

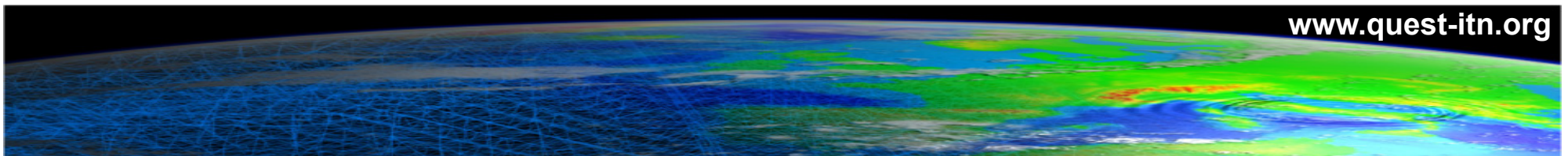


Application of seismic noise correlation: surface waves imaging and body waves emergence

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*3rd QUEST Workshop, May 20-26, 2012 at the Grandhotel Praha in Tatranska
Lomnica (Slovakia)*

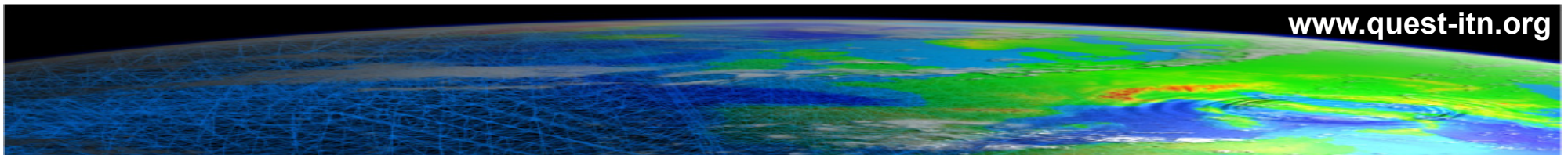


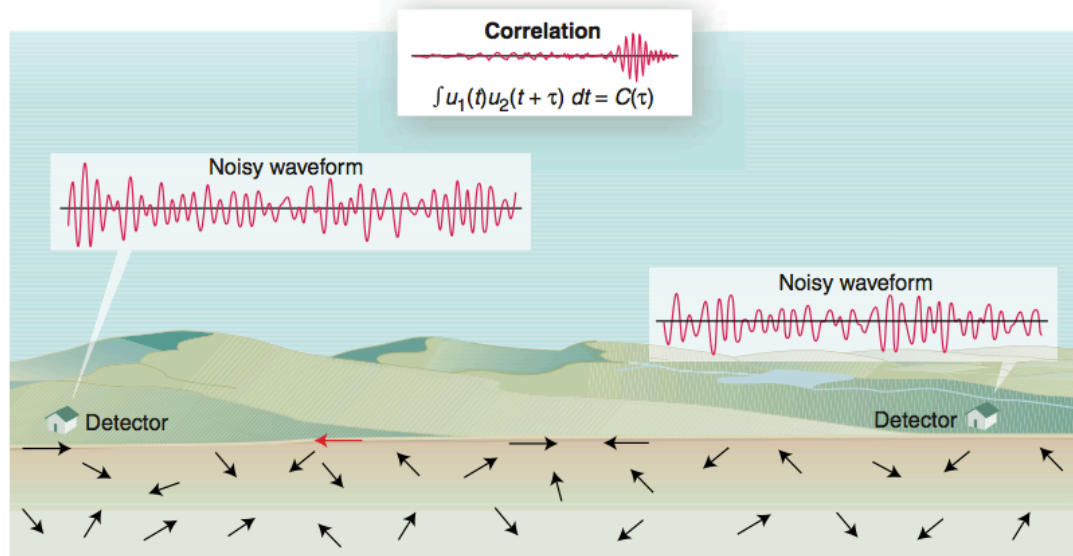


OUTLINE



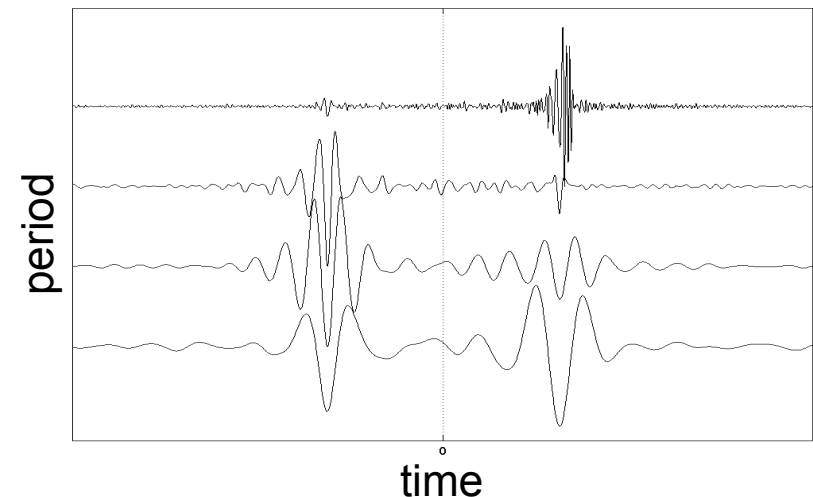
- Theory of seismic noise correlation
- Tomography of Finland
- Body waves
- Conclusions & perspectives





(Weaver, 2005)

