Updates on NN Estimation

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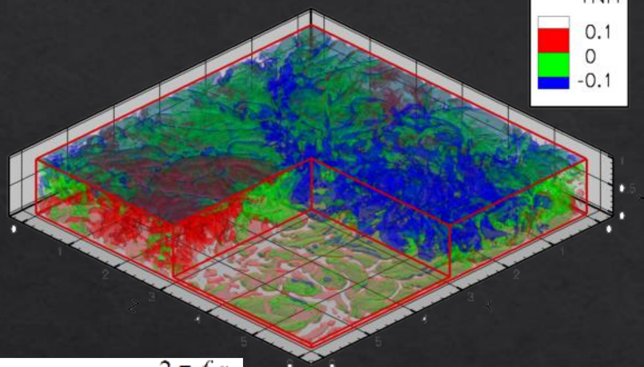
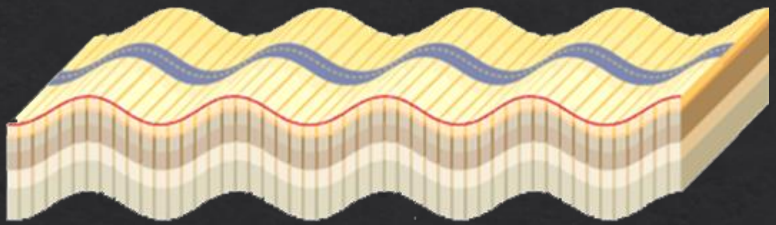
Main Sources of NN

Advected T field



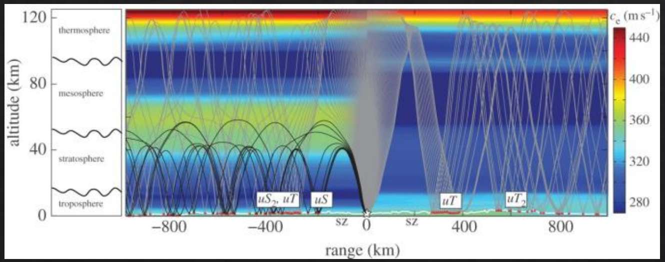
$$\frac{\delta \mathrm{T}(f)\, e^{-\frac{2\pi f r}{v}}}{f^{10/3}}$$

Seismic waves



$$\frac{\xi(f)\, e^{-\frac{2\pi f h}{c_{\mathrm{hor}}}}}{f^{2}}$$

Sound waves



$$\frac{p(f)\, e^{-\frac{2\pi d f}{c_{\mathrm{hor}}}}}{f^{3}}$$

- Whenever something follows a **rectilinear** motion or fields have plane boundaries, then you get an exponential cut-off in the form:

  exp(-2·π·f·x/c)

- Examples: sound and seismic waves, advected fields, moving objects, flowing water

Water NN

Full dimension:

1) Capilary / gravity waves
2) Transportation
3) Compression / sound

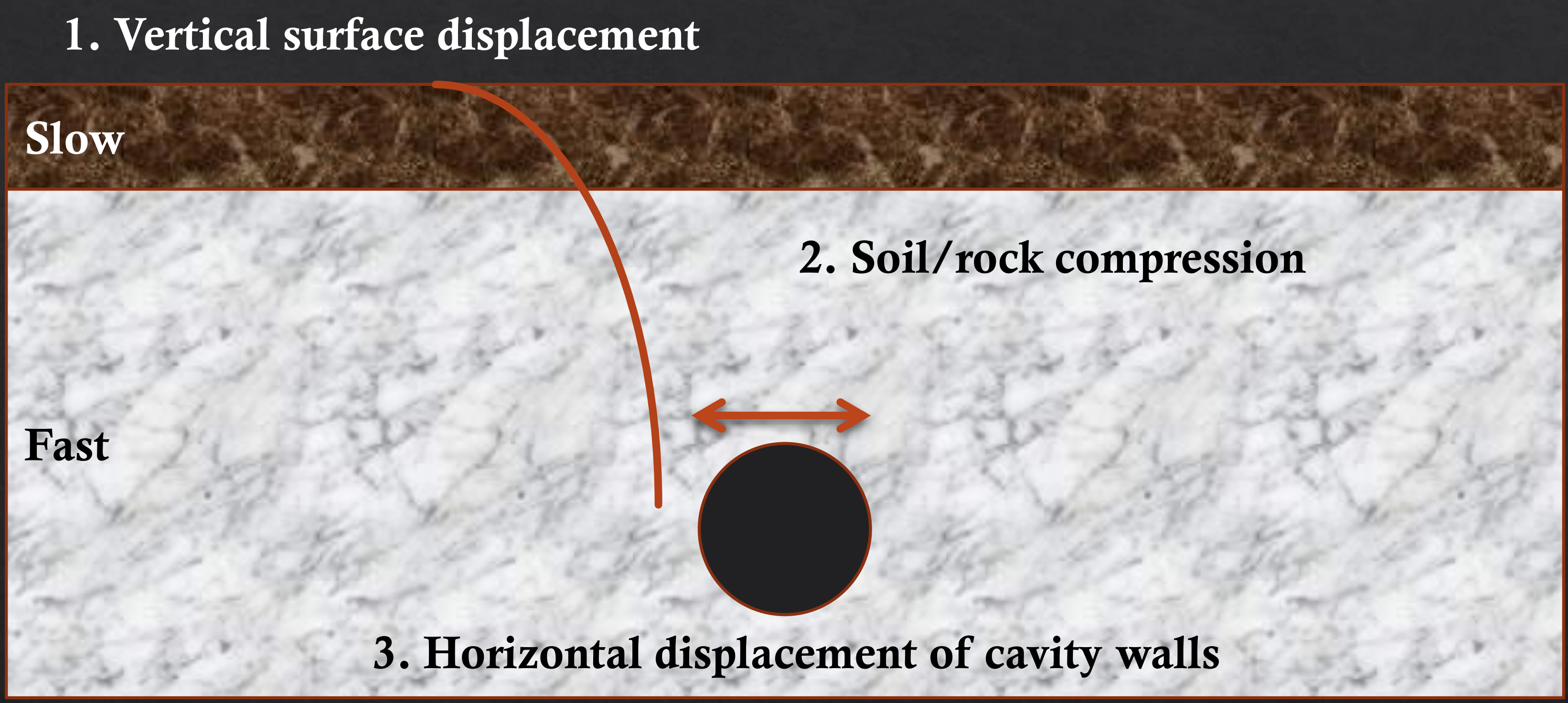
Localized perturbation:

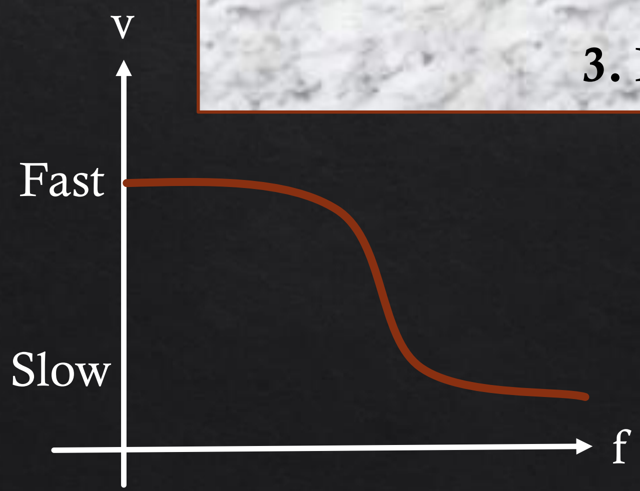
4) Vortices / turbulence
5) Channel-floor to water-surface interaction
6) Flow around obstacles

Water flow and waves are both too slow for (1) – (3) to matter (exponential cut-off at very low frequencies), even if the water flows closely to the test mass.

Perturbation produced by vortices and other structures included in (4) – (6) in the NN band are supported by small water volumes and associated NN is very likely insignificant, but one should look at this more carefully.

