Introduction to Ambient Noise Correlations

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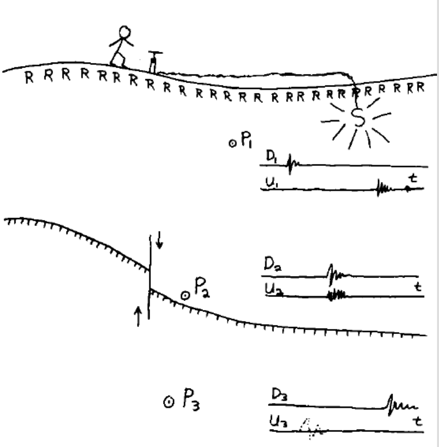
LMU München

History: the early days

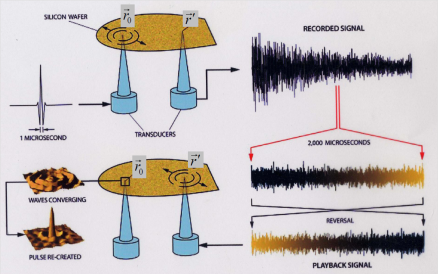
1957: Aki, SPAC

1968: Claerbout



History

- early 90s: acoustics (Fink)
- 1993: helioseismology (Duvall)
- $\geq$ 2000: ultrasonics (Weaver & Lobkis)
- 2003: seismology (Campillo & Paul)



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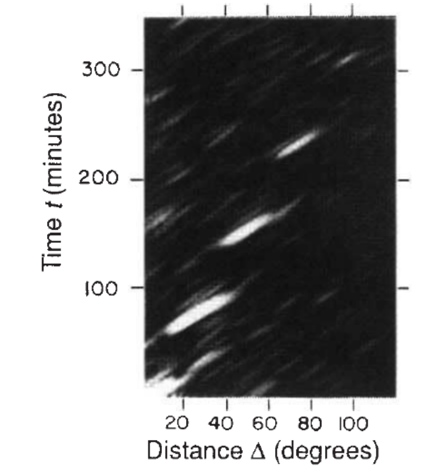

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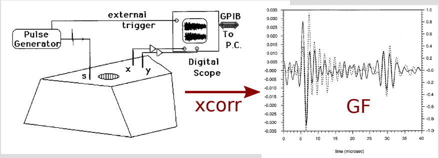

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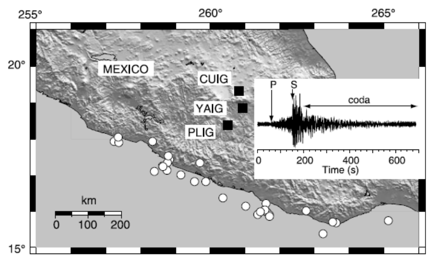
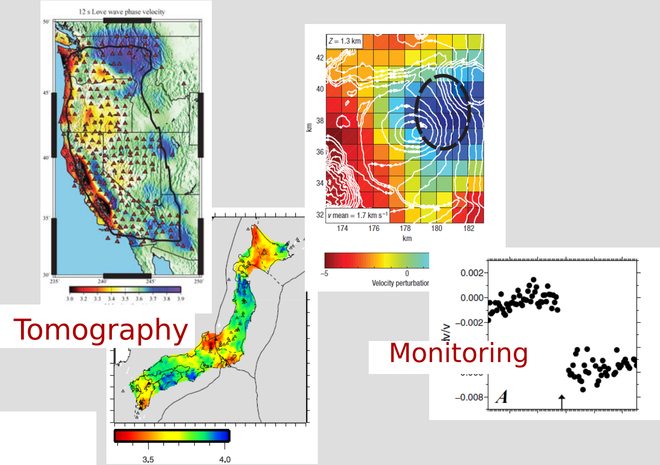
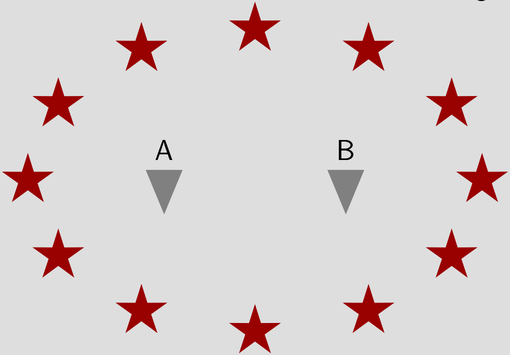