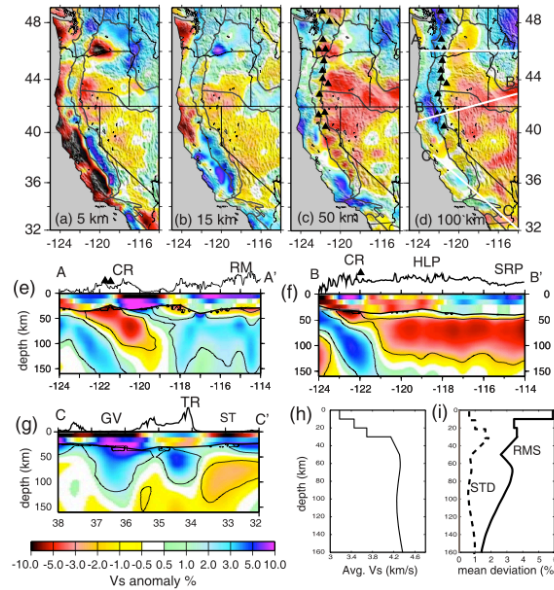
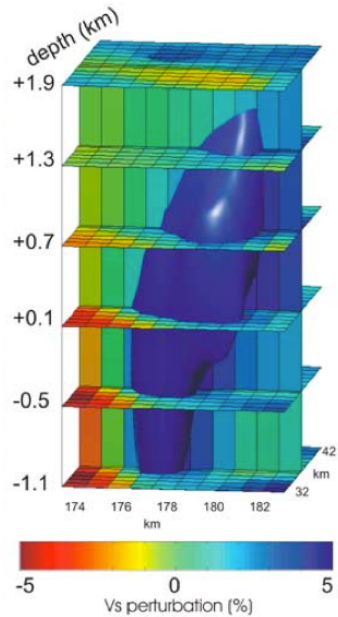
'...equipartitioned wave fields must have correlation functions equal to the signals that one would obtain following a concentrated impulsive force (GF)....'



Causal and acausal GF

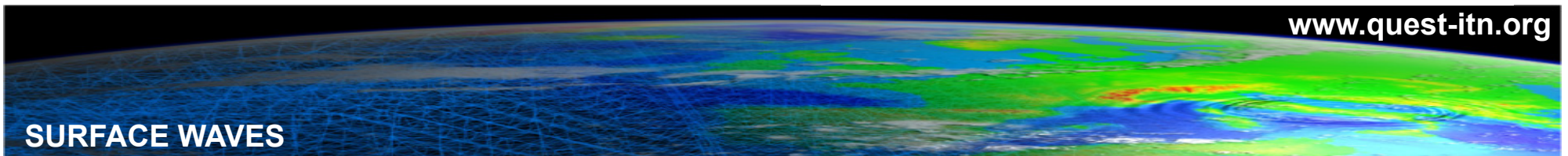
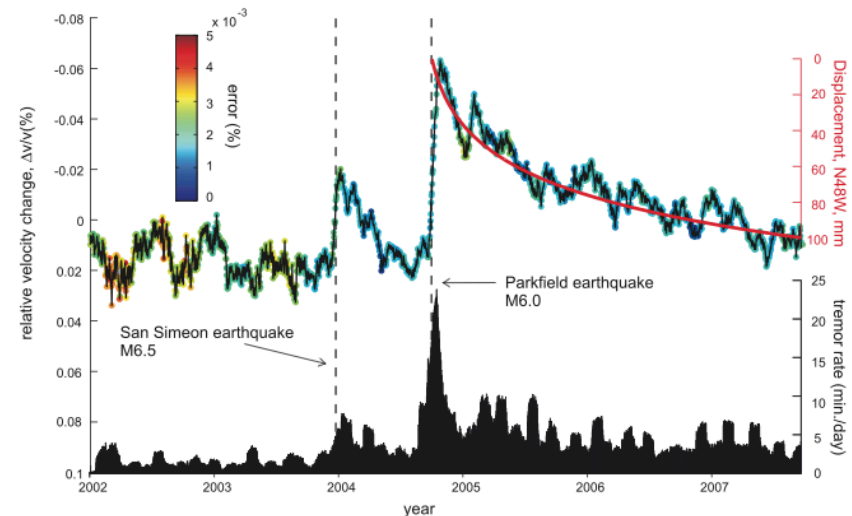
$$\frac{dC_{ij}}{dt} \approx -G_{ij}(r_1, r_2, t) + G(r_2, r_1, -t)$$

