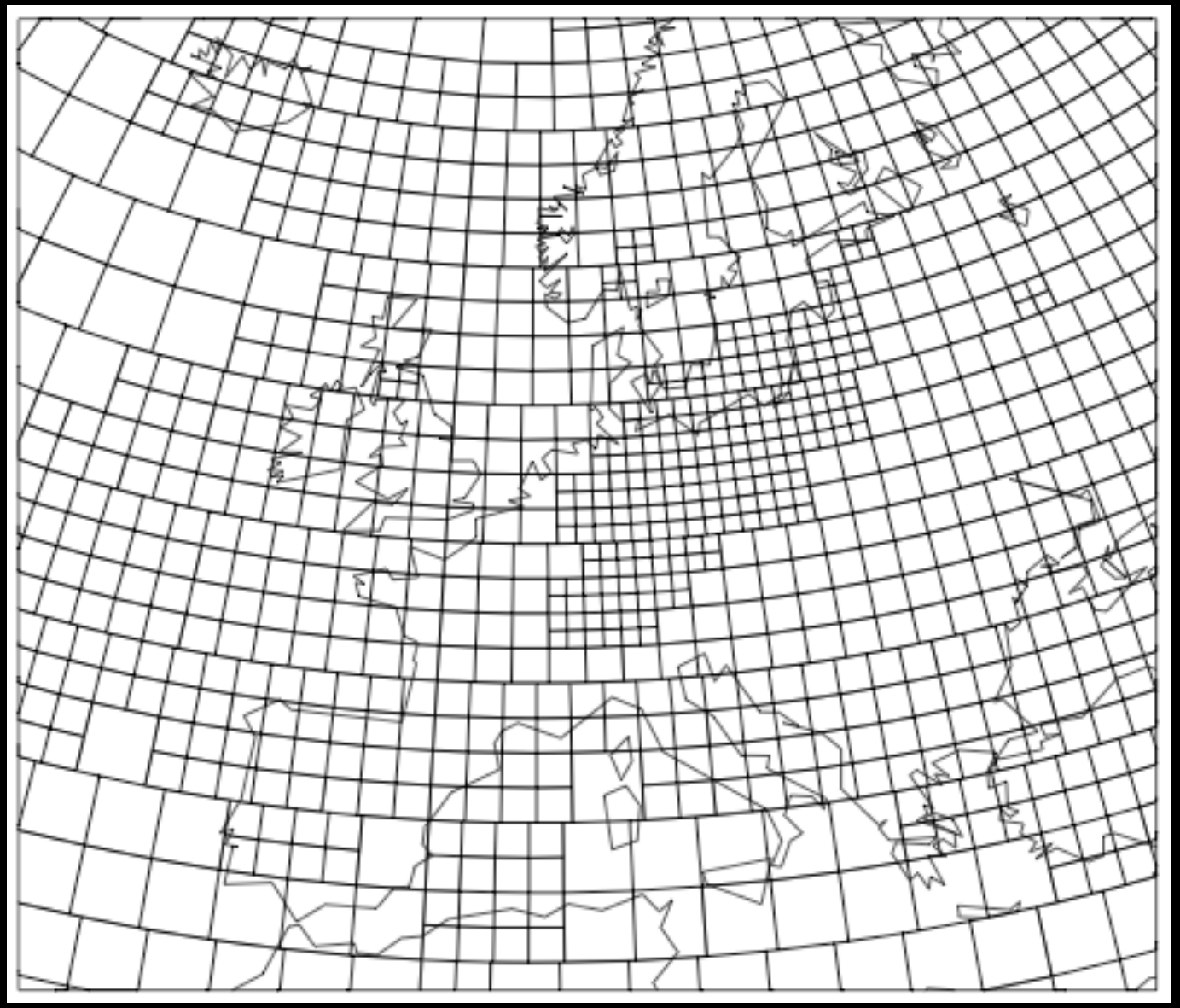
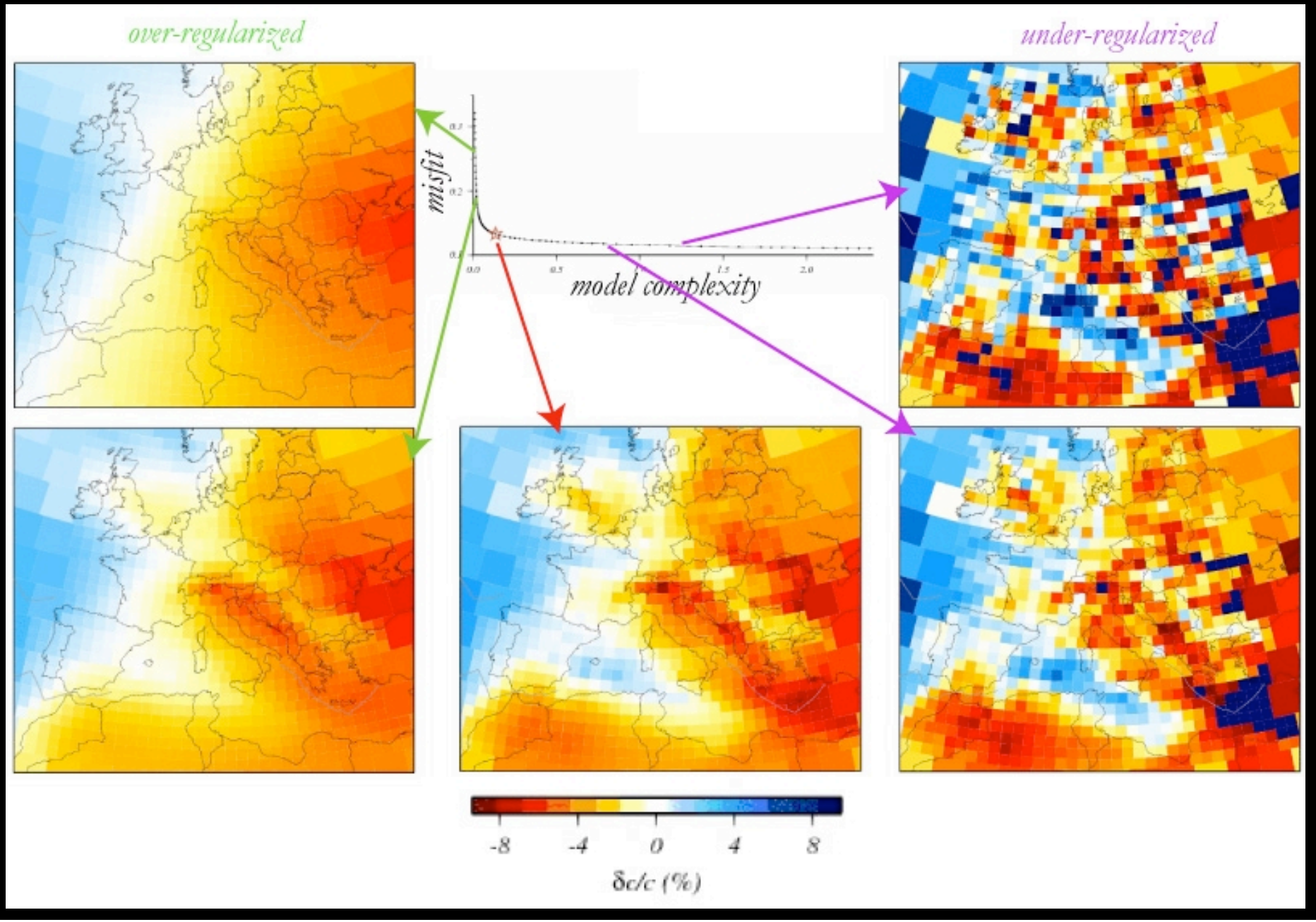
Surface-wave tomography: Europe

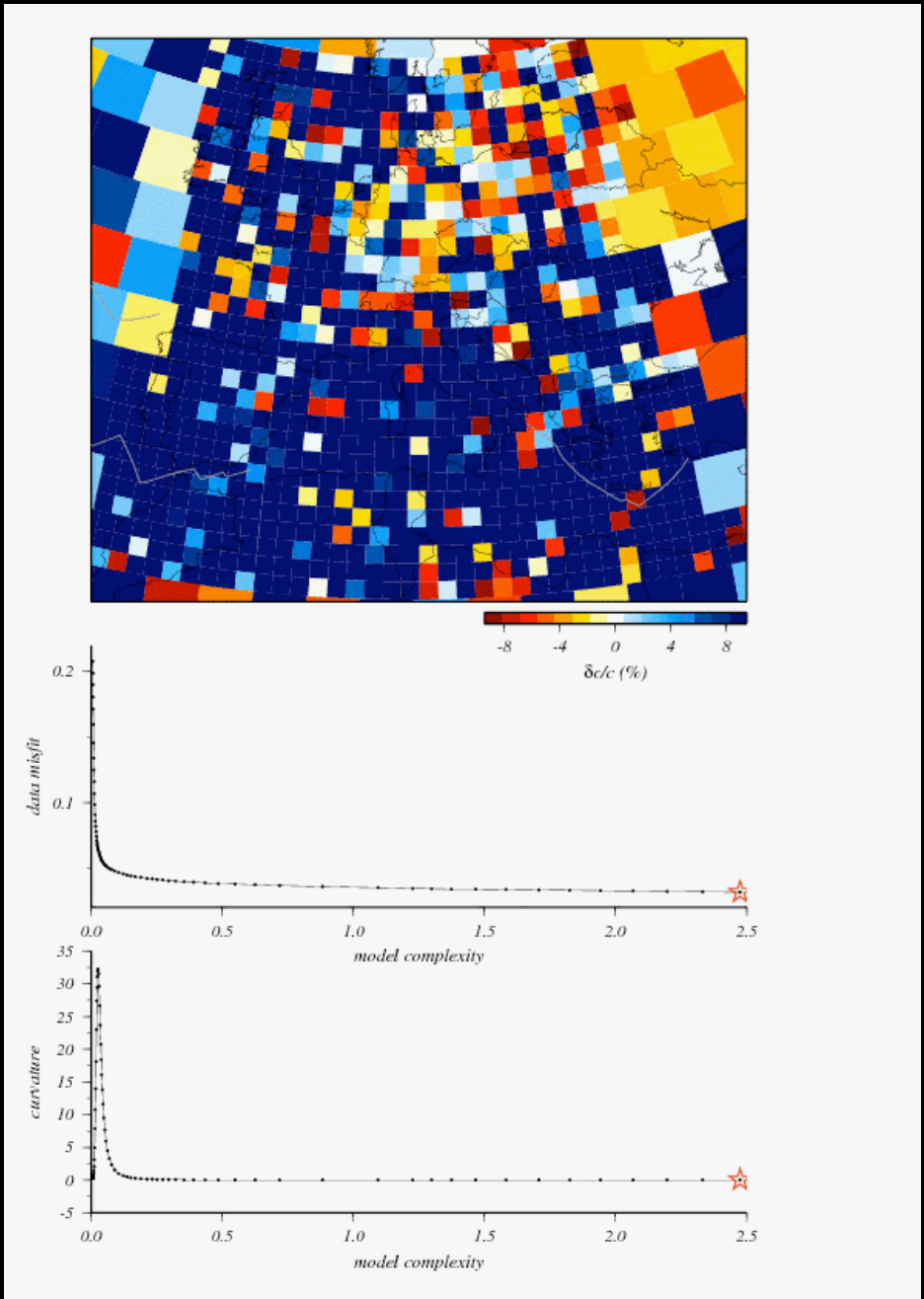


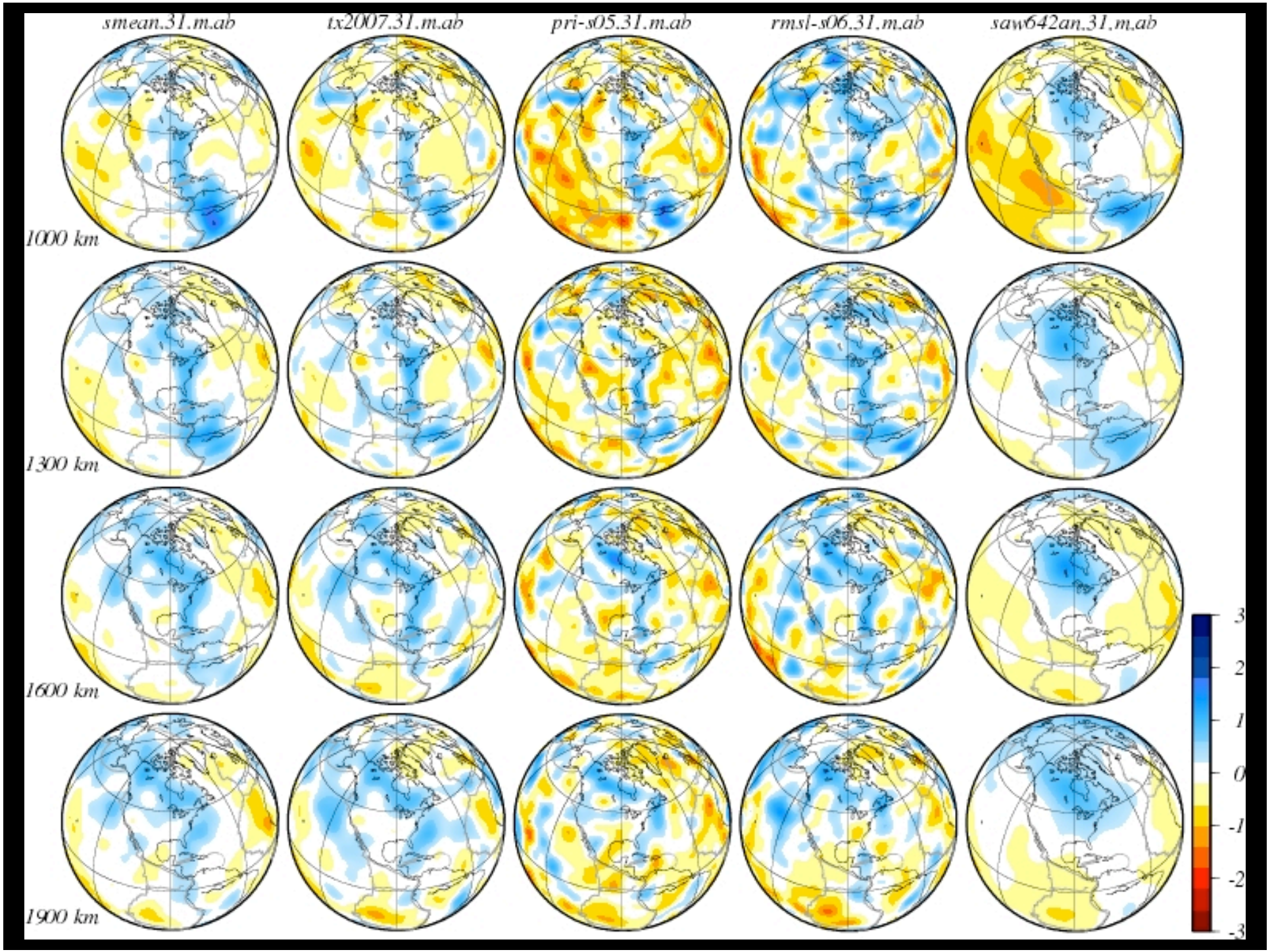
Lapo Boschi ETH Zürich (with Bill Fry)

