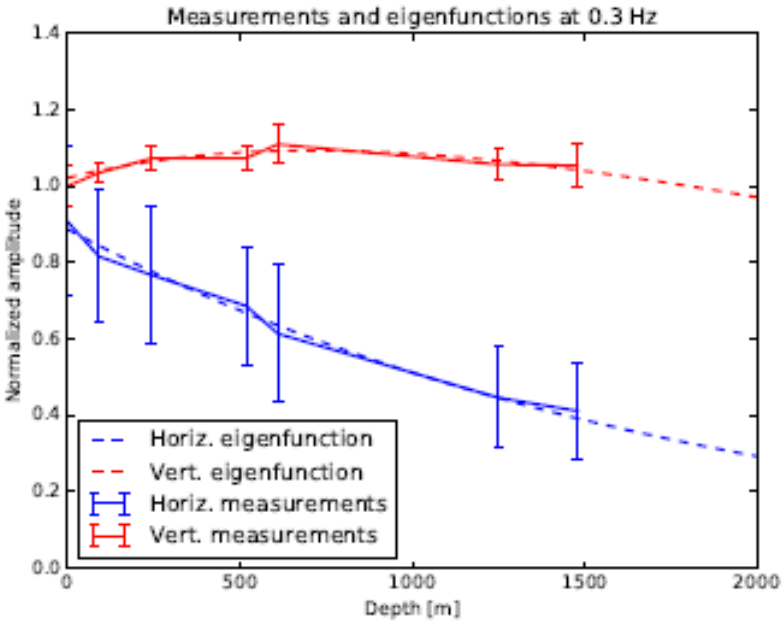
- Parameter estimation:
  - Pick a set of model parameters for a given frequency.
  - Generate r_1 and r_2.
  - Compare to all measurements at all depths for the given frequency using a χ^2 function.
  - Run parameter estimation with MultiNest.
  - Extract point with maximum likelihood and calculate eigenfunctions.

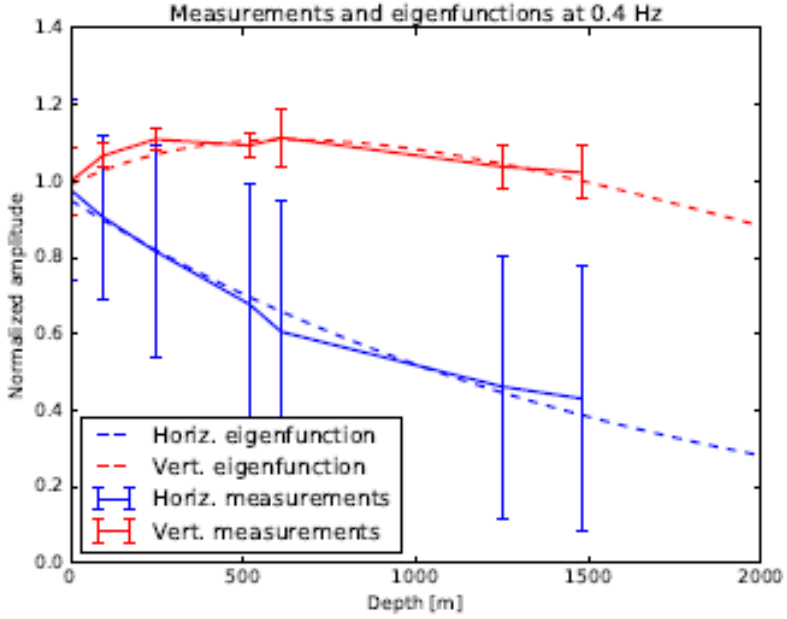

Station 300, channel HHR
1.05e-07
0.00e+00
-1.05e-07
0.10 Hz
1.05e-06
0.00e+00
-1.05e-06
0.20 Hz
7.00e-07
0.00e+00
-7.00e-07
0.50 Hz
1.40e-07
0.00e+00
-1.40e-07
1.00 Hz
2.80e-06
0.00e+00
-3.50e-06
Tapered
2.80e-06
0.00e+00
-3.50e-06
Raw
40
60
80
100
120
140
Seconds from 05/20/2015 21:42:11.660070 UTC