Several applications using Surface waves

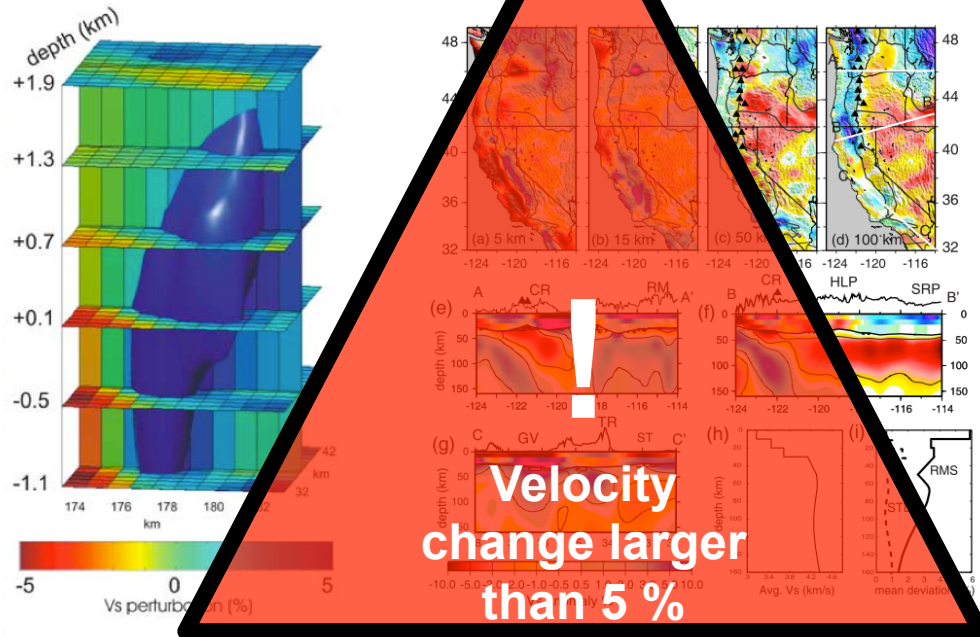


Tomography

Seismic velocity change

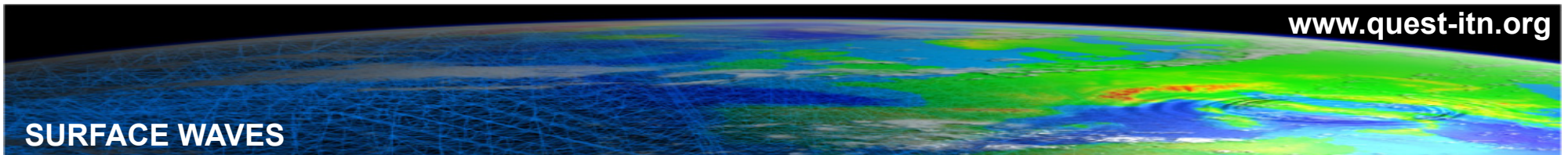
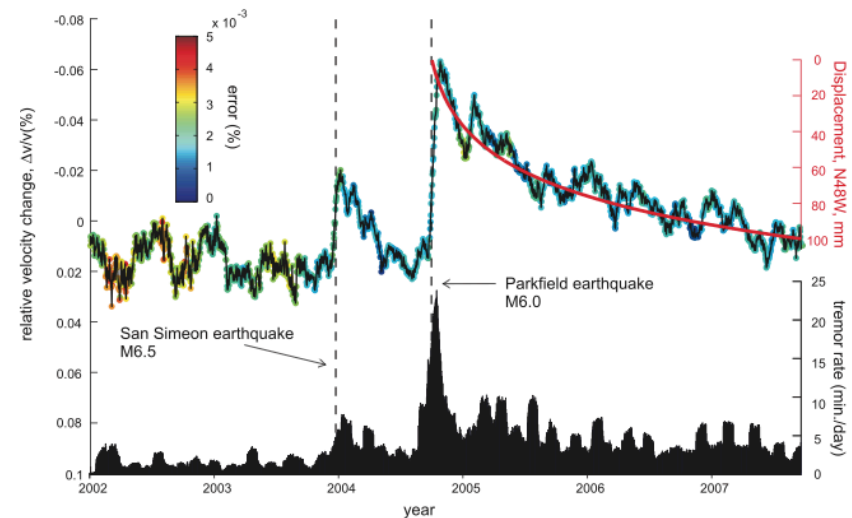


Several applications using Surface waves



Seismic velocity change

Tomography



ANT in northern Finland

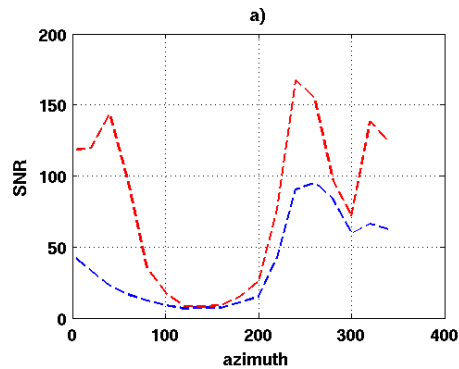
POLENET/LAPNET Seismological array
42 3 components broad-band stations

Archean crust (4 Ga)

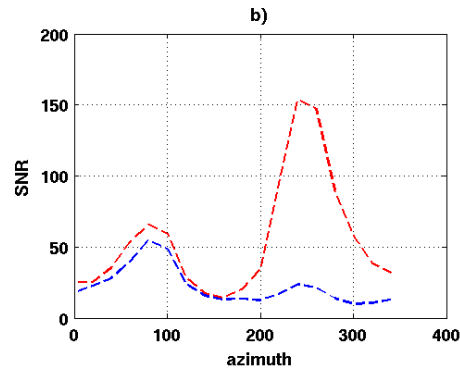
Expected vel. variation: $\pm 2\%$

Strong directivity of seismic noise

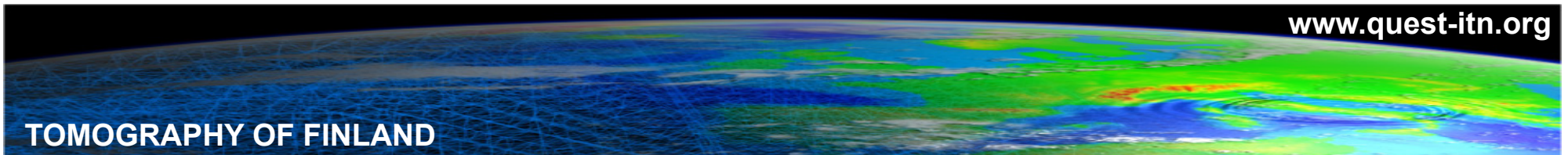
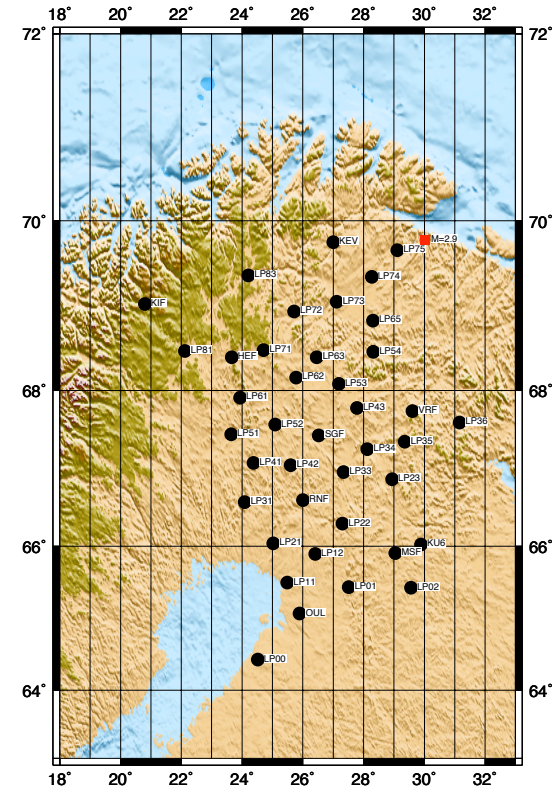
10-20 sec