Tomography results are non-unique



Tomography results are non-unique

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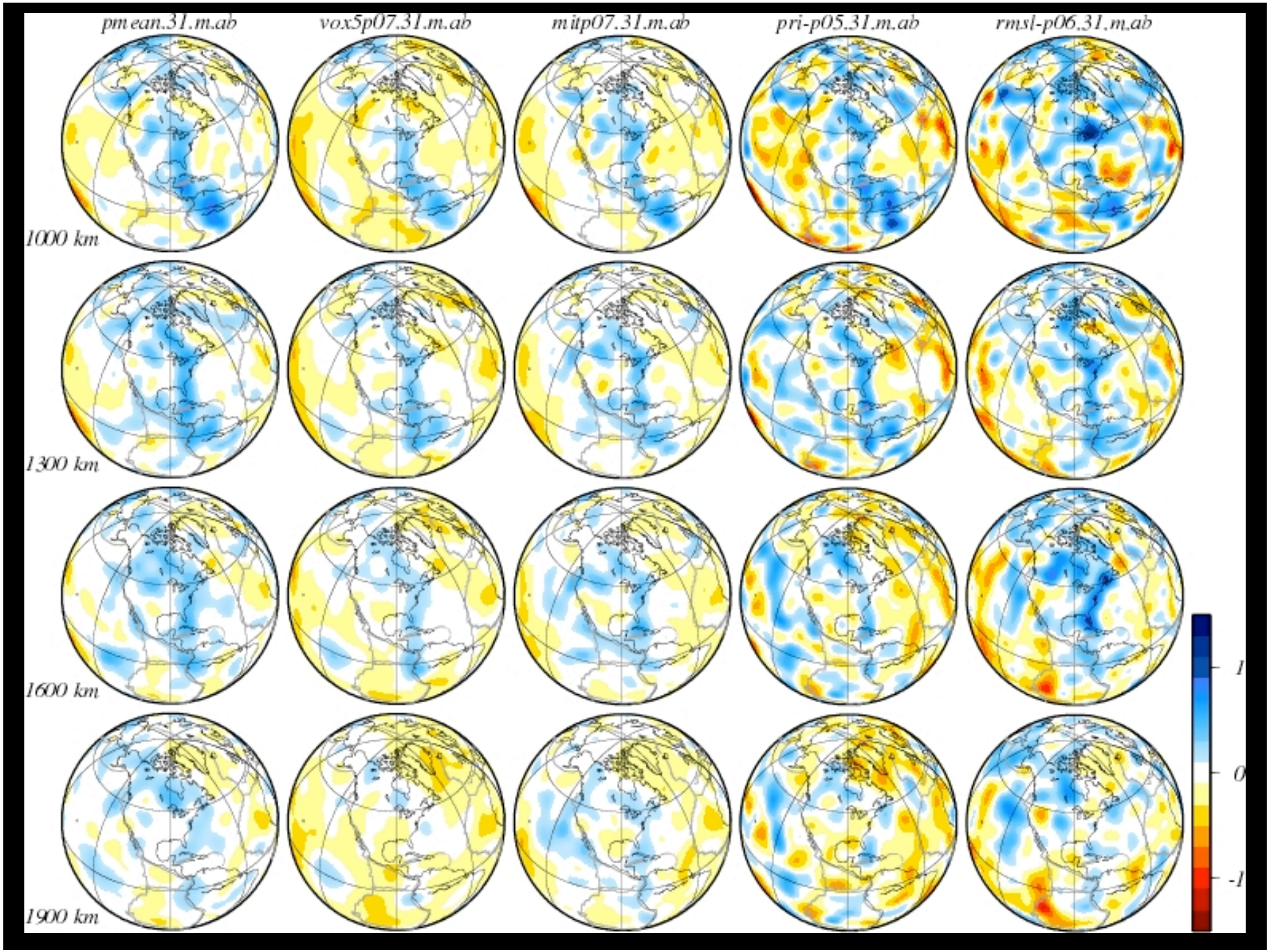
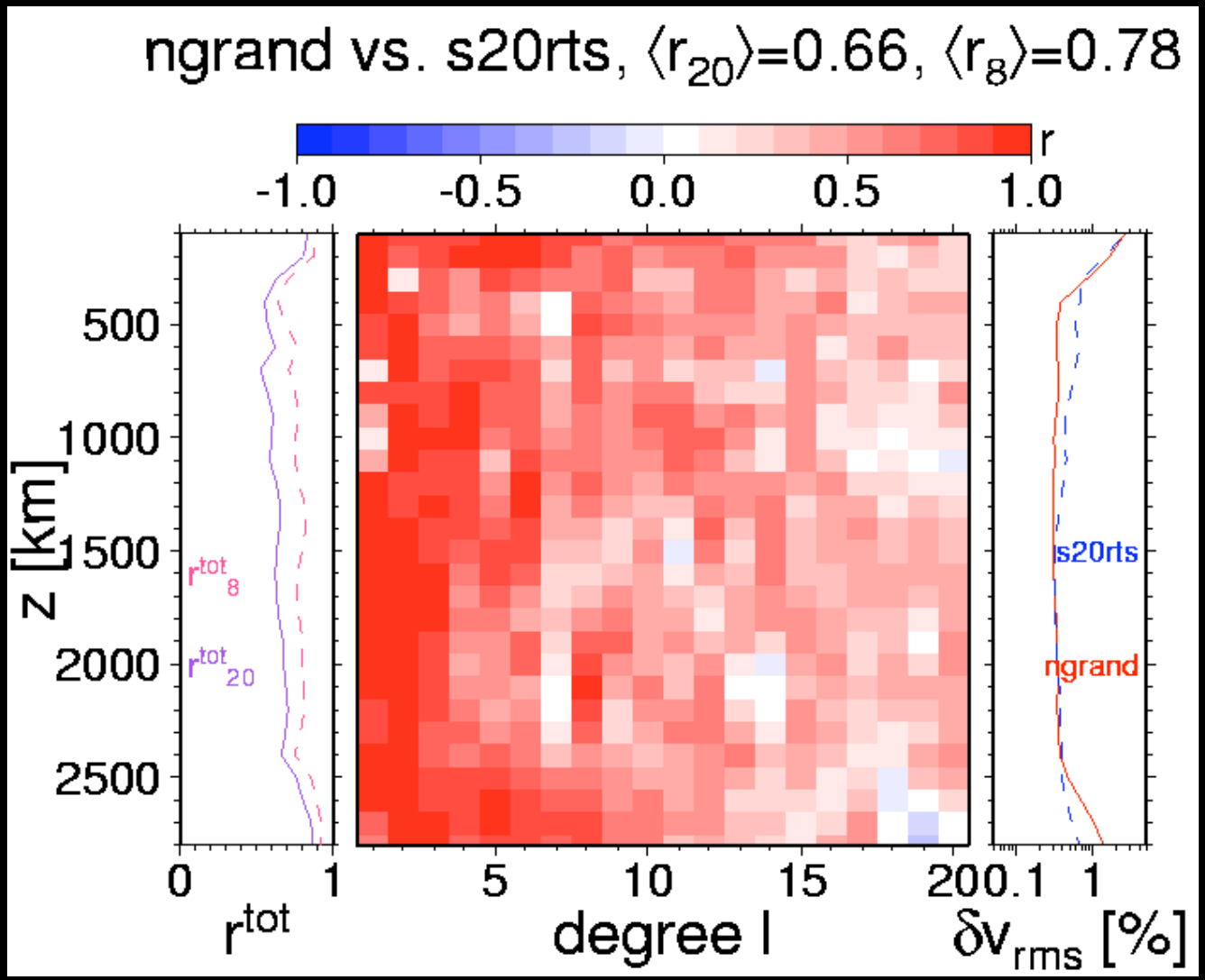
tx2007.31.m.ab
pri-s05.31.m.ab
rmsl-s06.31.m.ab
saw642an.31.m.ab
1000 km
1300 km
1600 km
1900 km
3
2
1
0
-1
-2
-3

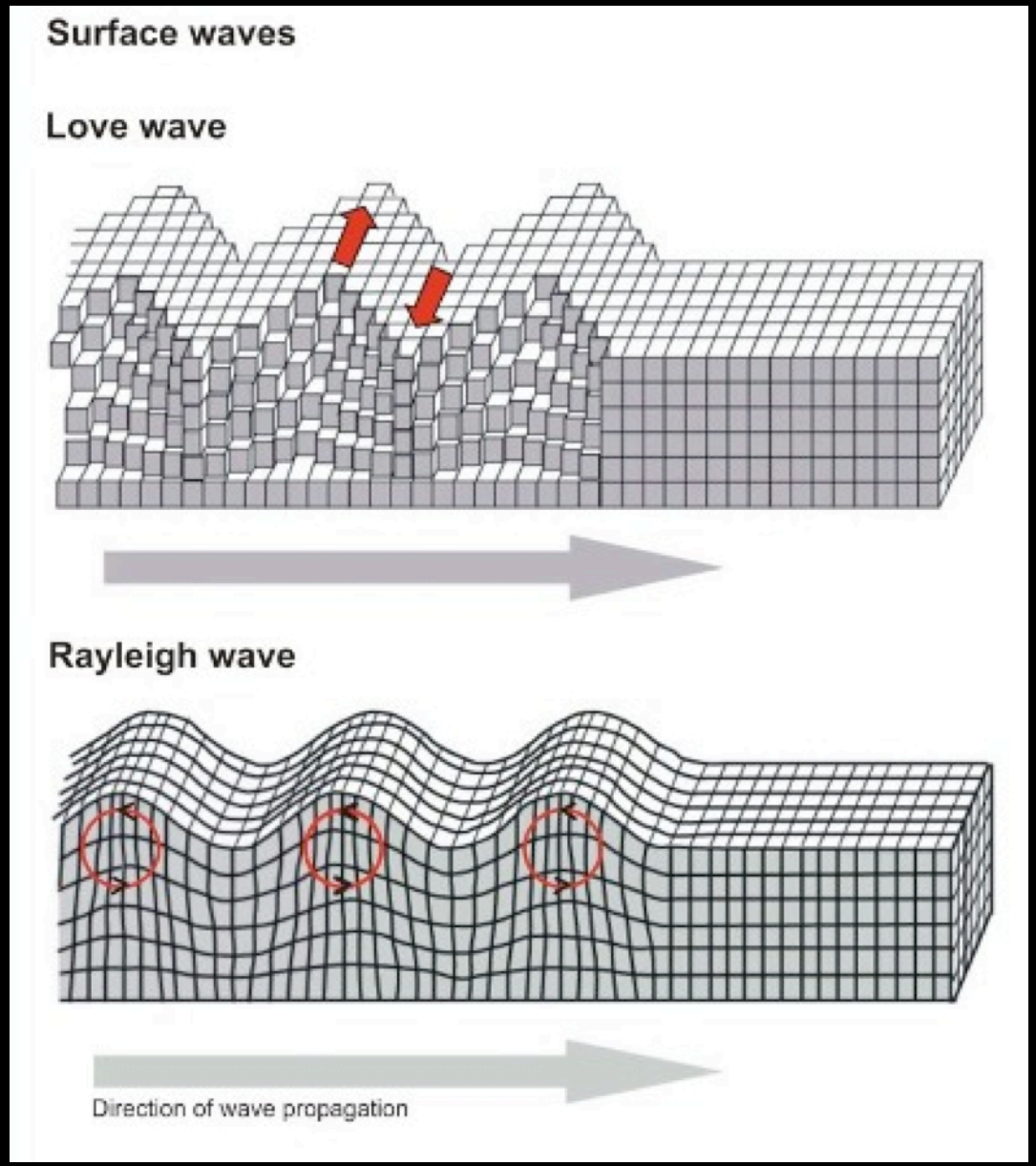

pmean.31.m.ab
vox5p07.31.m.ab
mitp07.31.m.ab
pri-p05.31.m.ab
rmsl-p06.31.m.ab
1000 km
1300 km
1600 km
1900 km
1
0
-1