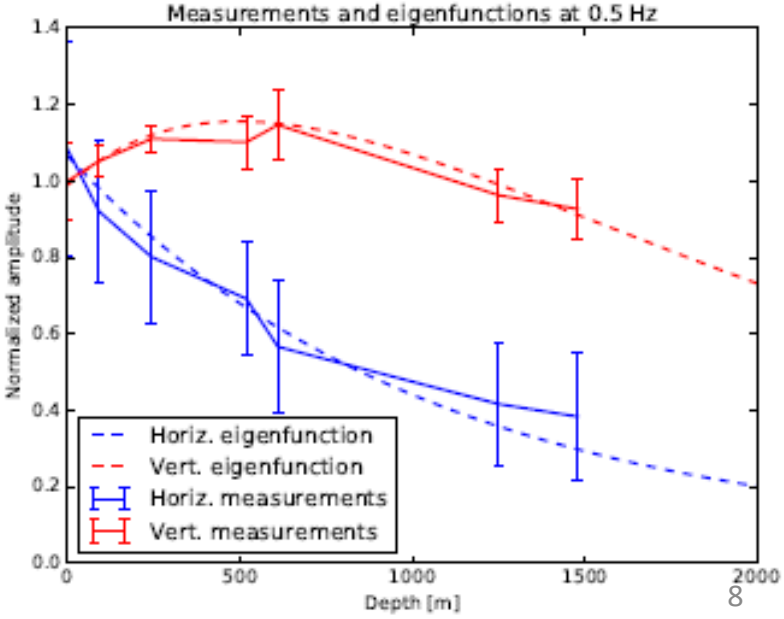

Station 300, channel HHR
Velocity [m/s]
3500
3000
2500
2000
1500
1
0.5
0.2
0.1
0.05
Frequency [Hz]