1-10 sec



Rayleigh
Love



ANT in northern Finland

Geophys. J. Int. (2007) **169**, 1239–1260

doi: 10.1111/j.1365-246X.2007.03374.x

Processing seismic ambient noise data to obtain reliable broad-band surface wave dispersion measurements

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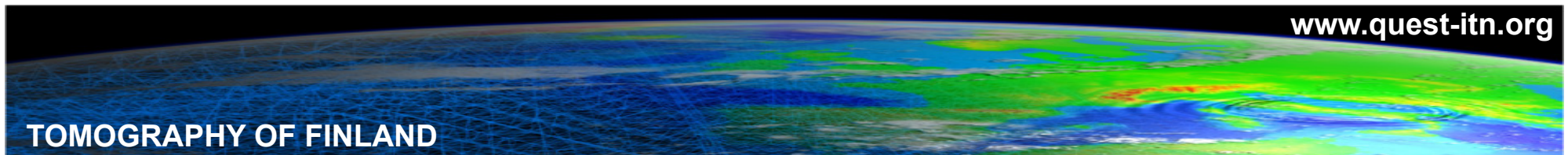


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Anelastic Earth structure from the coherency of the ambient seismic field

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Received 31 August 2008; revised 11 February 2009; accepted 27 April 2009; published 9 July 2009.




ANT in northern Finland

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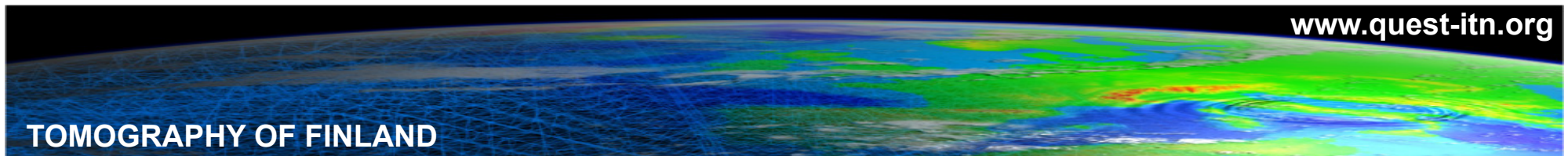
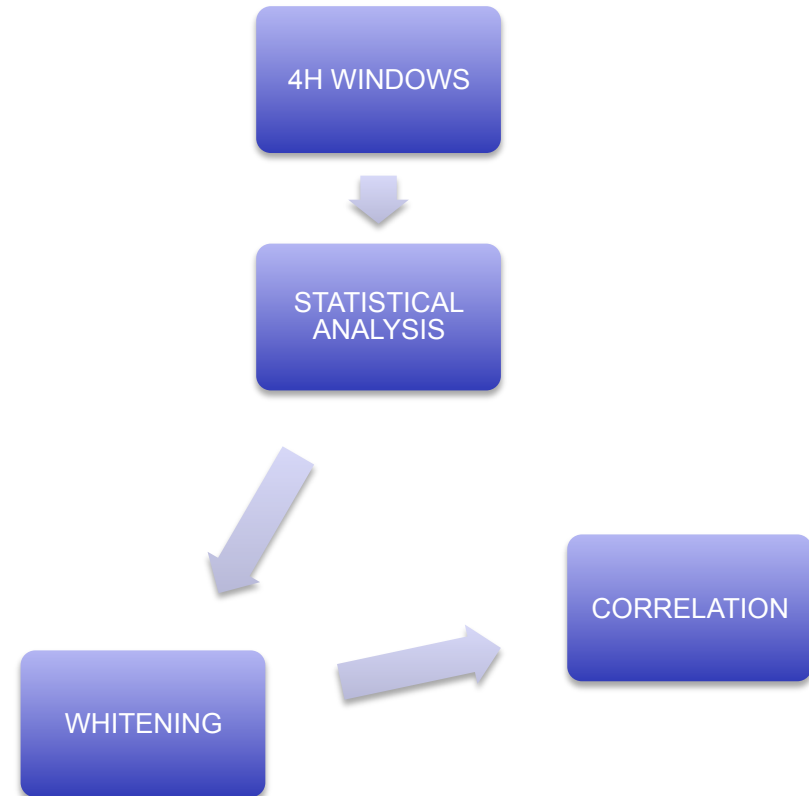
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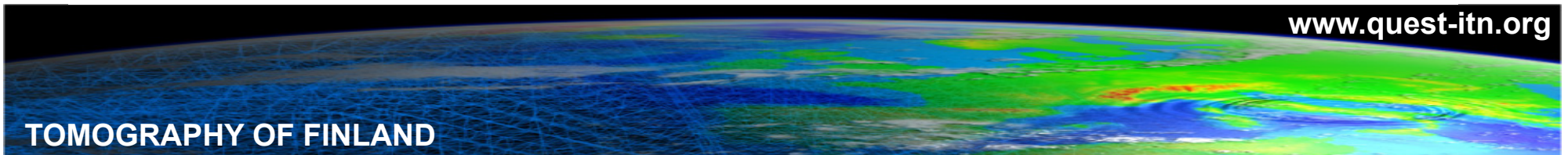
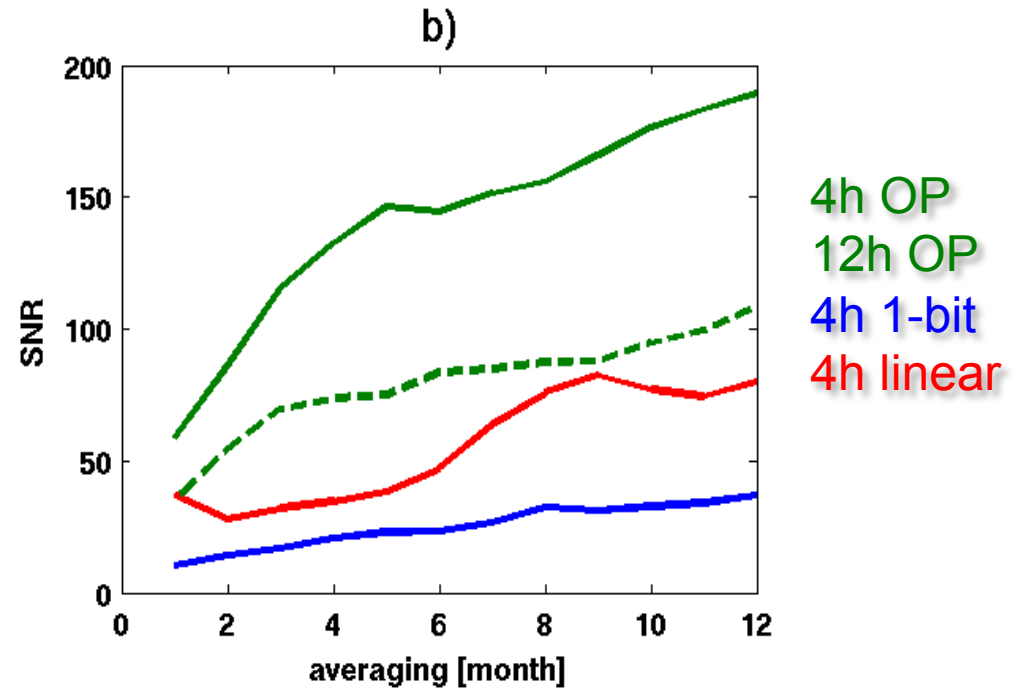
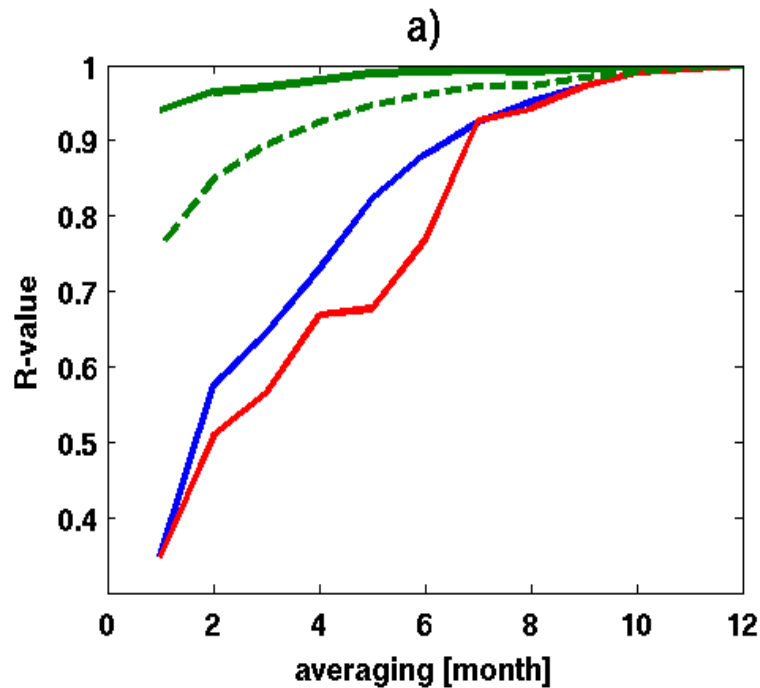
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Quality of the correlations