Correlation between two Vs models, as a function of depth and harmonic degree

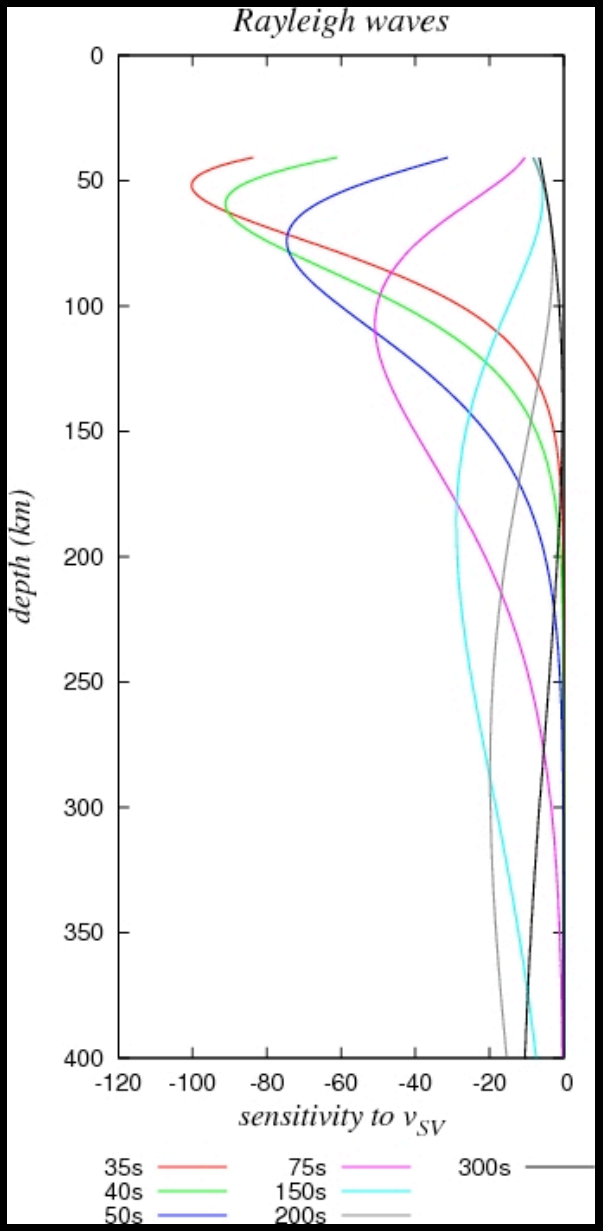


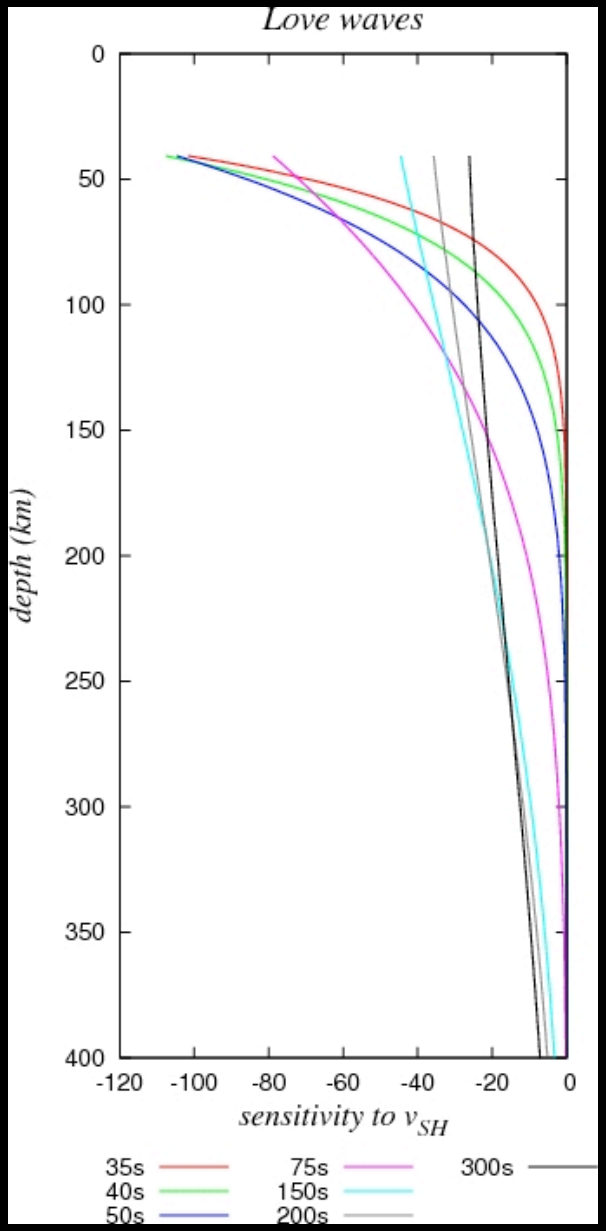
Becker and Boschi, 2002-present

surface-wave tomography

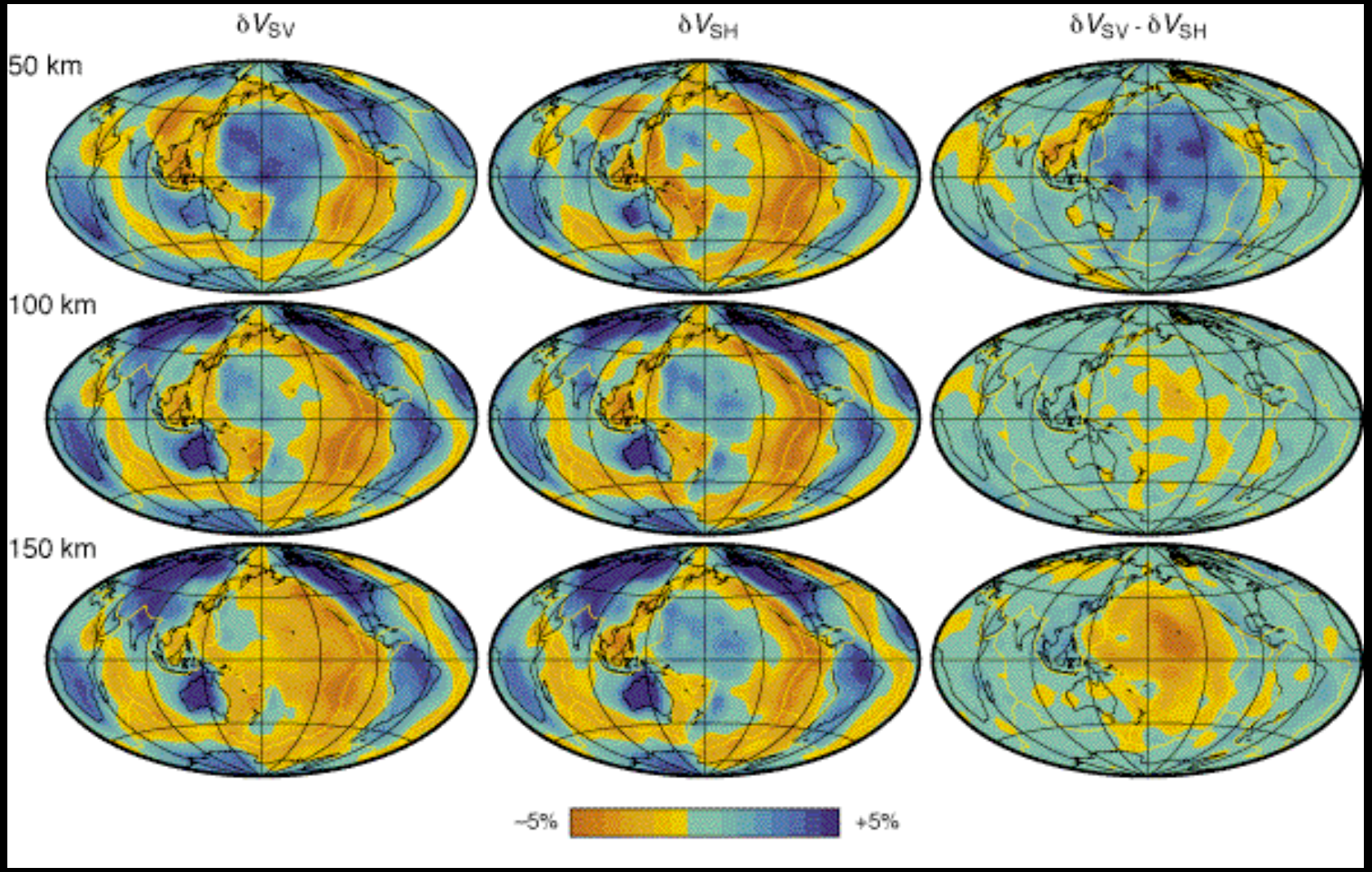


surface-wave tomography



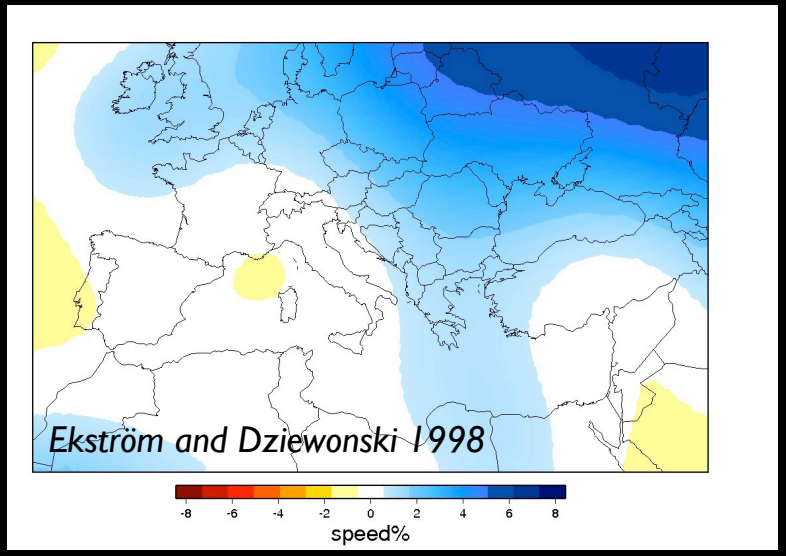


surface-wave tomography

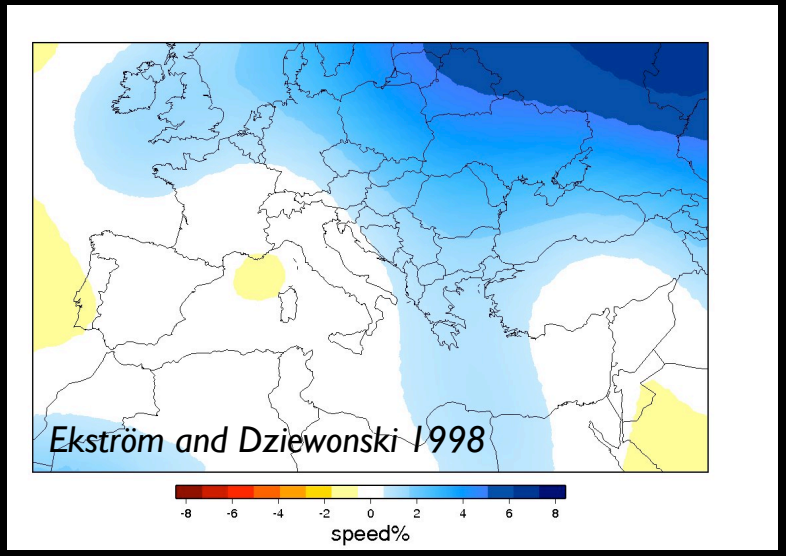


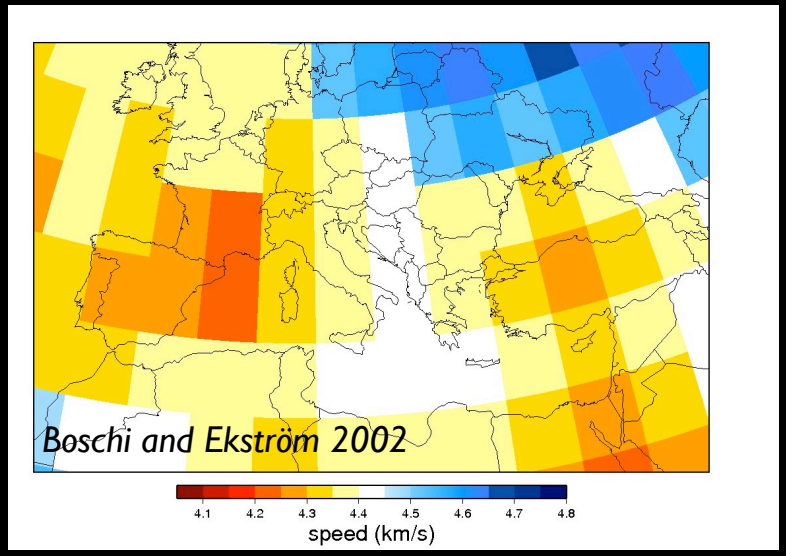
Ekström & Dziewonski, 1998

Vsv at 150 km: Anisotropic models from Harvard database

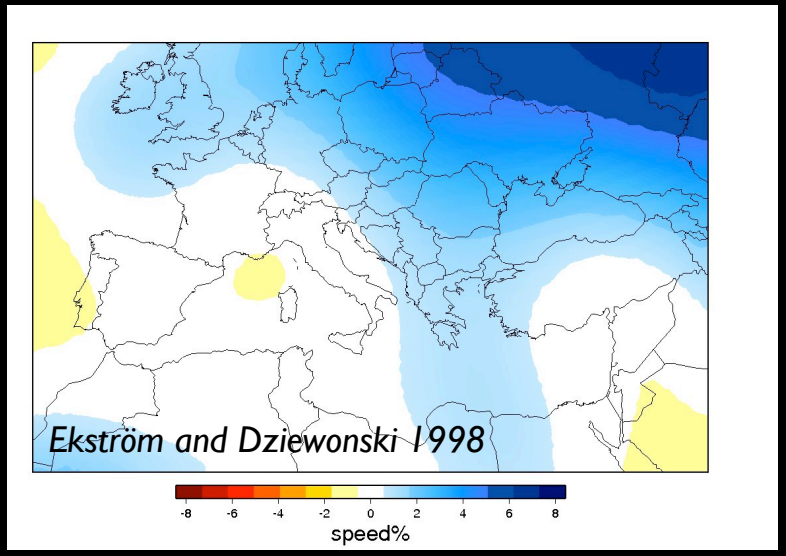


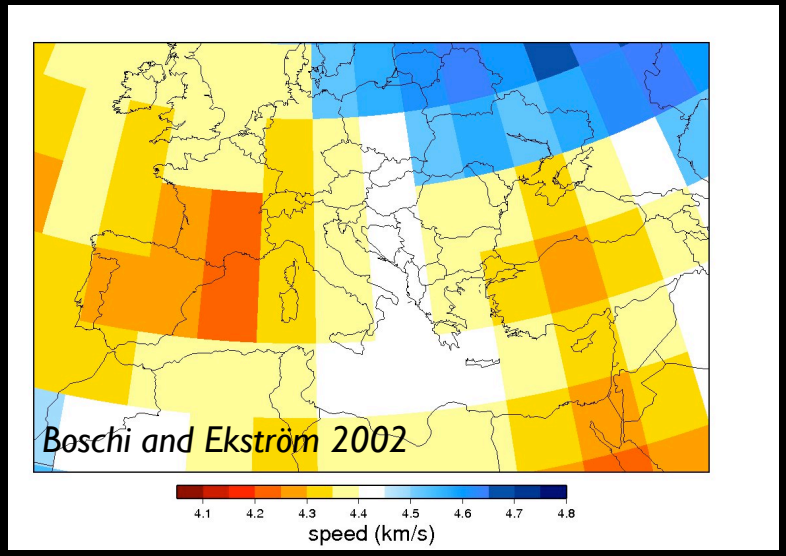
Vsv at 150 km: Anisotropic models from Harvard database

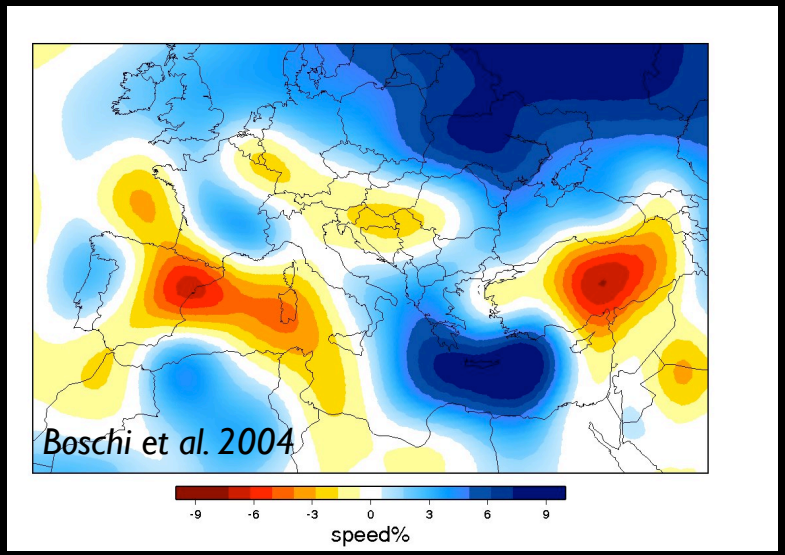




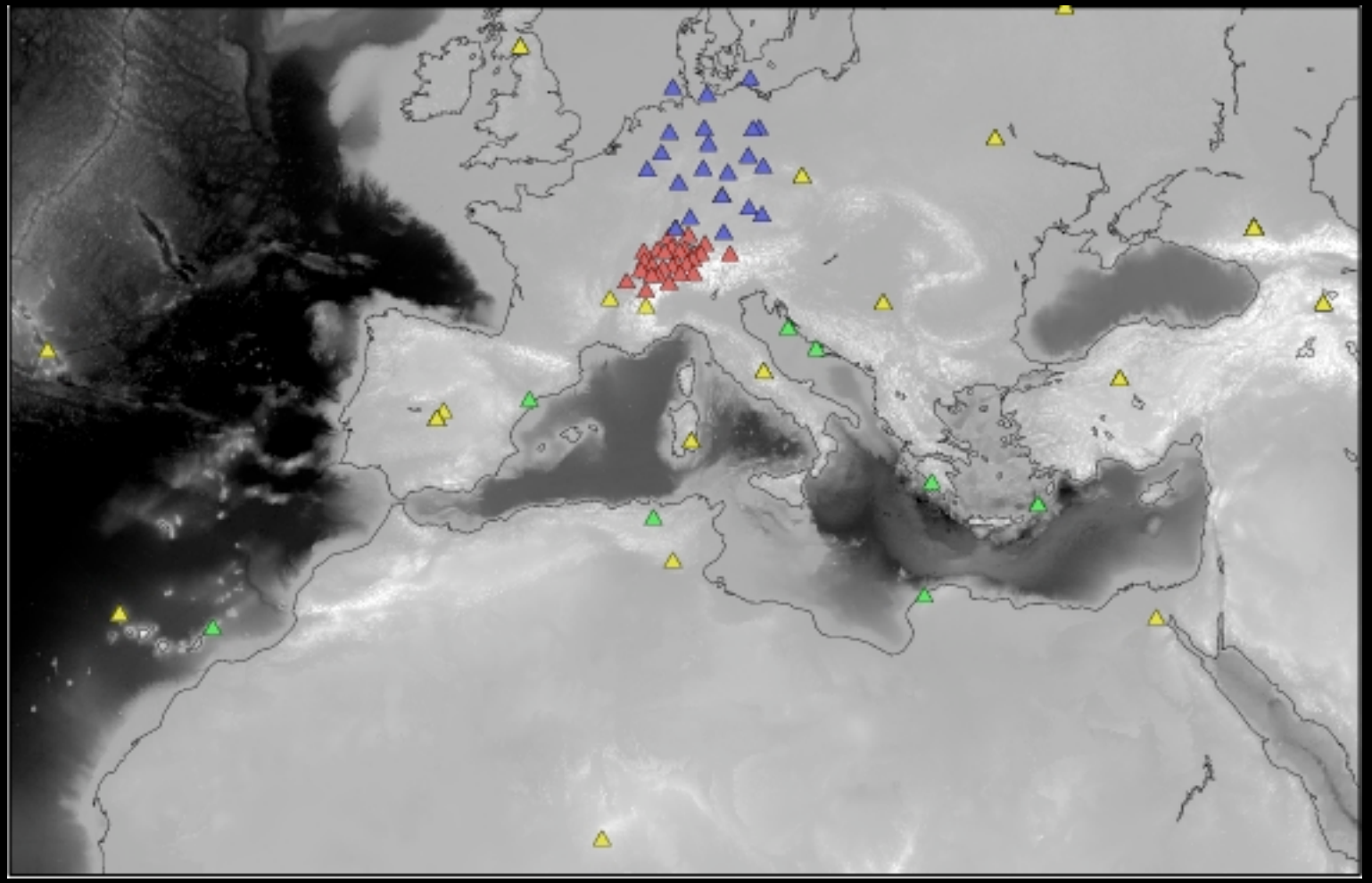
Vsv at 150 km: Anisotropic models from Harvard database