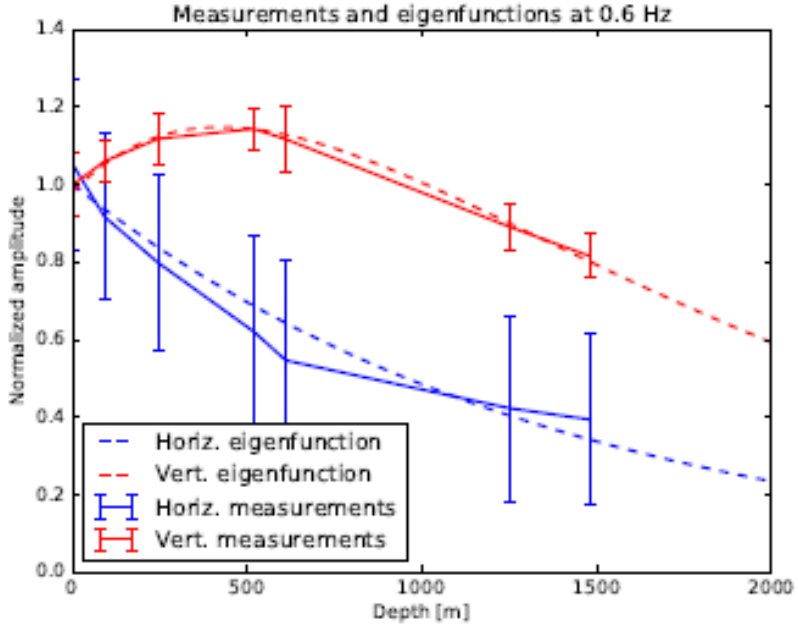
Results

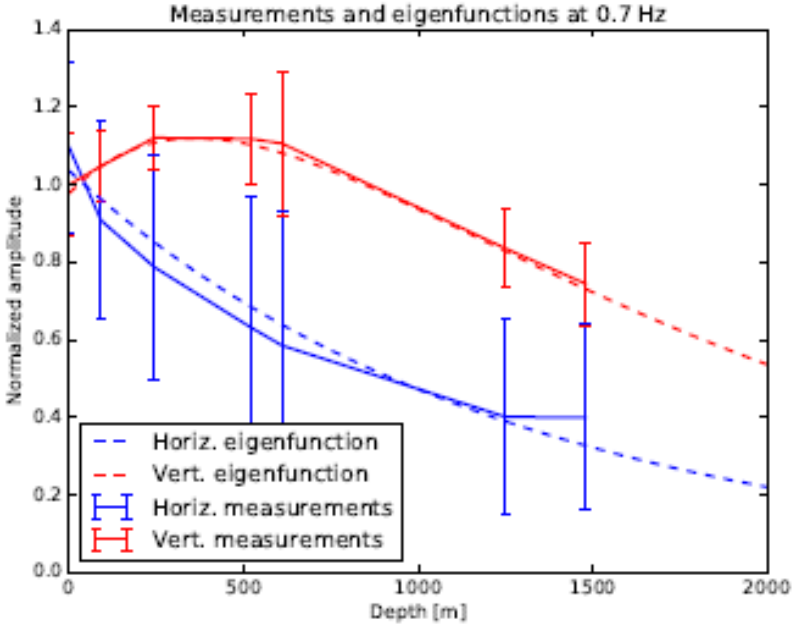

Measurements and eigenfunctions at 0.2 Hz
Normalized amplitude
Depth [m]
Horiz. eigenfunction
Vert. eigenfunction
Horiz. measurements
Vert. measurements

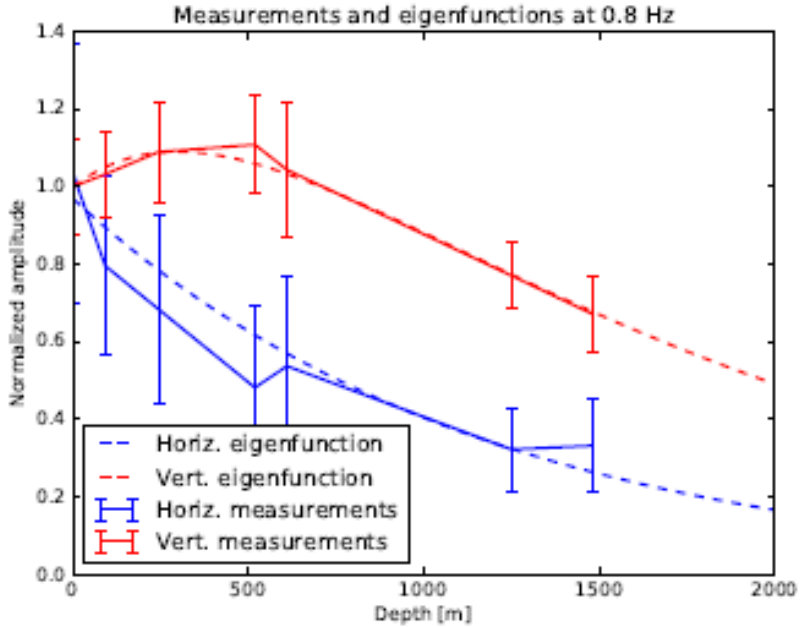

Measurements and eigenfunctions at 0.3 Hz
Normalized amplitude
Depth [m]
Horiz. eigenfunction
Vert. eigenfunction
Horiz. measurements
Vert. measurements

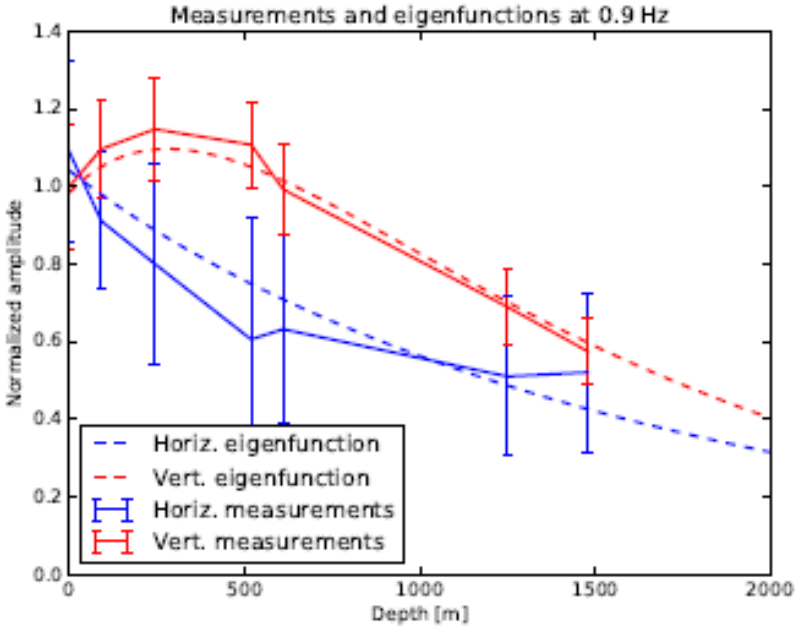

Measurements and eigenfunctions at 0.4 Hz
Normalized amplitude
Depth [m]
Horiz. eigenfunction
Vert. eigenfunction
Horiz. measurements
Vert. measurements