Applications



Generating signals from noise

ideal case: noise is a random field + average over long time



Noise sources surround the receivers

Generating signals from noise

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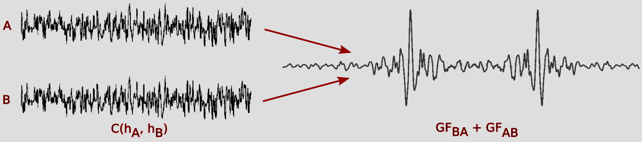
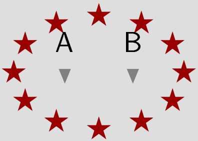


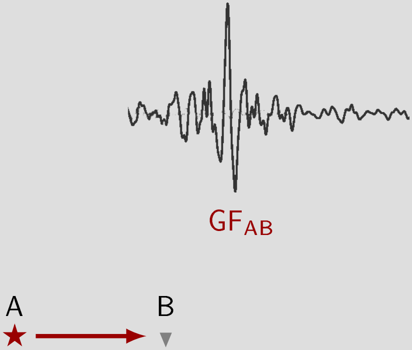


correlation of field in A and B

=

Green's function between A and B

Generating signals from noise



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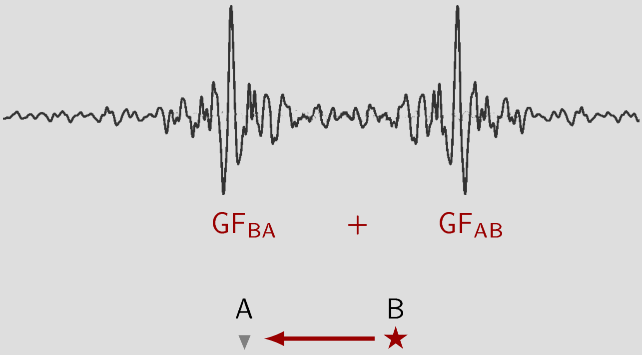

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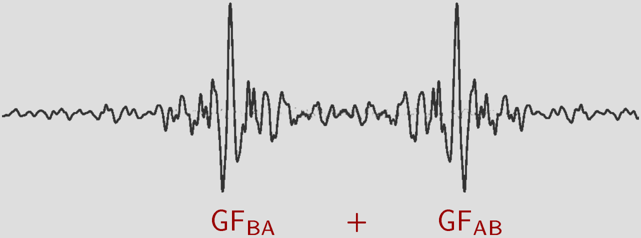
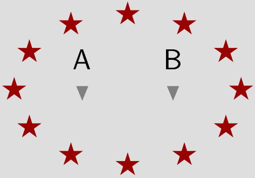


advantages:

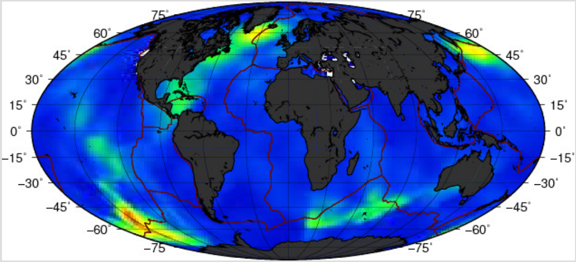
Green's function *anywhere*

Green's function *anytime*



What does the future hold?