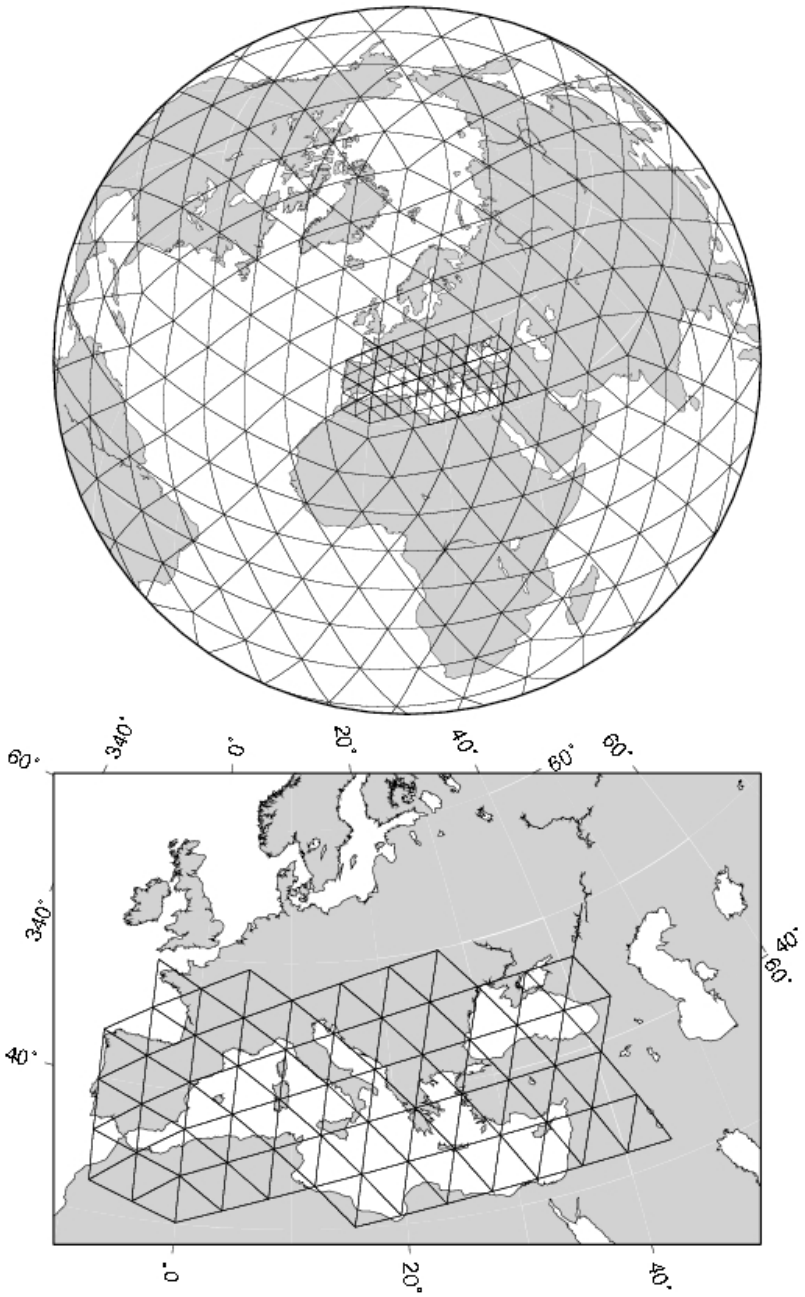


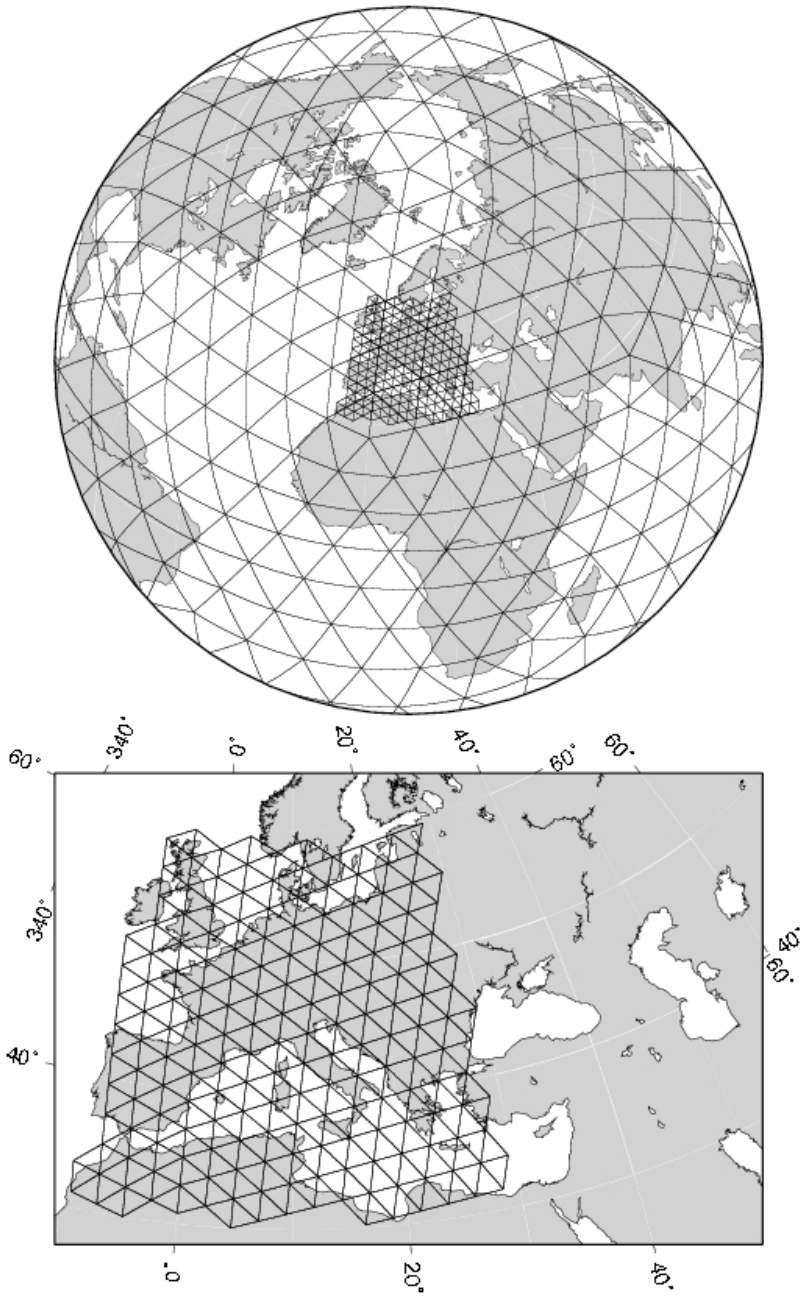


improvement in database

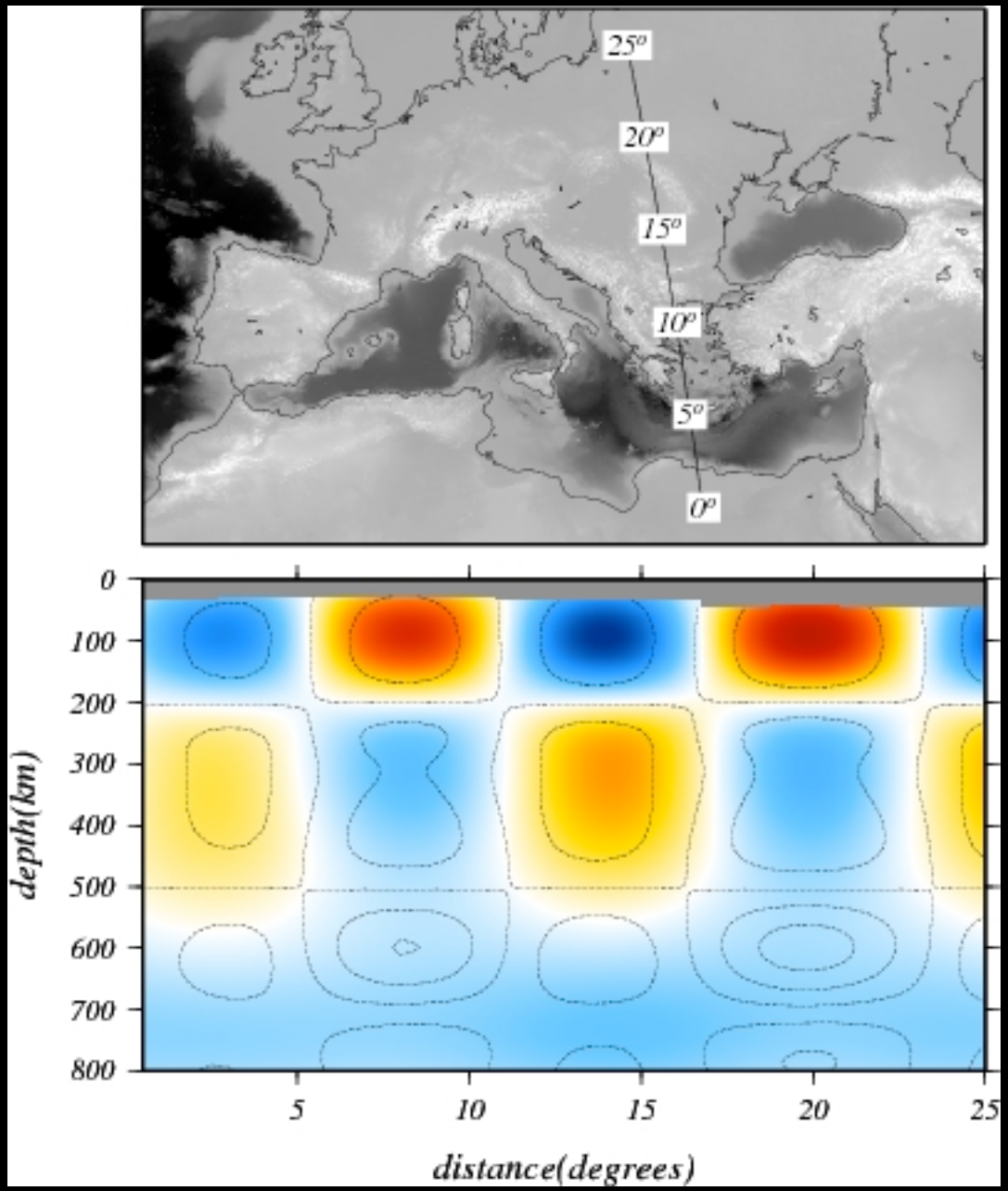


multiple resolution model

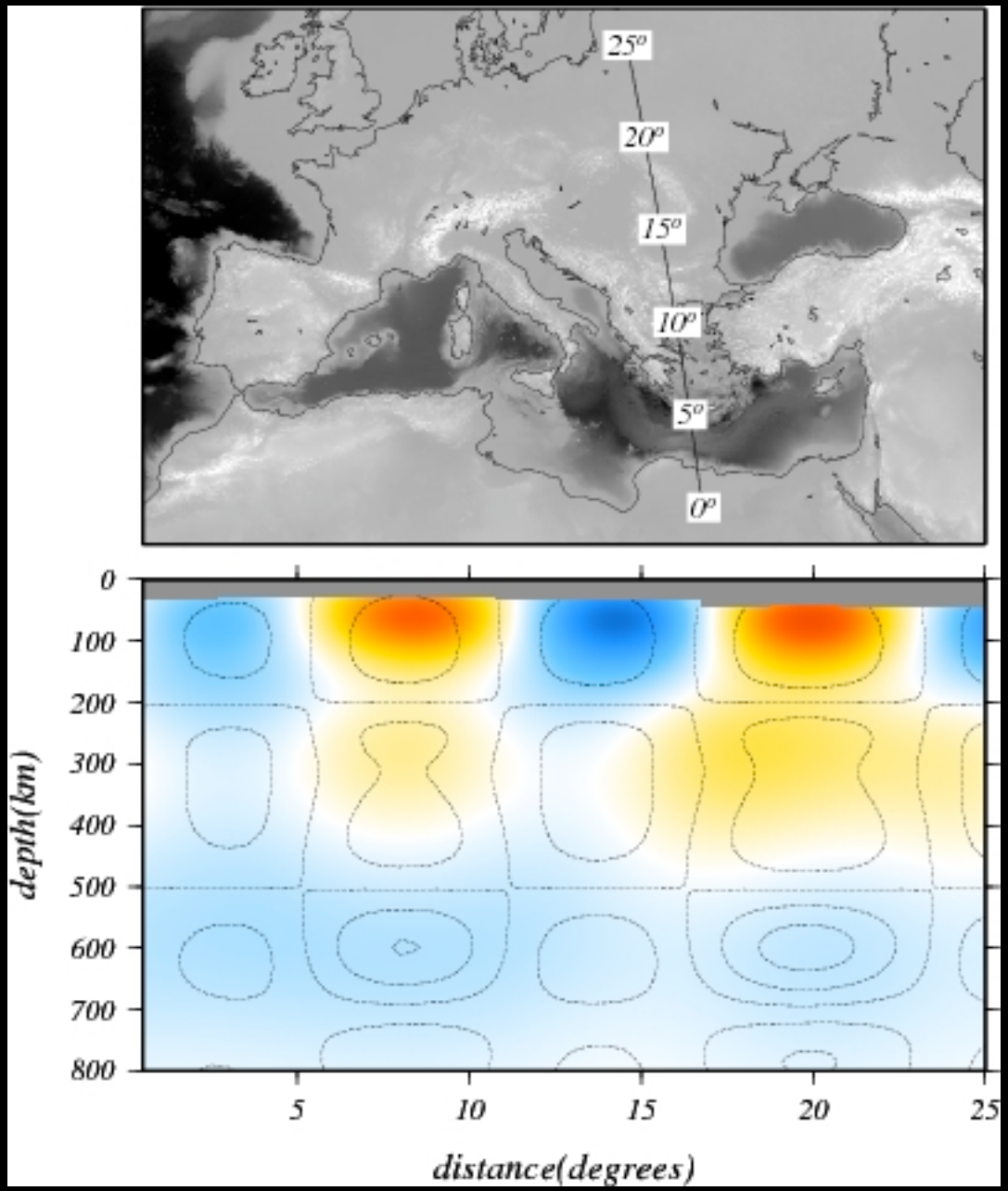




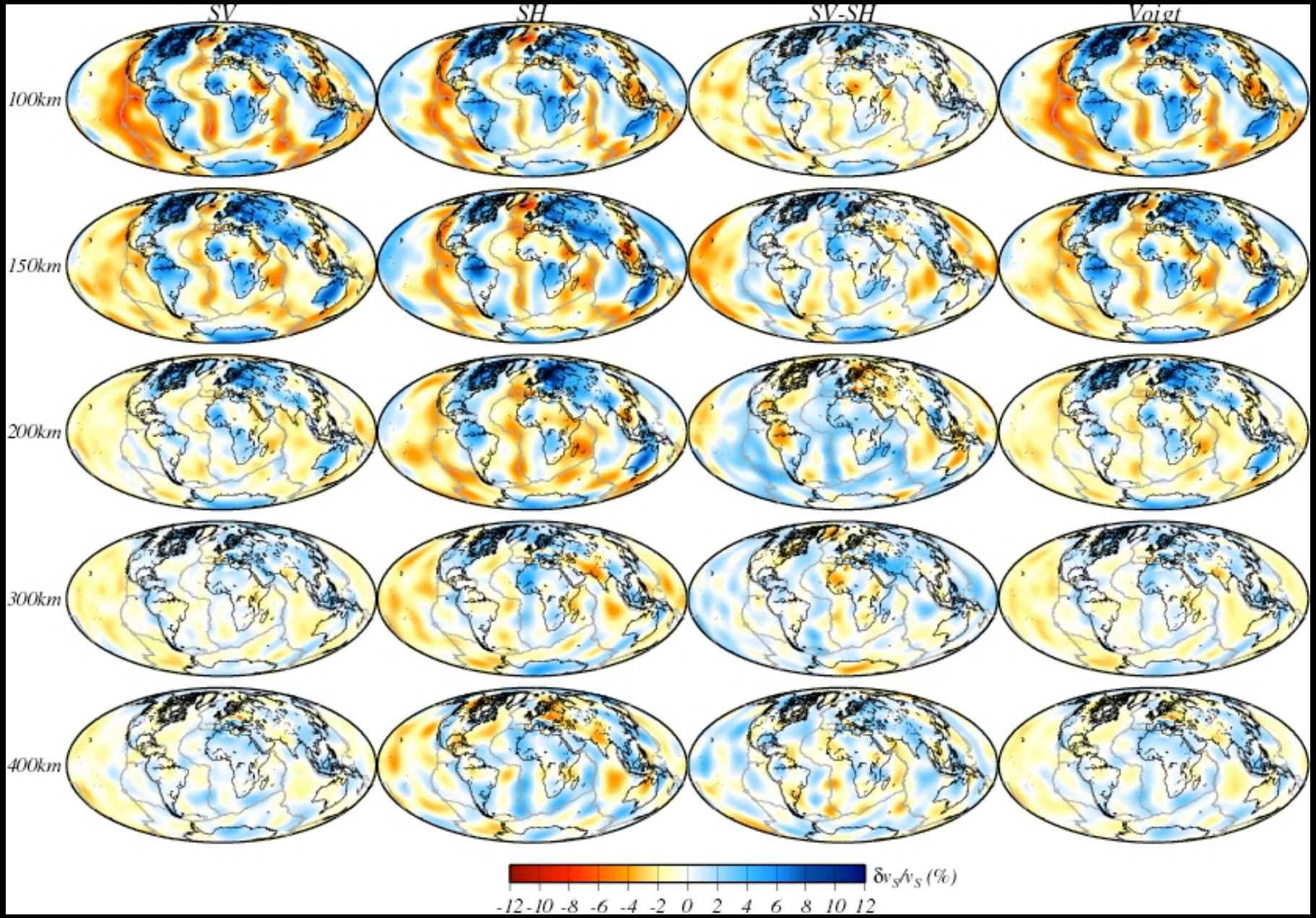
checkerboard test (SV)