Measurements and eigenfunctions at 0.5 Hz
Normalized amplitude
Depth [m]
Horiz. eigenfunction
Vert. eigenfunction
Horiz. measurements
Vert. measurements


Measurements and eigenfunctions at 0.6 Hz
Normalized amplitude
Depth [m]
Horiz. eigenfunction
Vert. eigenfunction
Horiz. measurements
Vert. measurements

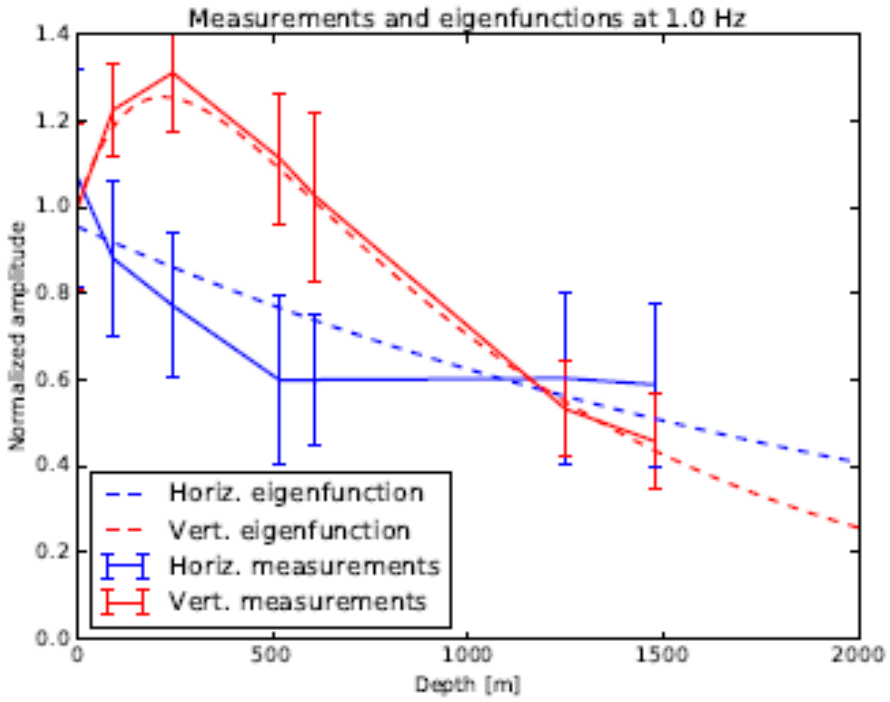

Measurements and eigenfunctions at 0.7 Hz
Normalized amplitude
Depth [m]
Horiz. eigenfunction
Vert. eigenfunction
Horiz. measurements
Vert. measurements


Measurements and eigenfunctions at 0.8 Hz
Normalized amplitude
Depth [m]
Horiz. eigenfunction
Vert. eigenfunction
Horiz. measurements
Vert. measurements


Measurements and eigenfunctions at 0.9 Hz
Normalized amplitude
Depth [m]
Horiz. eigenfunction
Vert. eigenfunction
Horiz. measurements
Vert. measurements

Results

- Great fits at 0.2, 0.3 Hz.
- OK fits from 0.4-0.7 Hz.
- Good vertical and bad horizontal fits from 0.8 Hz – 1.0 Hz.



Parameters

Frequency [Hz]	C_2	C_3	C_4	a_1	a_2	a_3	a_4	c_p [m/s]
0.2	-0.07	-1.36	2.36	0.59	0.43	0.78	0.36	2599
0.3	-0.11	2.16	-1.14	0.63	0.94	0.30	0.79	2025
0.4	-0.05	-1.47	2.46	0.45	0.86	0.69	0.29	1795
0.5	0.07	-1.32	2.31	0.55	0.04	0.87	0.30	1781
0.6	0.001	-1.94	2.92	0.38	0.21	0.84	0.39	1997
0.7	0.04	2.09	-1.11	0.28	0.81	0.25	0.77	1620
0.8	-0.03	2.00	-1.00	0.37	0.76	0.28	0.86	2087
0.9	0.04	-1.12	2.11	0.11	0.63	0.46	0.16	1107
1.0	-0.05	1.95	-0.95	0.08	0.06	0.19	0.99	1208