Rayleigh NN





A Rayleigh NN model requires:

1) Spectrum of vertical surface displacement
2) Dispersion curve
3) Density estimates for near surface soil and rock around the cavern

Length Scales

1) Depth

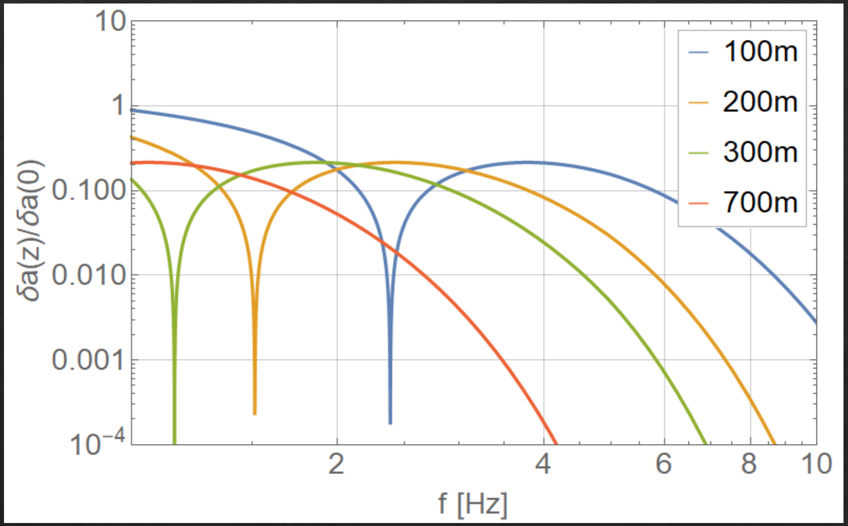
2) Reduced wavelengths

a) $1/k$ (reduced Rayleigh wavelength)
b) $(1/k^2-1/k_P^2)^{1/2}$ (inh. vertical compressional wavelength)
c) $(1/k^2-1/k_S^2)^{1/2}$ (inh. vertical shear wavelength)