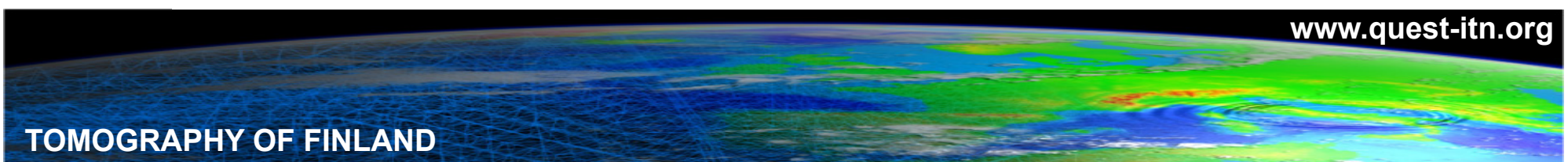
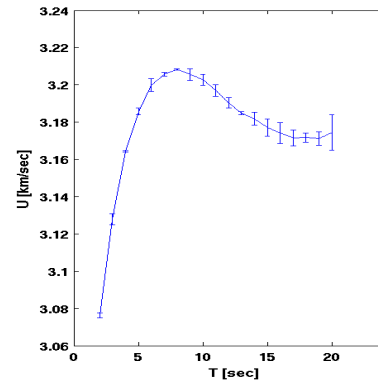
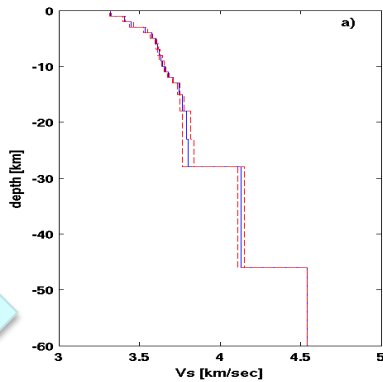
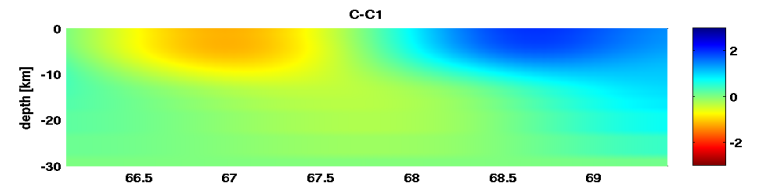
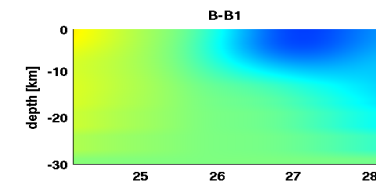
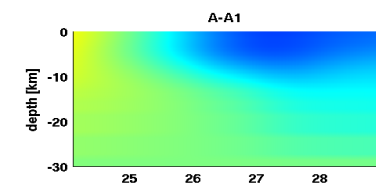
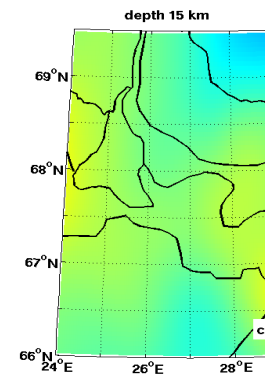
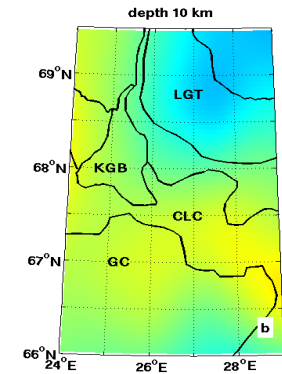
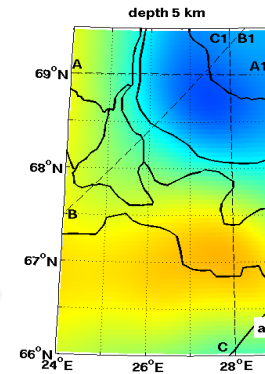
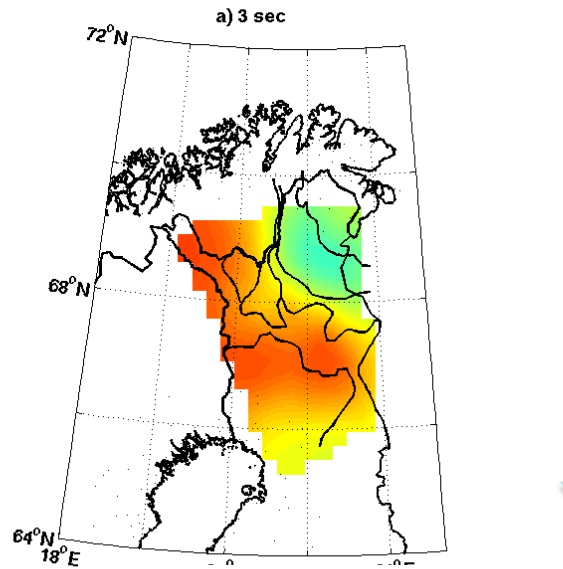
$$R(j) = \frac{\Theta(j, ref)}{\sqrt{\Theta(ref, ref)\Theta(j, j)}}$$