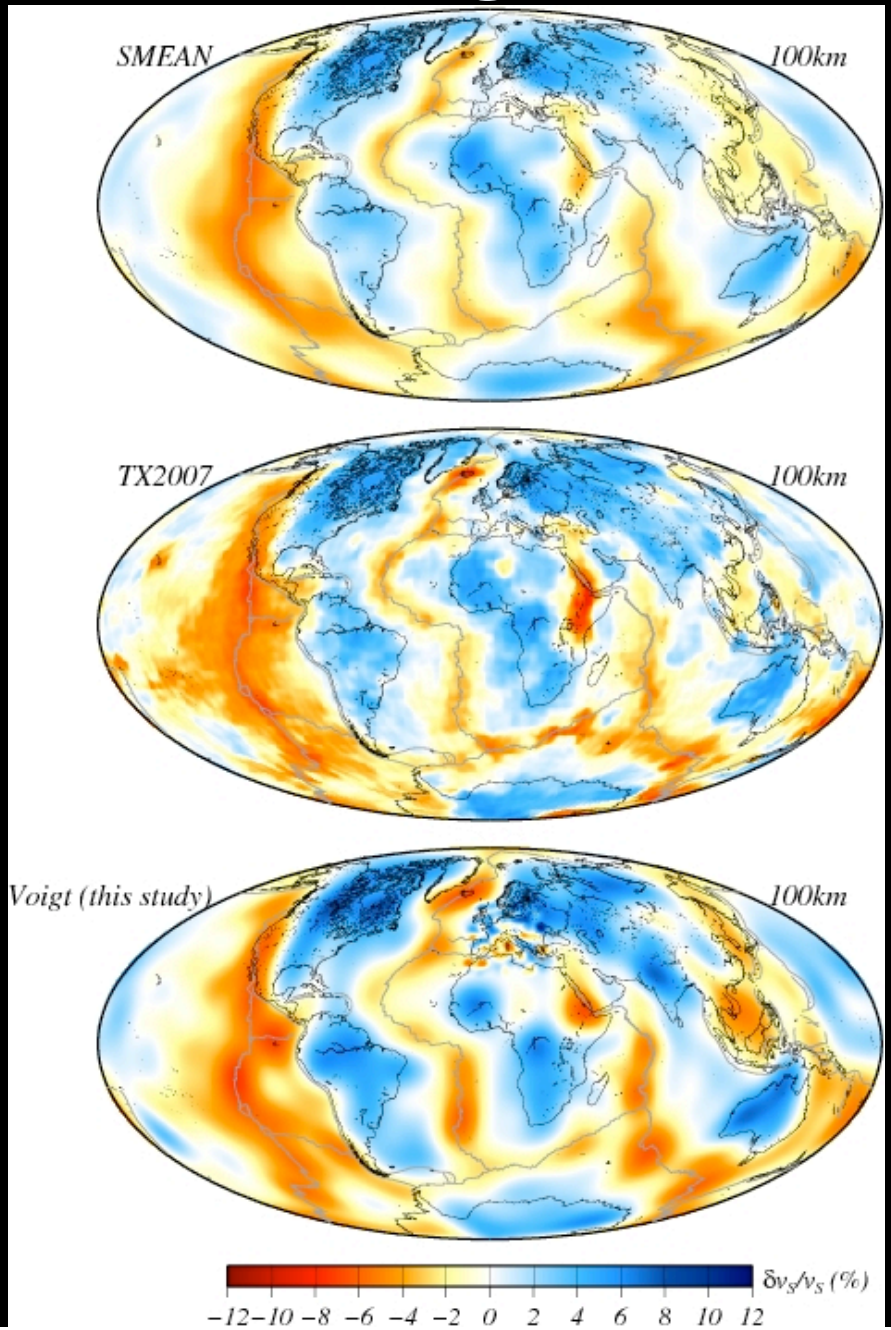
checkerboard test (SH)