Oceanic noise sources

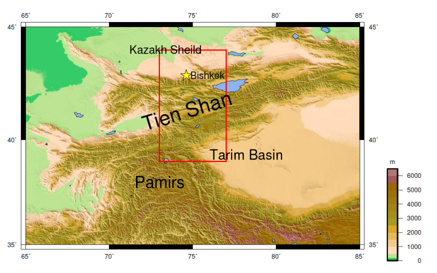


Gualtieri: *Modeling seismic noise by normal mode summation*

Imaging Improvements

Tien Shan:

- Rayleigh wave group velocities
- Receiver functions
- $\rightarrow$ Joint inversion

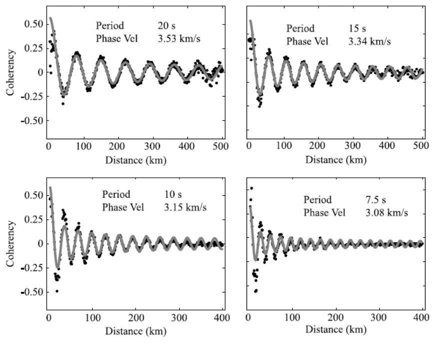


Amy Gilligan: *Imaging the stucture of the Tien Shan using receiver functions and seismic ambient noise*

Amplitude & Attenuation

Amplitude information in correlation

Invert for attenuation

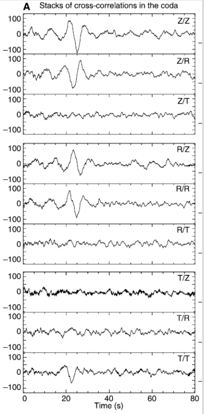


Kees Weemstra: *Constraining seismic attenuation from the ambient seismic field*

Use all 3 components!

9-C Green Tensor

Use crossterms to improve accuracy



Dylan Mikesell: *Investigating the accuracy of Green's function estimates from Z-Z and Z-R correlations*

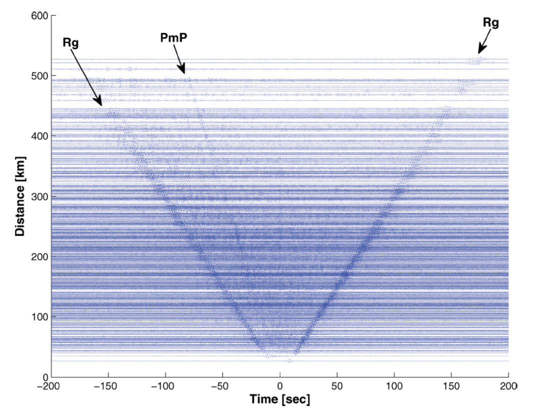
Body waves

Body waves in correlations

Confirm with:

Synthetic seismograms, polarization,

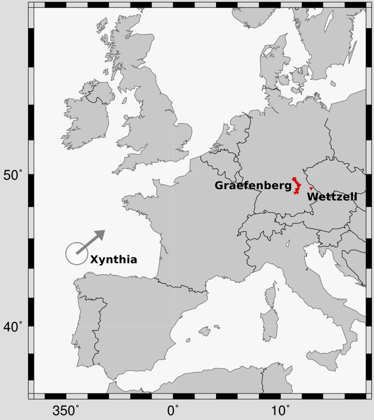
Earthquake records



Piero Poli: *Application of seismic noise correlation: surface waves imaging and body waves emergence*

Rotational Motion

Can we observe the oceanic microseism with the Wettzell Ringlaser?