$$SNR(j) = \frac{\max(signal(j))}{rms(noise(j))}$$



Group Velocity

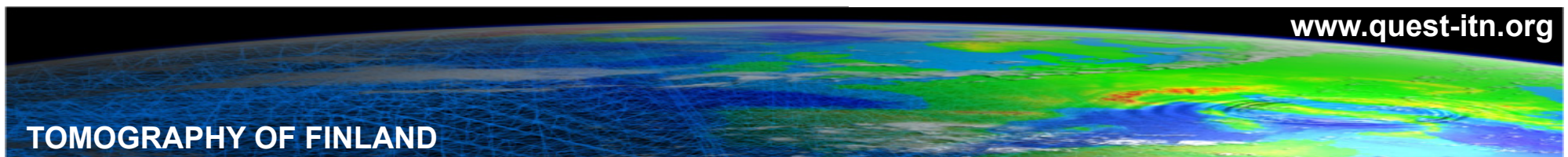
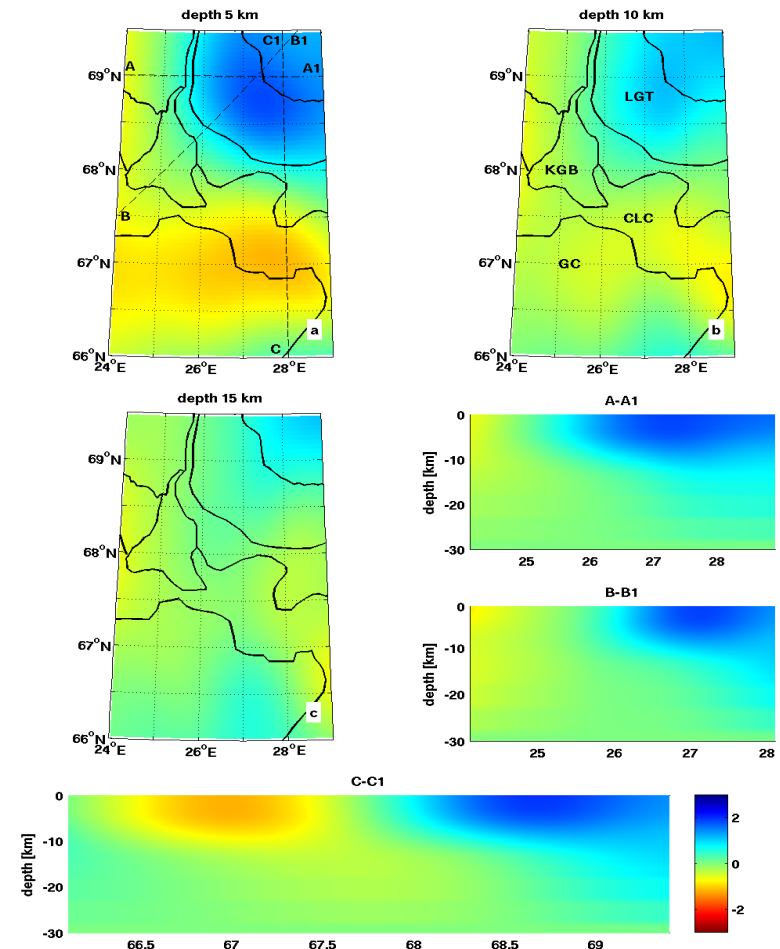
Vs Model