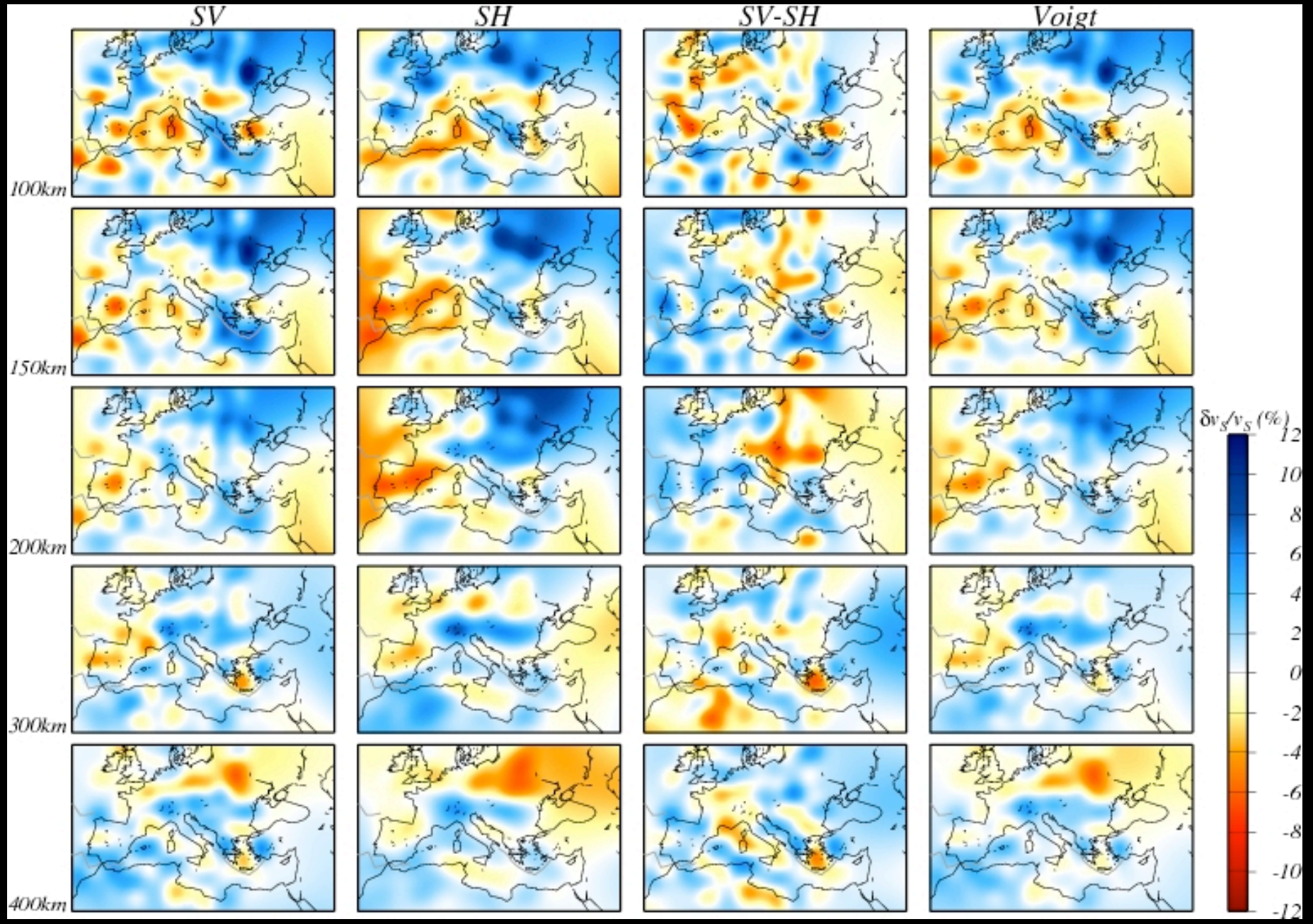
new model, global view



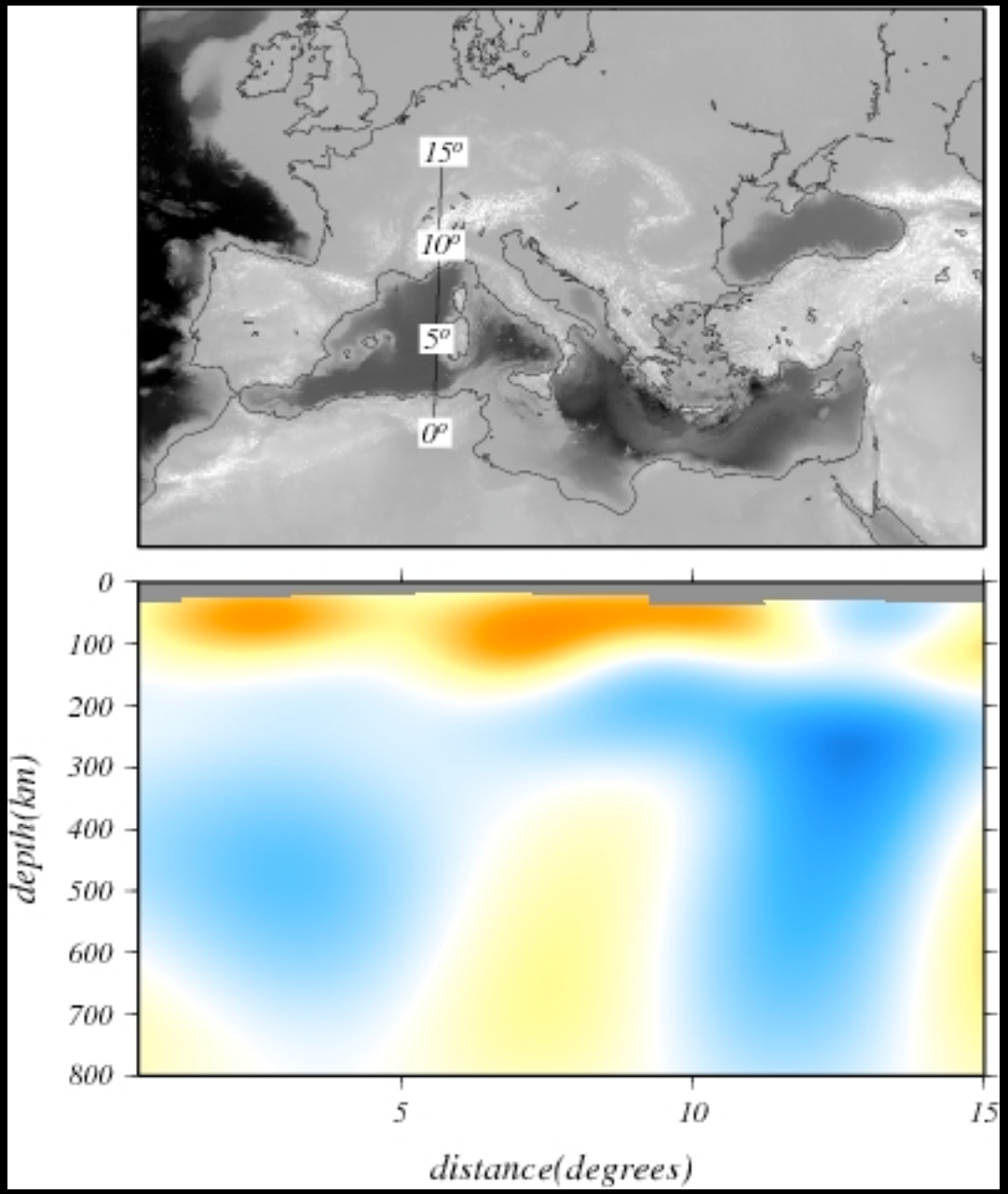
new model, global view



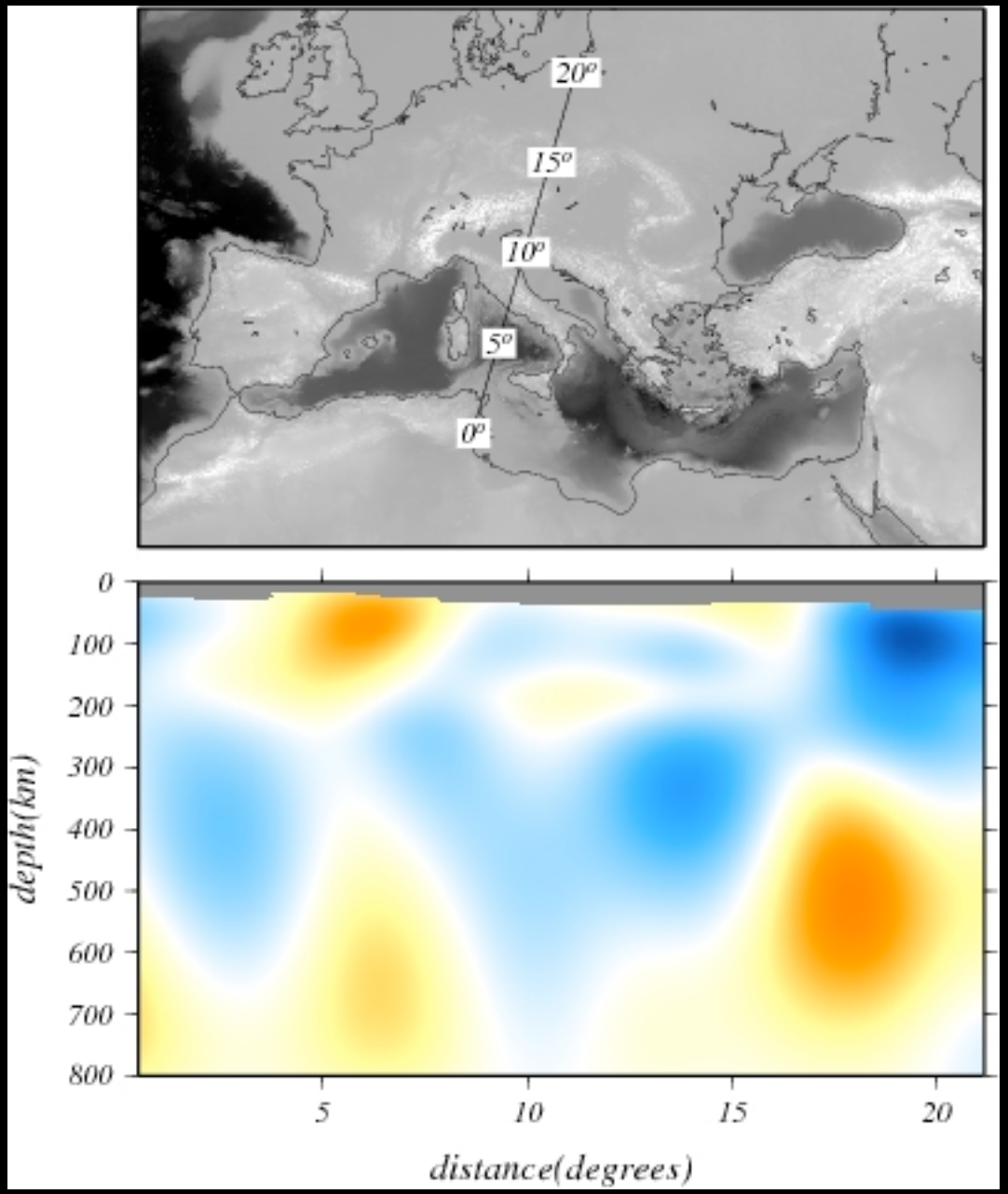
new model, continental-scale view



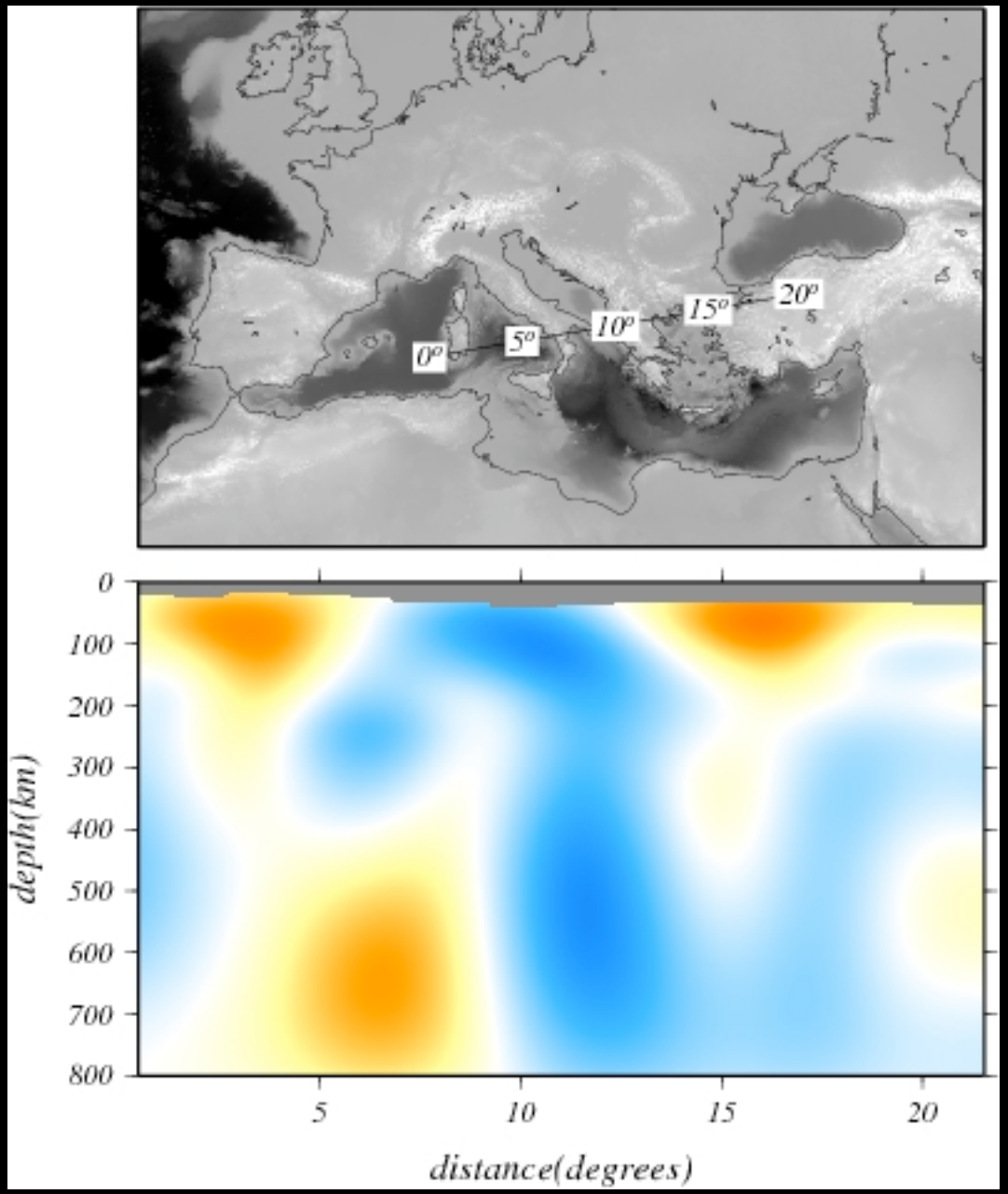
new model, vertical sections



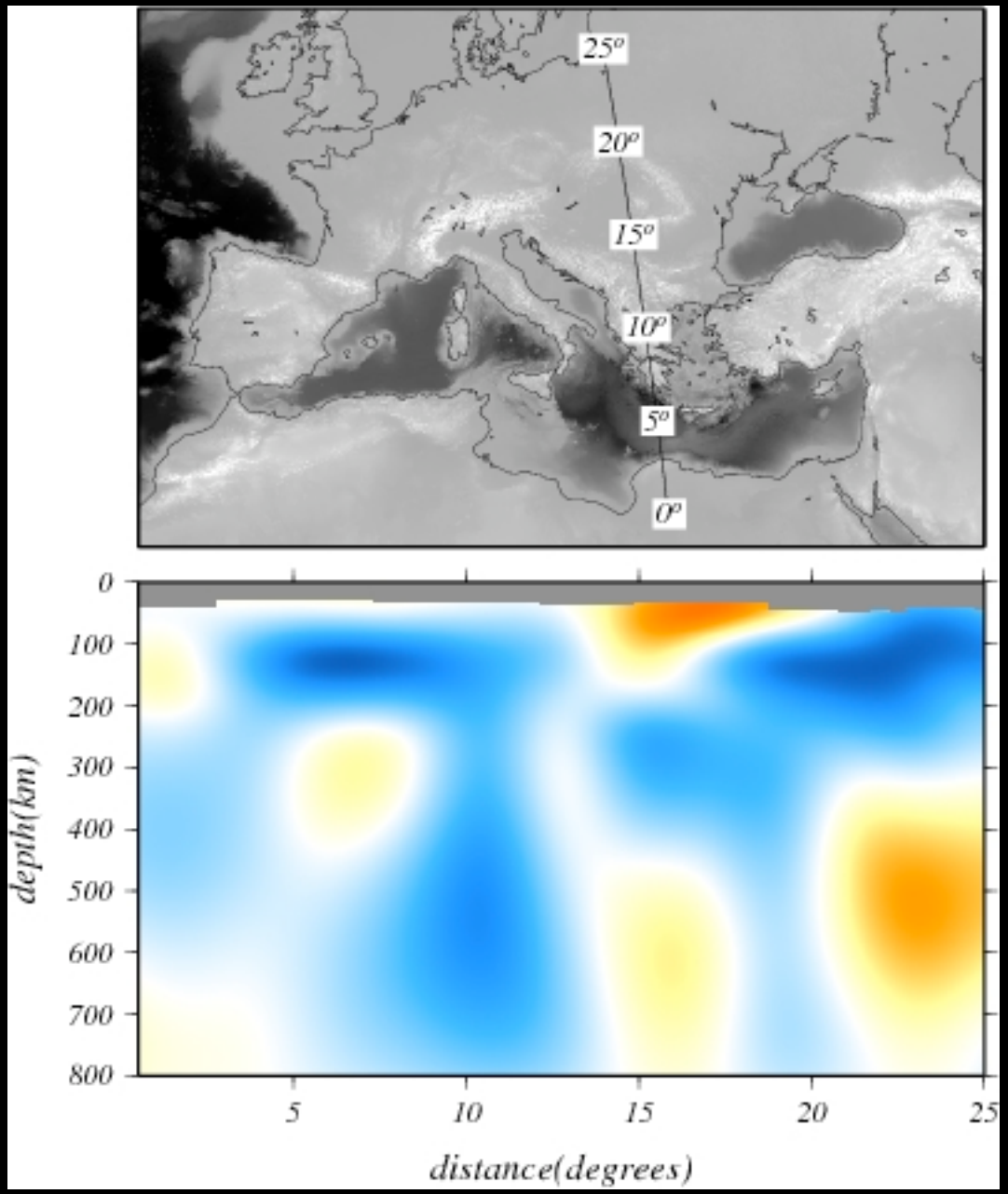
new model, vertical sections



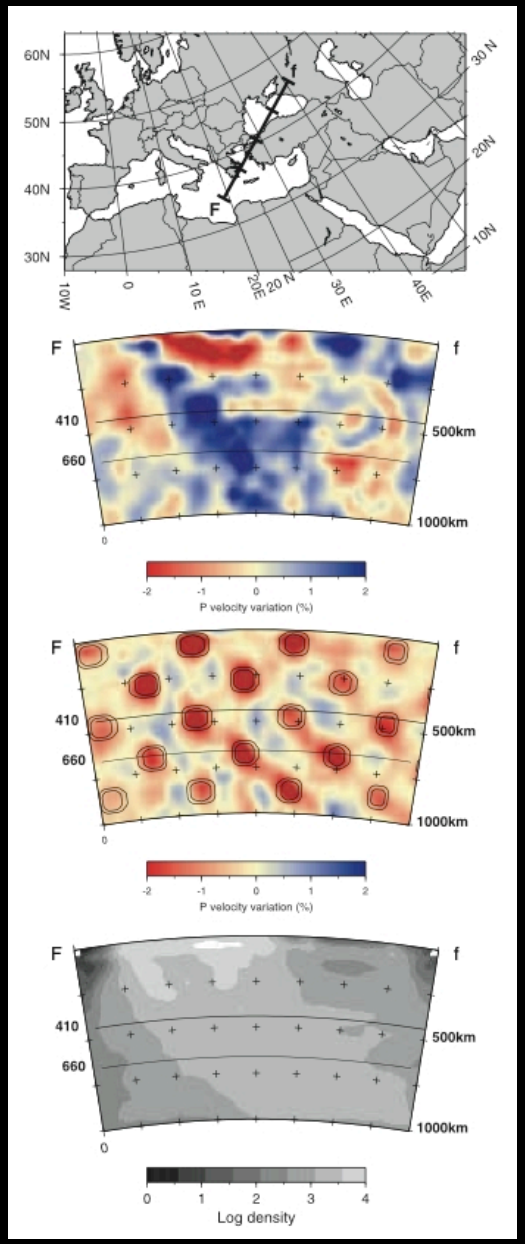
new model, vertical sections



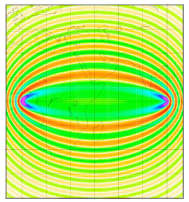
new model, vertical sections



Comparison with body-wave tomography



Piromallo & Morelli 2005



Sensitivity kernels (Fréchet derivatives, partial derivatives, banana-doughnuts…)

We assume a function K exists such that phase anomaly is linearly related to phase velocity perturbations:

$$\frac{\delta\phi}{\phi} = \int_{\Omega} K(\theta,\varphi)\frac{\delta v}{v}(\theta,\varphi)d\Omega$$

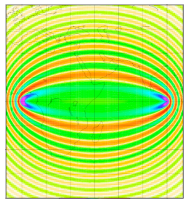
Phase velocity perturbations (unknown):

$$\frac{\delta\phi}{\phi} = \int_{\Omega} K(\theta,\varphi)\frac{\delta v}{v}(\theta,\varphi)d\Omega$$

Sensitivity kernel (can be calculated):

$$\frac{\delta\phi}{\phi} = \int_{\Omega} K(\theta,\varphi)\frac{\delta v}{v}(\theta,\varphi)d\Omega$$

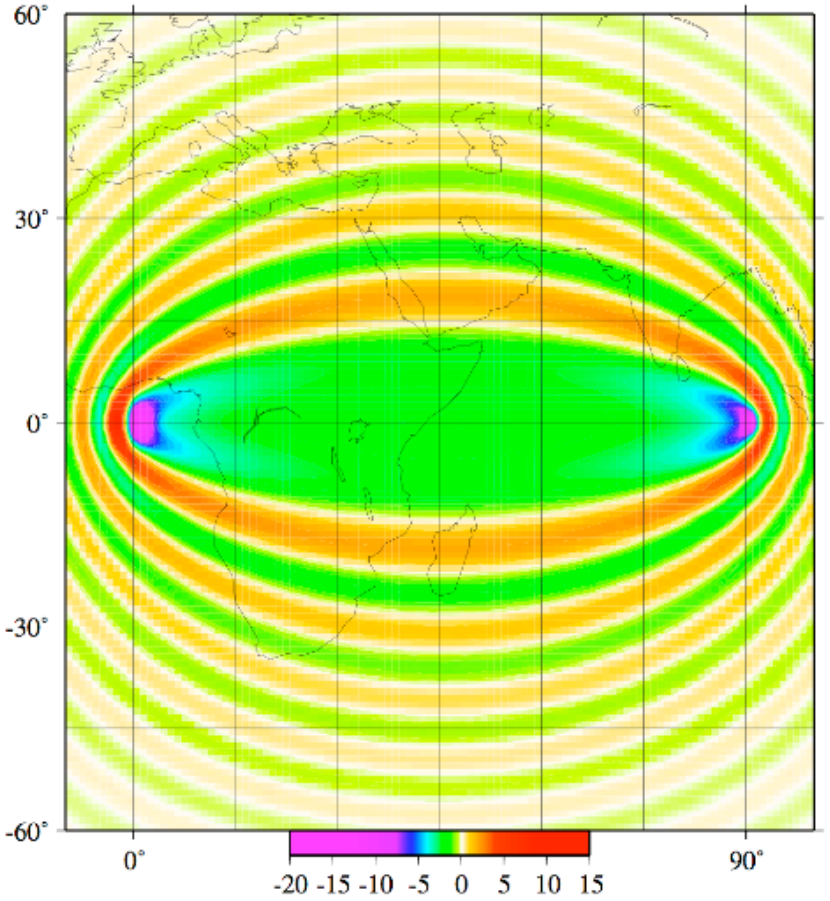
Peter, Tape, Boschi, Woodhouse, 2007



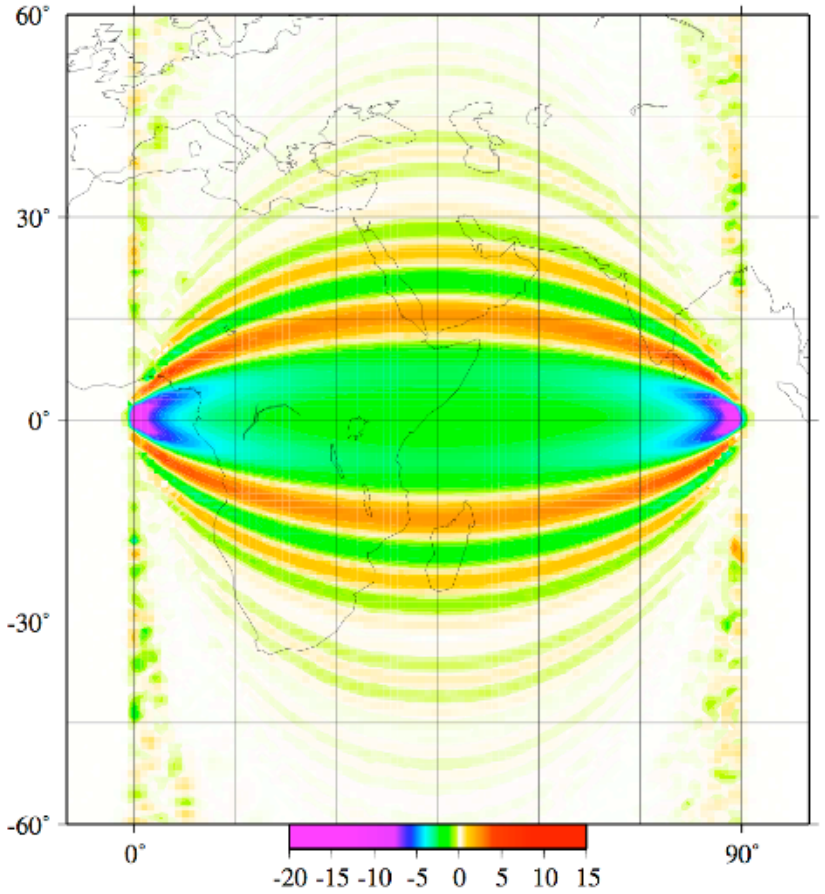
Sensitivity kernels: how they look like

Love waves, 150 s period. Source and receiver on the equator, 90° apart. Reference model is PREM.