Noise characterization

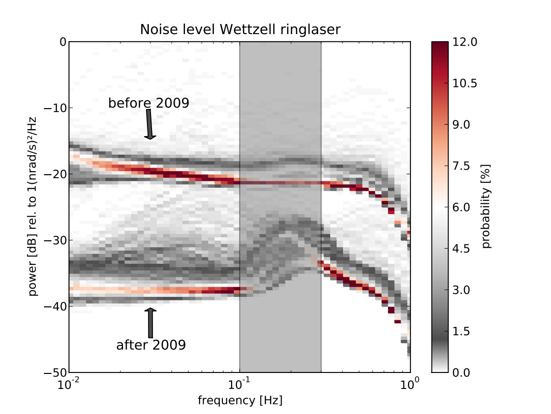
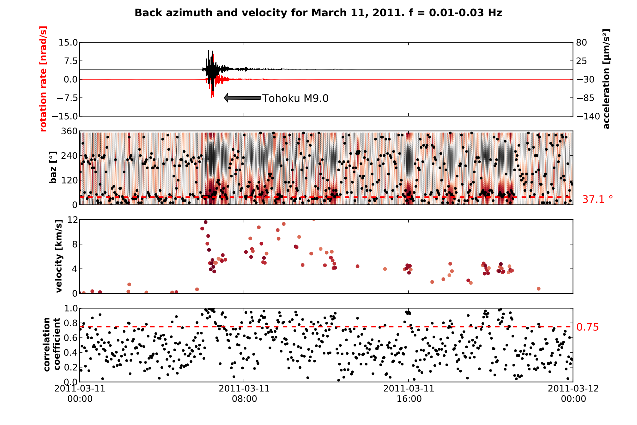


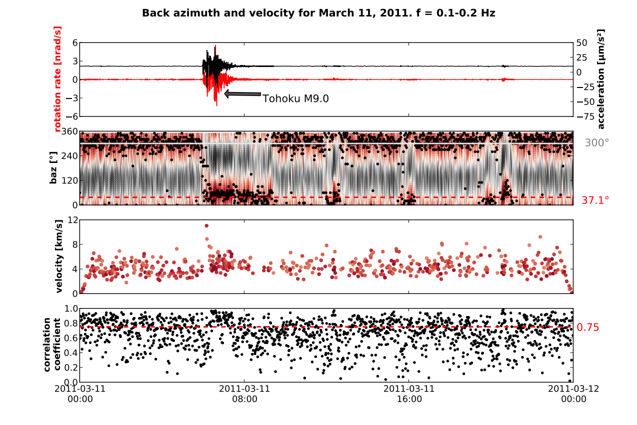
Figure: Wettzell Ringlaser noise level *before* and *after* 2009 mirror change. After *McNamara & Buland 2004*.

Source Direction from colocated ω_z and a_T measurements



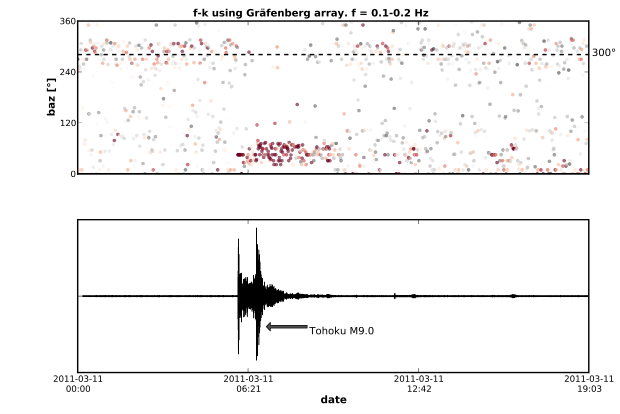
Excluding microseismic frequencies (0.01 – 0.03 Hz)

Source Direction from colocated ω_z and a_T measurements



.. and including them! (0.1 – 0.2 Hz)

f-k analysis on the Gräfenberg array



Summary

- Rotational motions detectable in ambient oceanic noise
- Sensitive to secondary microseism (0.1 – 0.2 Hz)
- Can determine source backazimuth & phase velocity from 2 measurements
- Backazimuth from $\frac{\omega_z}{a_T}$ in agreement with array beamforming

Conclusion

- Noise source distribution and their effect
- Further improvement of noise based imaging
- Use the information available!
  - Amplitude
  - 3 components
  - Body waves
  - New observables?

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Thank you!