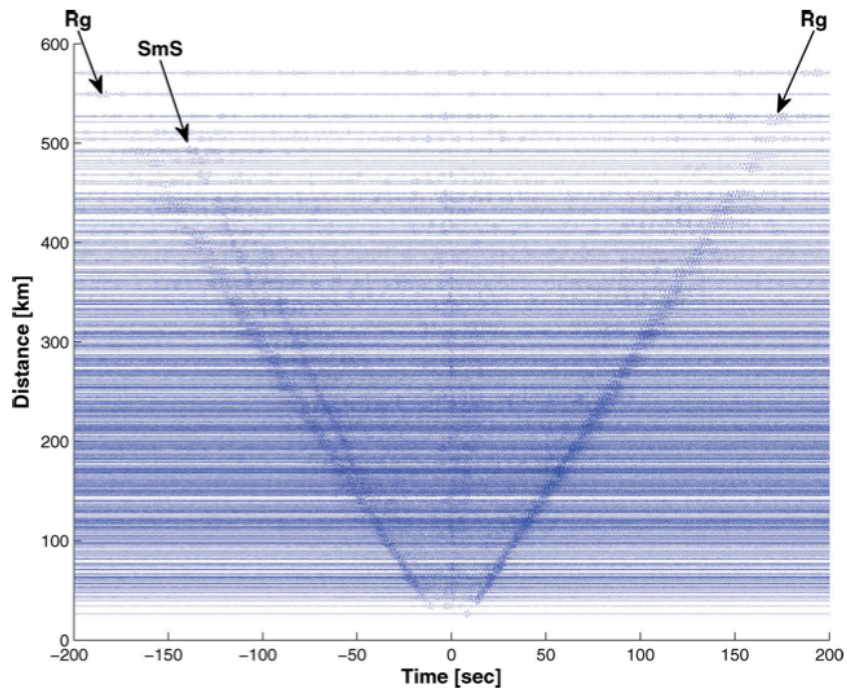
An homogeneous crustal model

... 'attenuation measurements for S wave in the crust (Uski & Tuppurainen 1996) suggest that the mean-free path is at least of the order of the aperture of the LAPNET network'... (Poli et al. 2012)

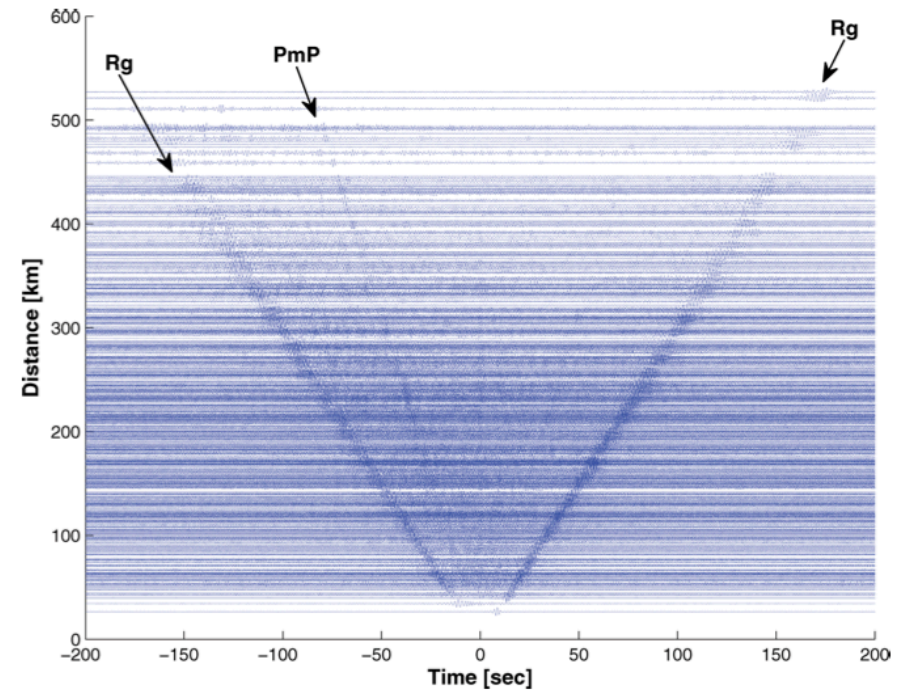
$$SNR \propto \sqrt{\frac{NR^2}{\tau_{cCR}} \frac{e^{-r/l^*}}{l^*}},$$