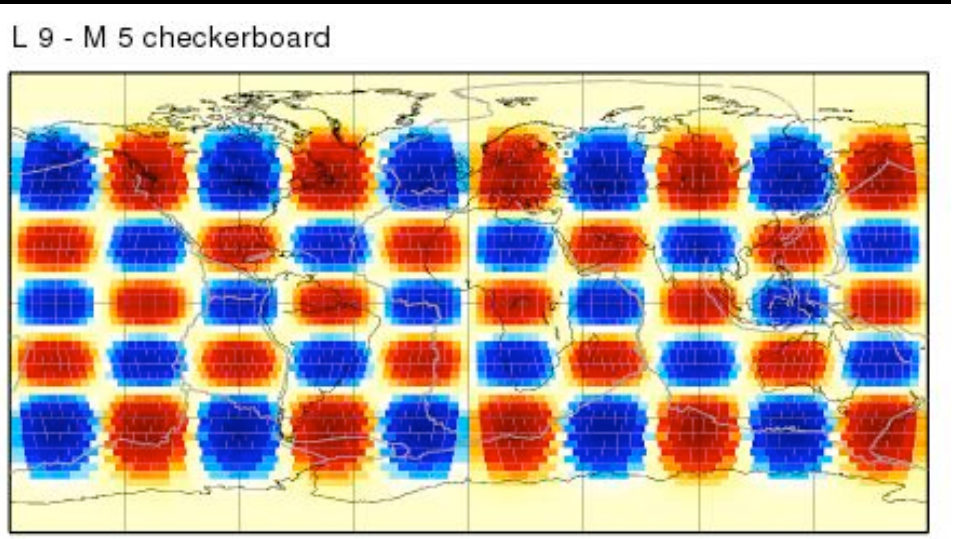
adjoint method (membrane waves)

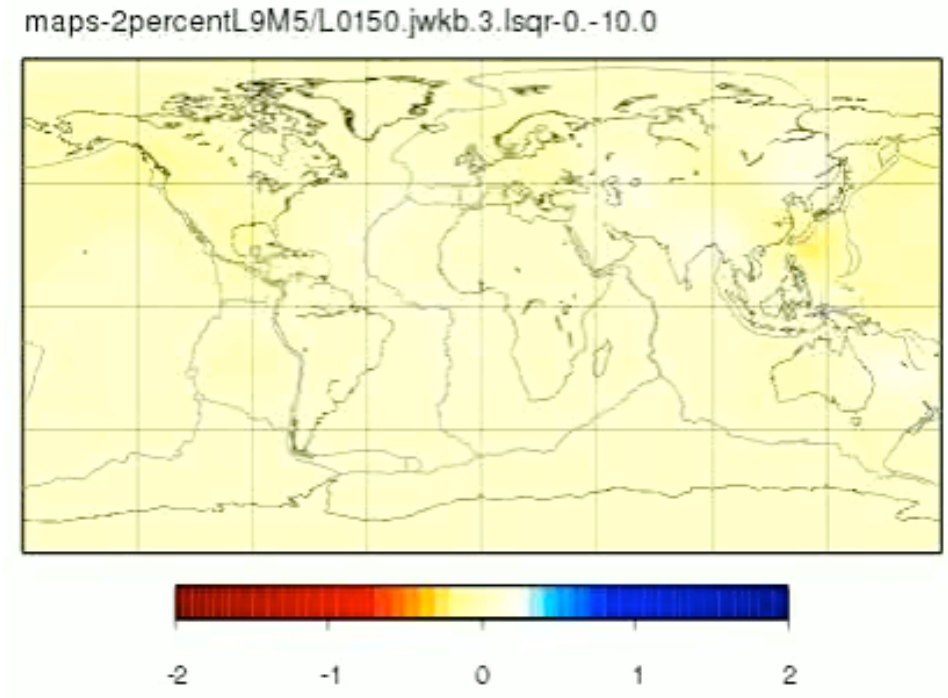


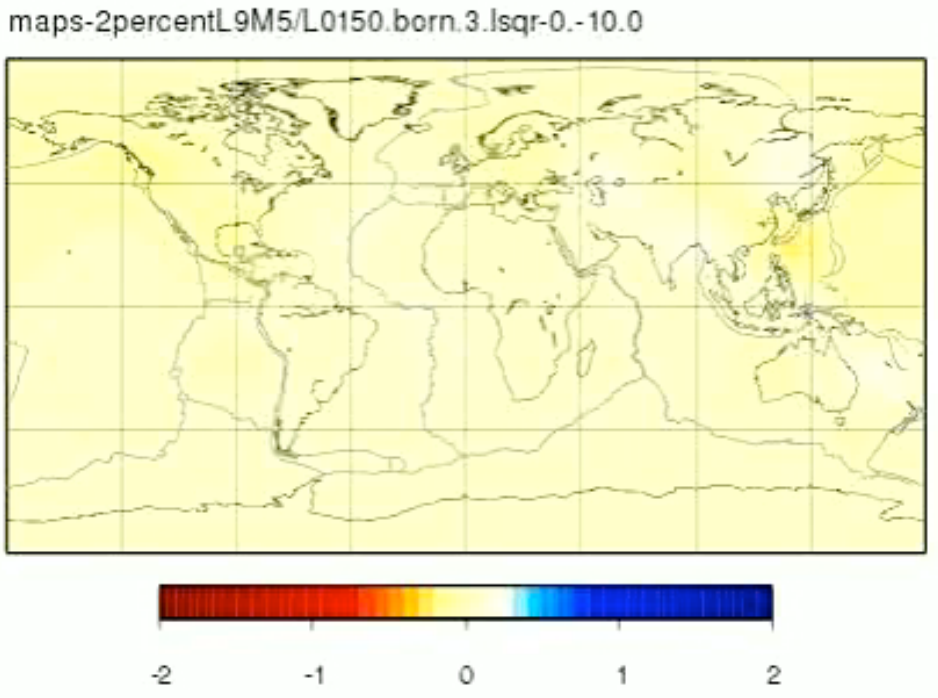
analytical kernel from e.g. Spetzler et al. (2002)