$$\exp(-\kappa\cdot d)$$

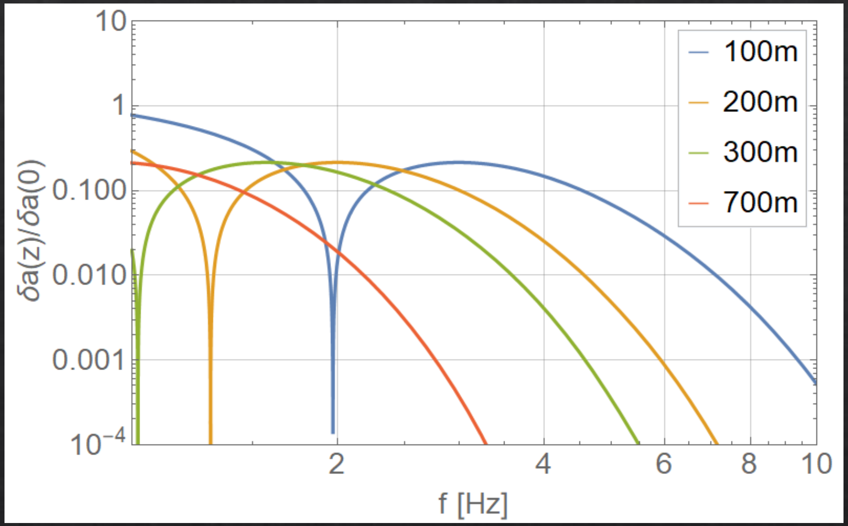
NN Suppression with Depth

Faster Rayleigh waves



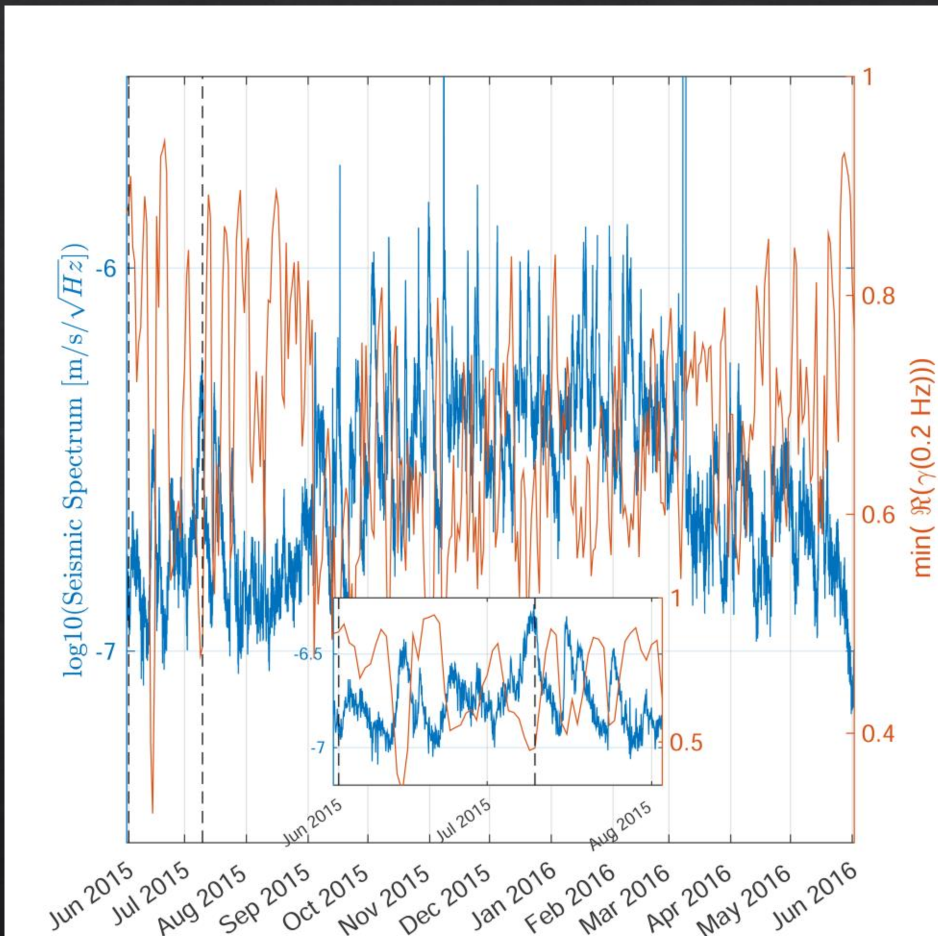
Rayleigh dispersion model:
1.8km/s @ 1Hz, 750m/s @ 5Hz, 450m/s @ 10Hz