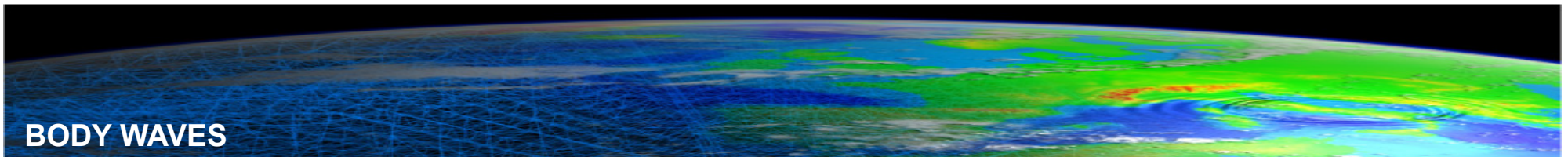
ZZ components



RR components



FB 0.5-1 hz

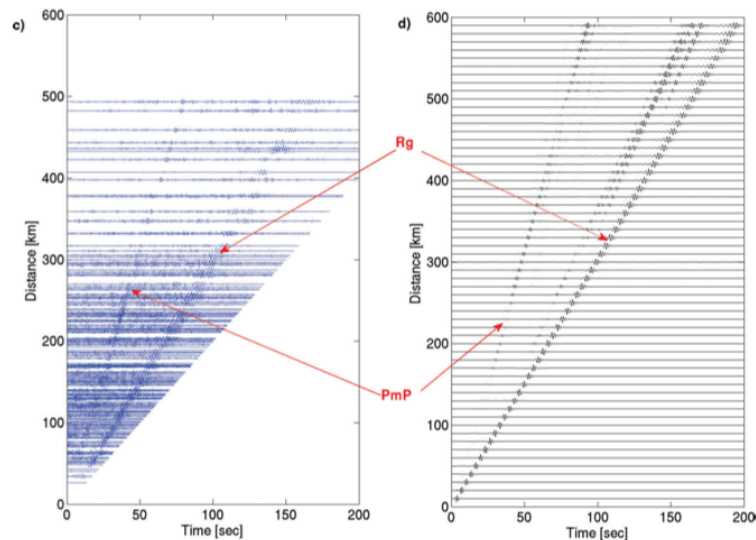
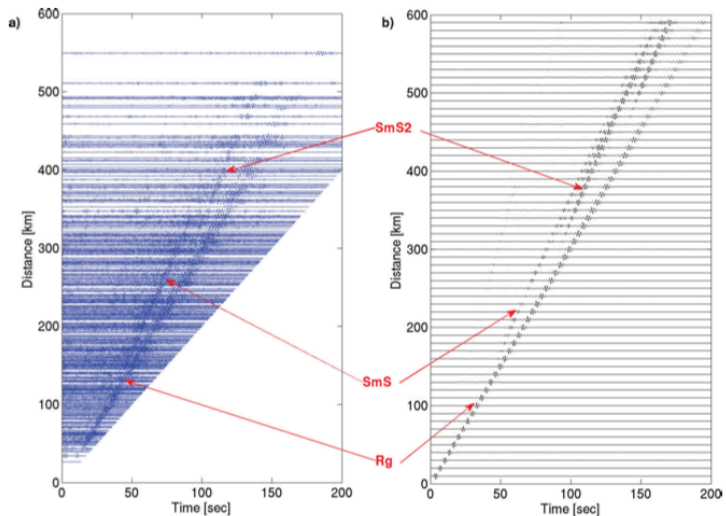


ZZ EGF

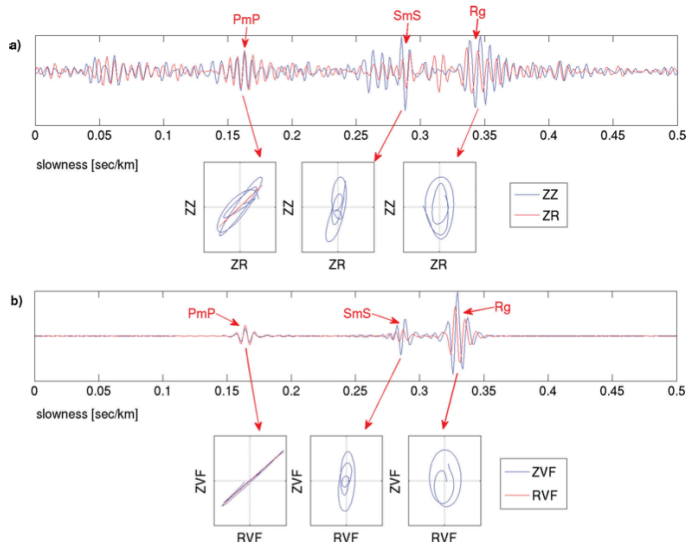
ZVF GF

RR EGF

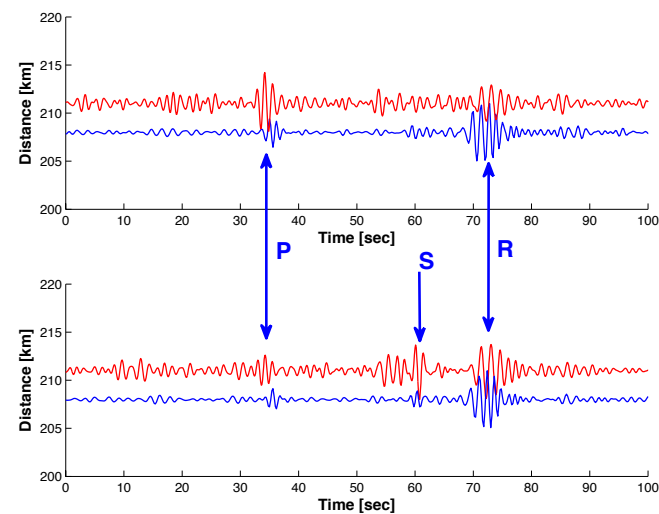
RHF GF



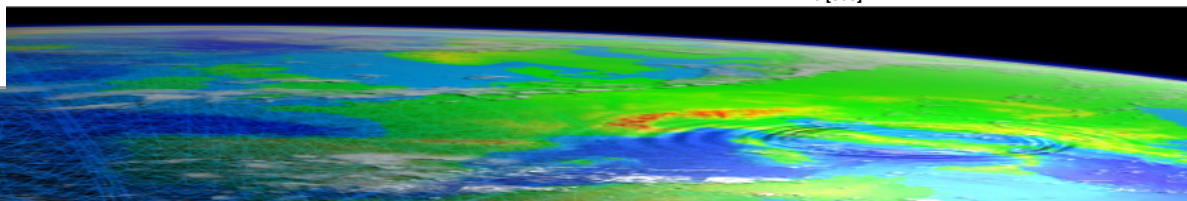
POLARIZATION



EGF
EQ



BODY WAVES



CONCLUSIONS & PERSPECTIVES

- Surface waves tomography: it works!!!!
- Understand the effect of 'windowing' in noise correlation
 - Exctraton of body waves everywhere (?).
- Observation of body waves reflected from mantle discontinuities/CMB using stacking techniques.
 - Imaging/monitoring using body waves.