Slower Rayleigh waves

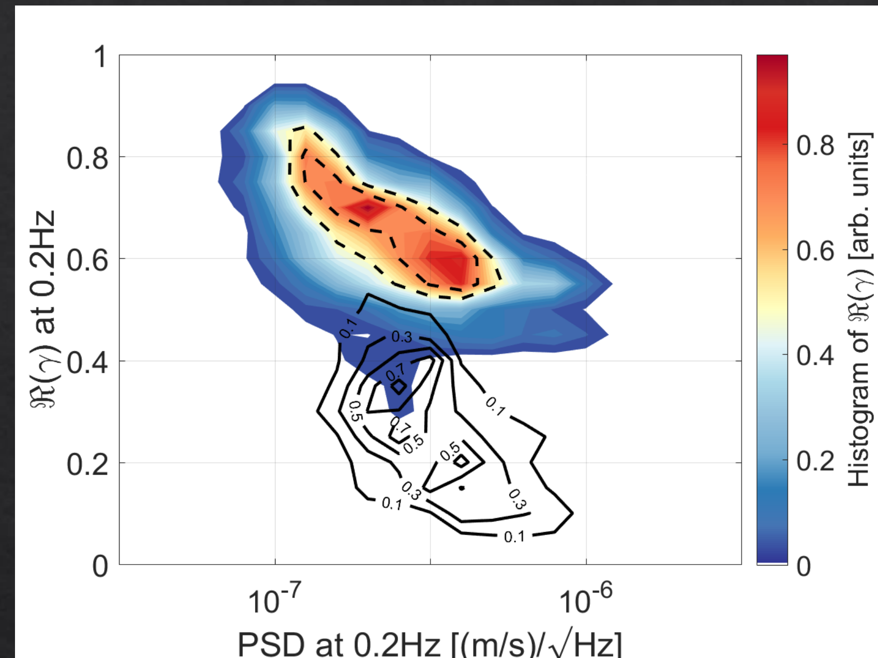


Rayleigh dispersion model:
1.5km/s @ 1Hz, 500m/s @ 5Hz, 350m/s @ 10Hz

Oceanic Microseisms



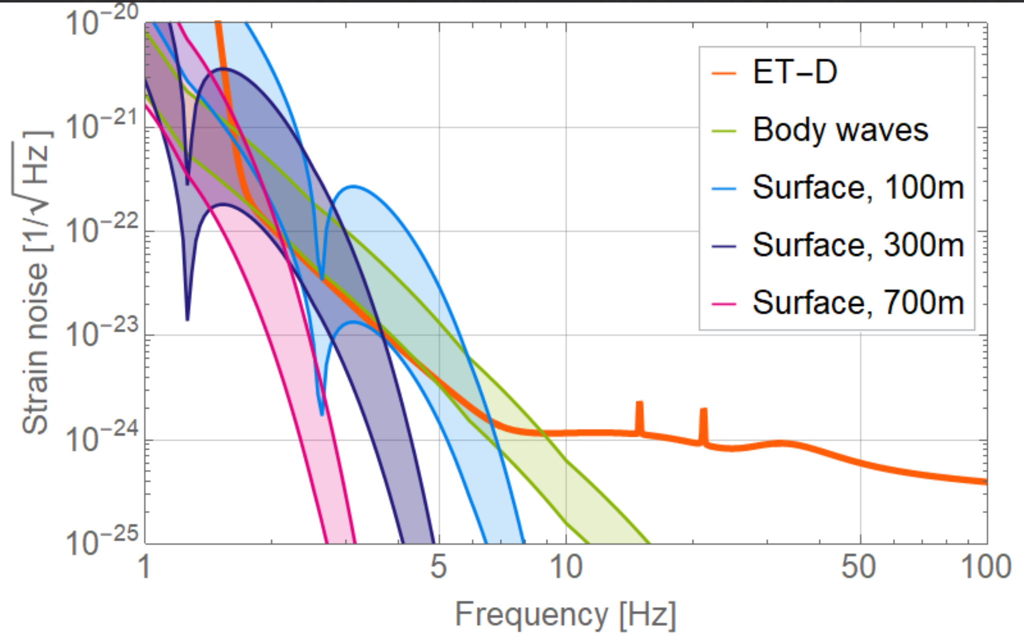
Coughlin et al, 2018



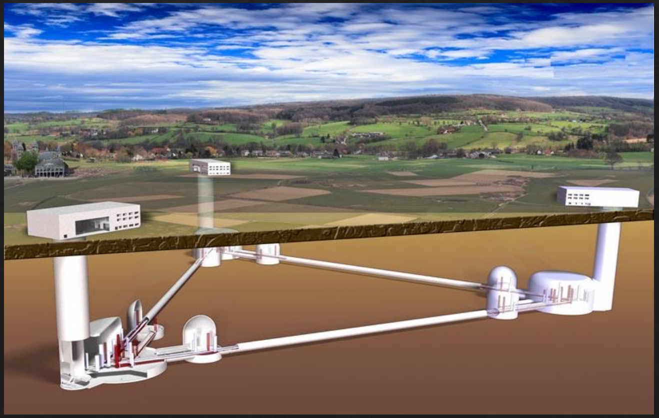
Suggested explanation:

1) When oceanic microseisms are strong, then the sources are relatively close and Rayleigh waves dominate
2) If microseisms are near the low-noise model, then many distant sources contribute and body waves dominate

ET: Seismic NN



Badaracco, 2019



- Seismic models:
  Body wave: 3x – 12x LNM, Surface: 50x – 1000x LNM
- Includes all three contributions from slide 4