"benchmark" test: long spatial wavelength anomalies

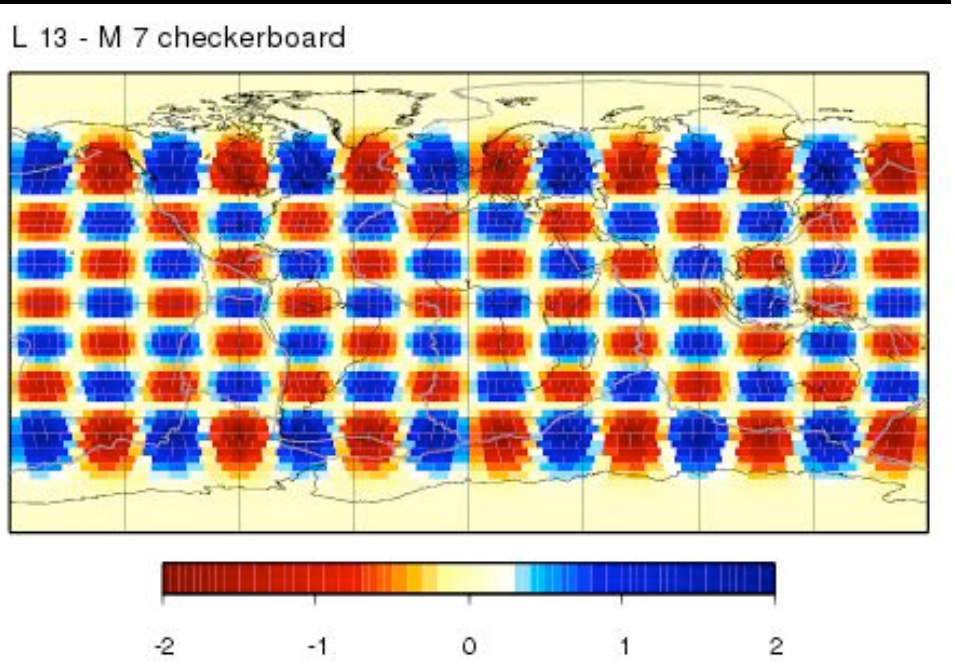


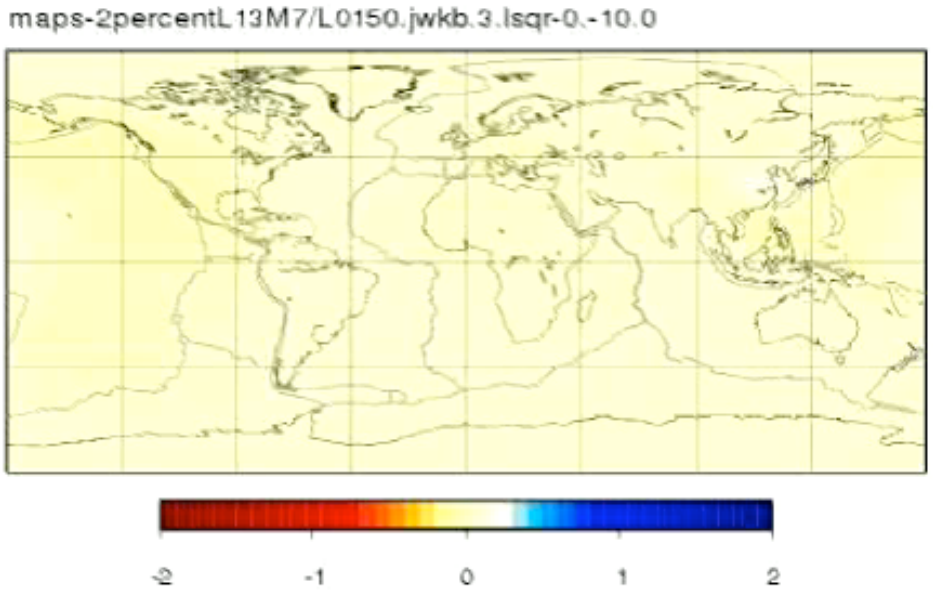


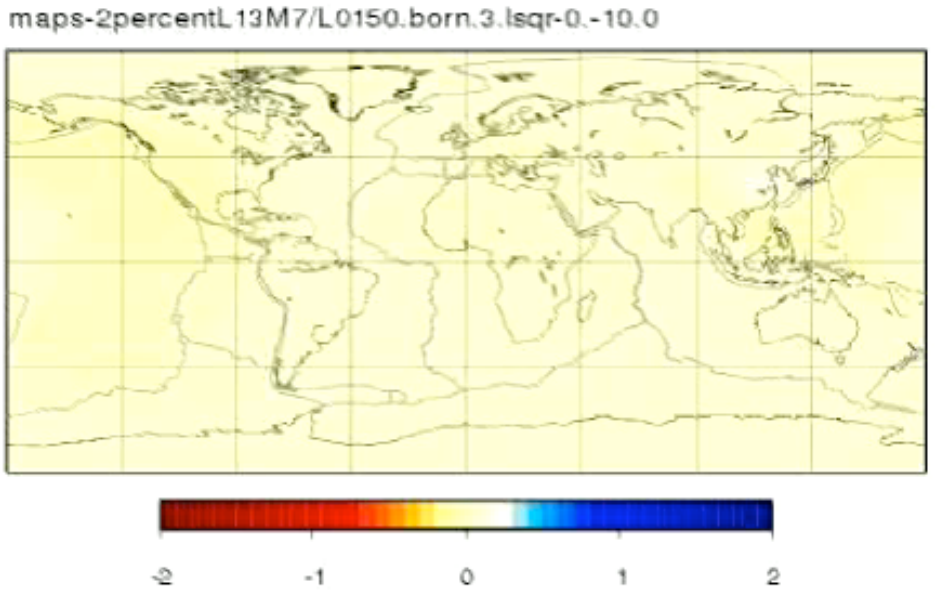


Peter, Boschi & Woodhouse, 2008

"benchmark" test: shorter spatial wavelength anomalies

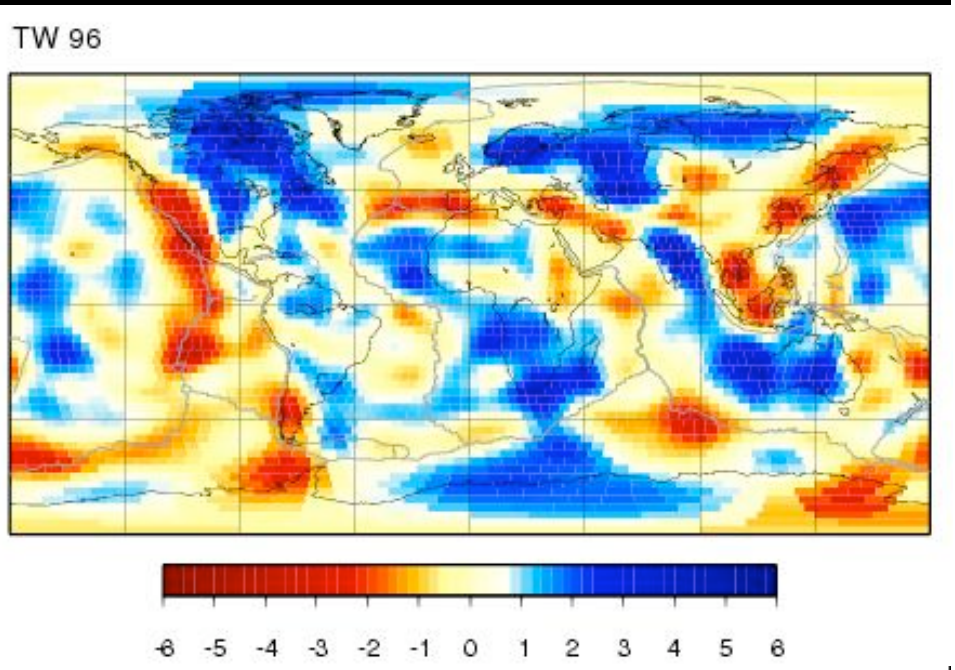


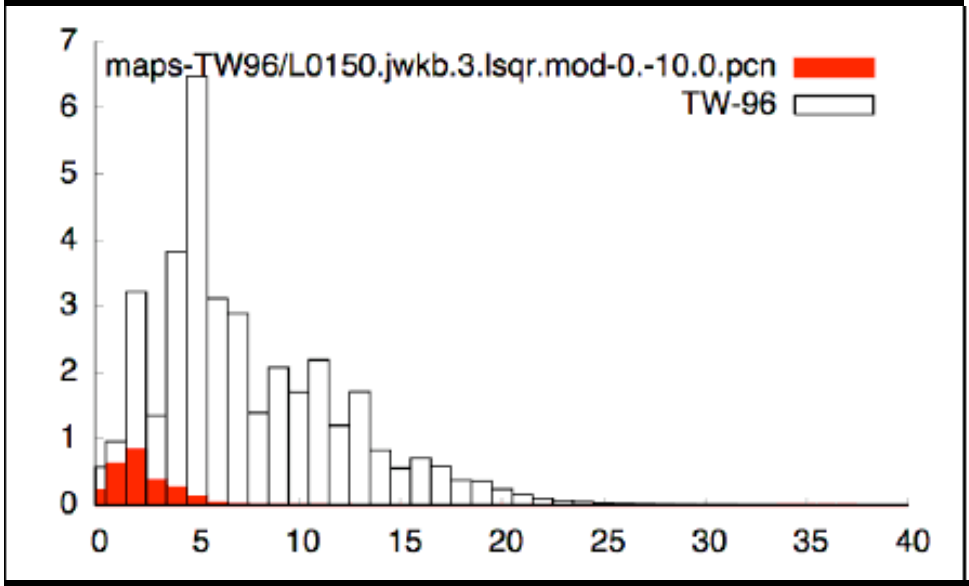


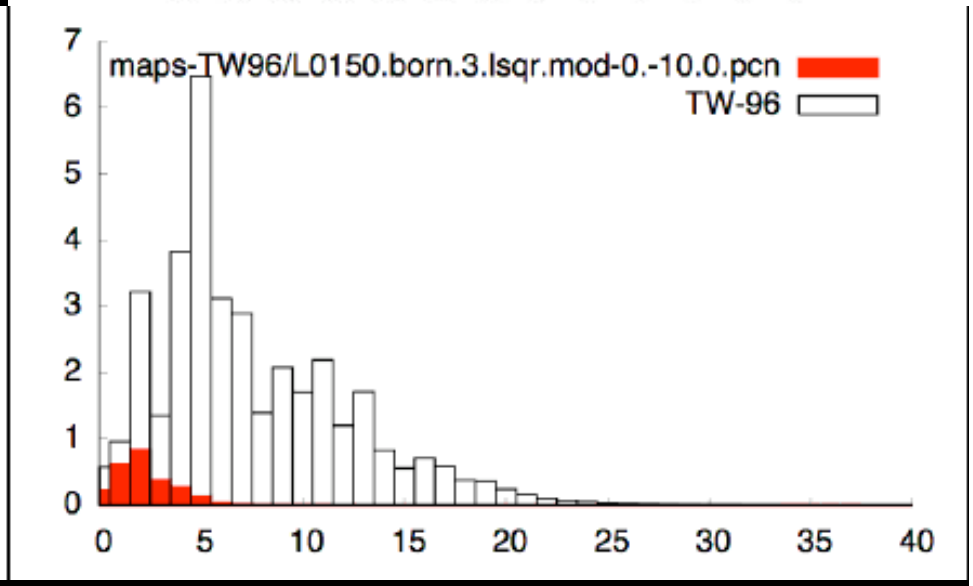


Peter, Boschi & Woodhouse, 2008

"benchmark" test: realistic "input" model

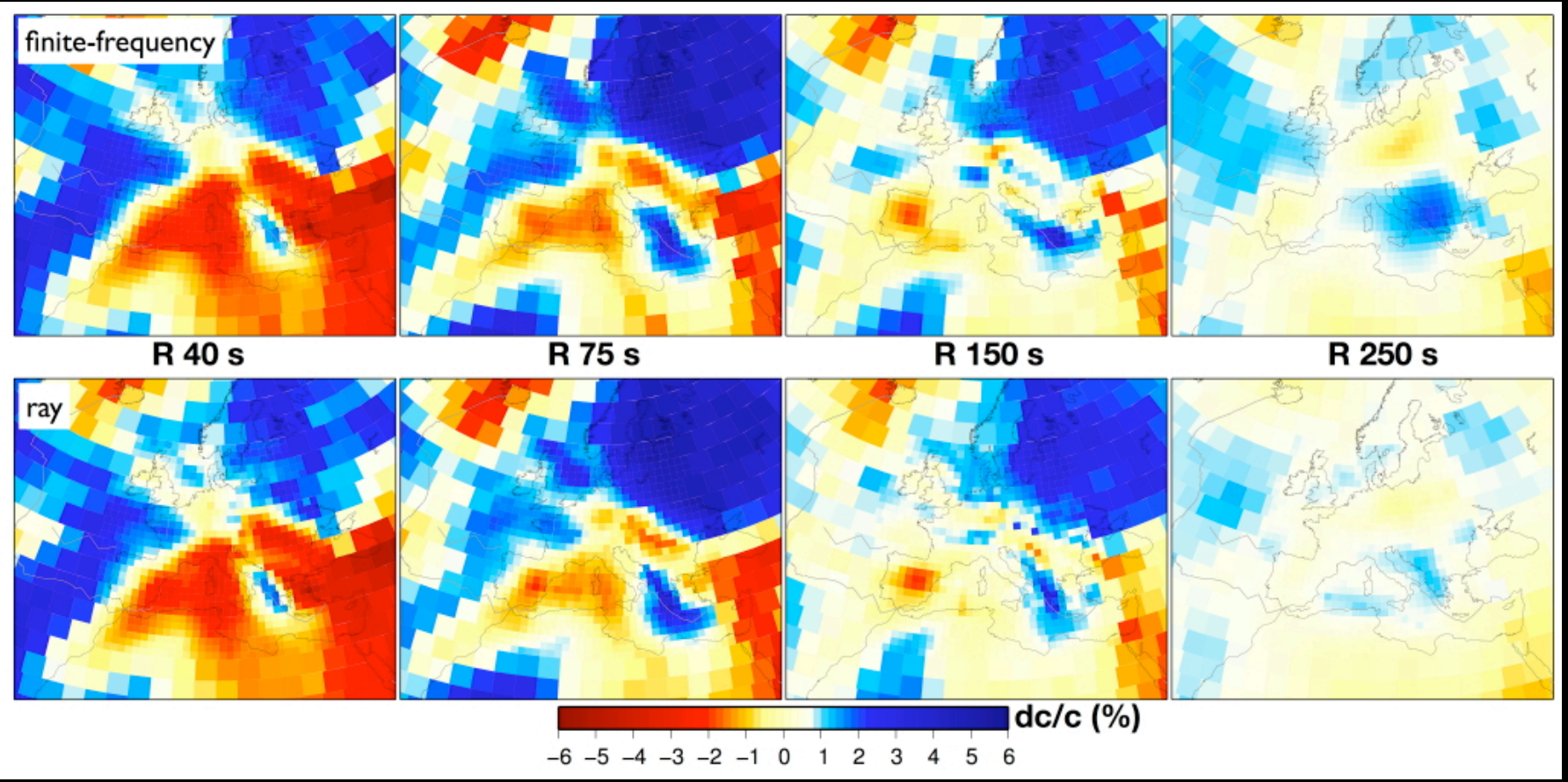






Peter, Boschi & Woodhouse, 2008

Ray and adjoint-method modeling of European upper mantle SV velocity

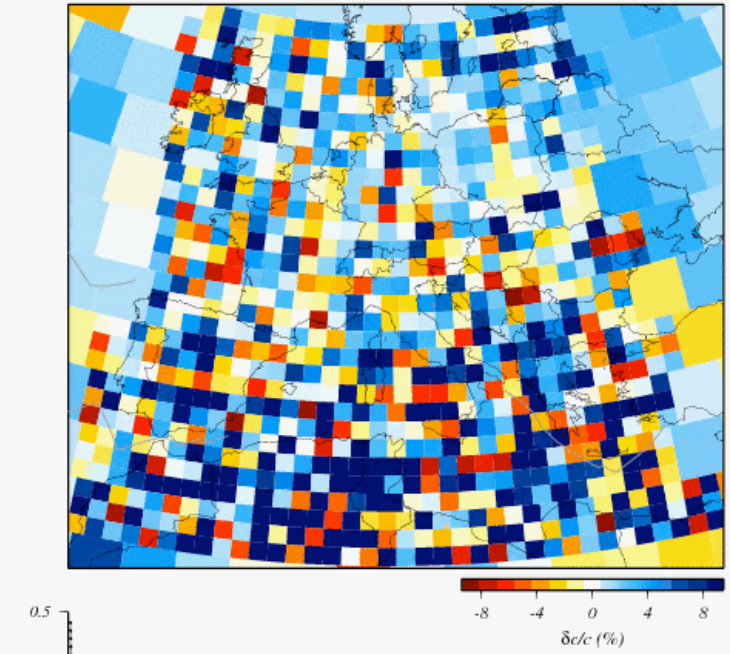


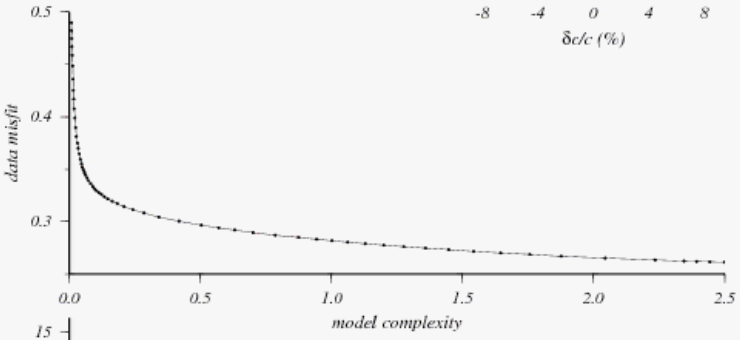
Peter, Fry, Boschi, Deschamps, Ekström, Giardini 2008

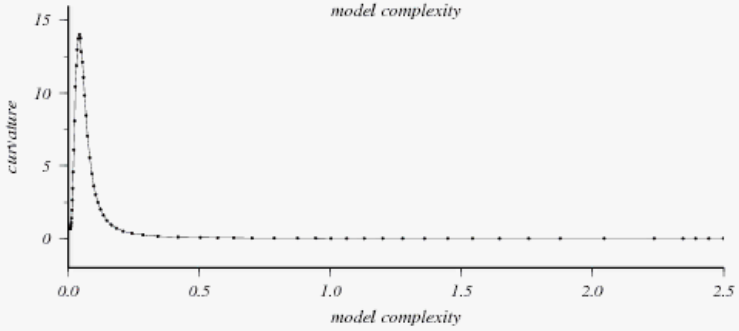
RAY

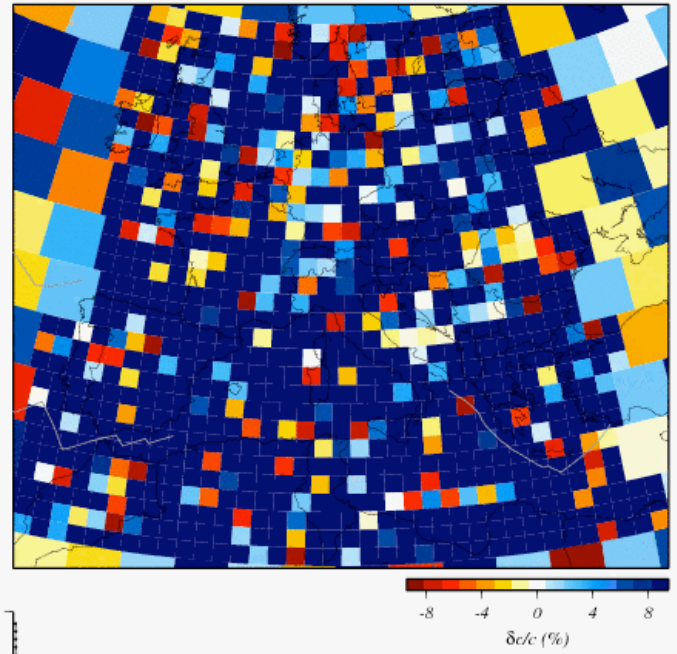
R150

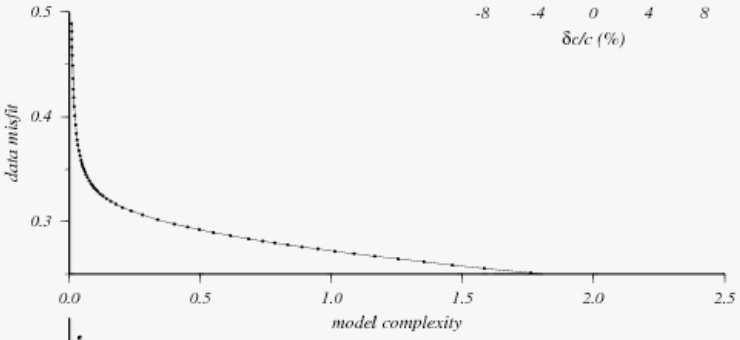
RYTOV

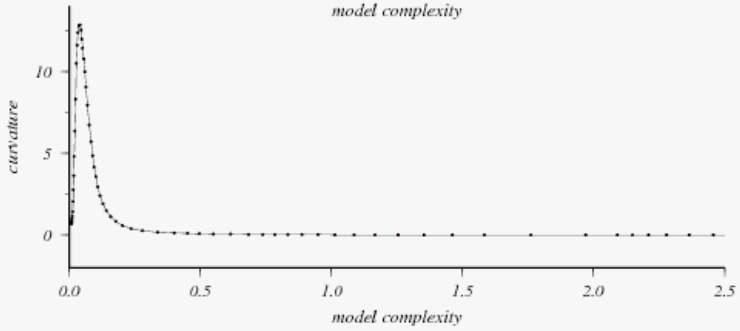




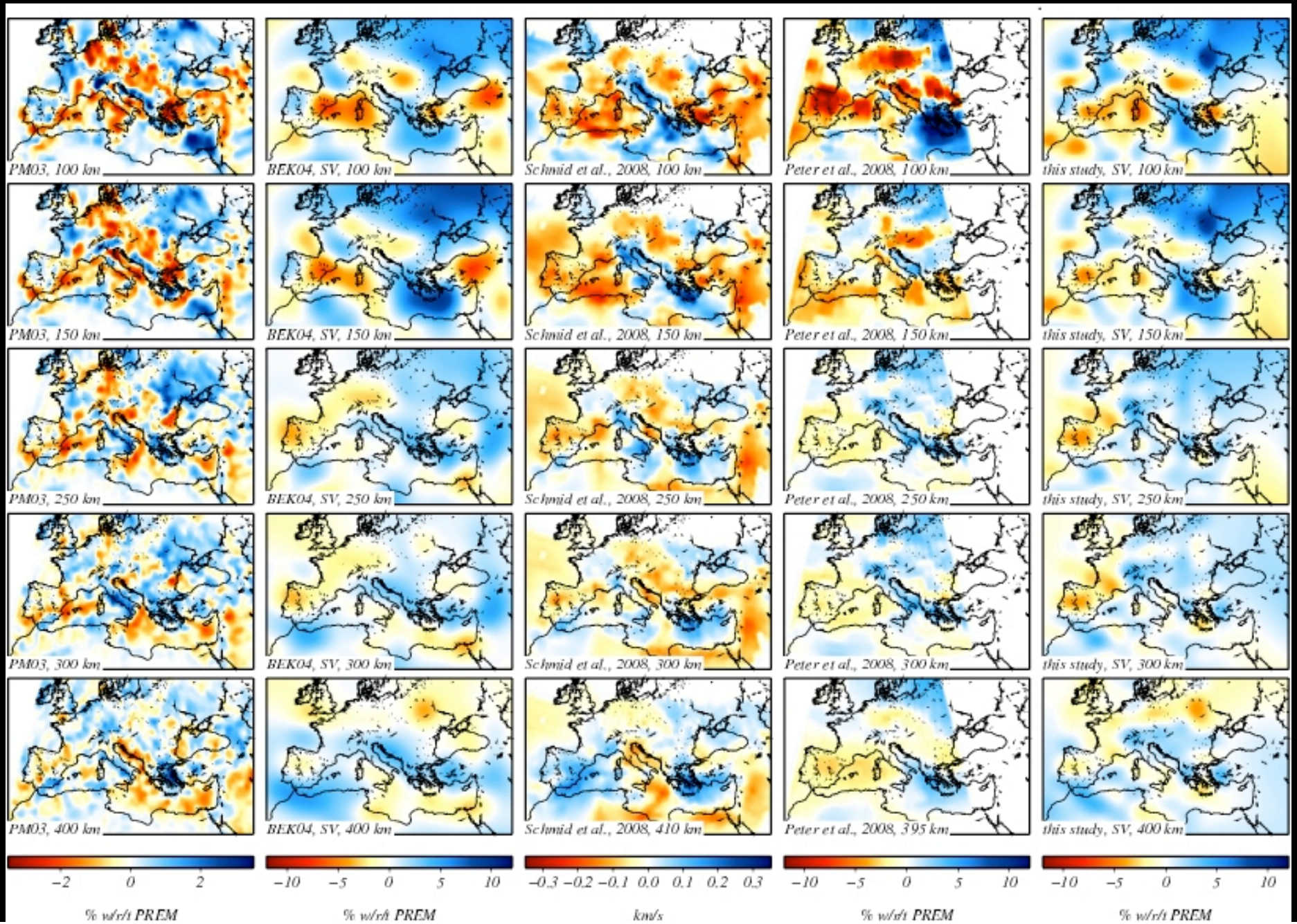




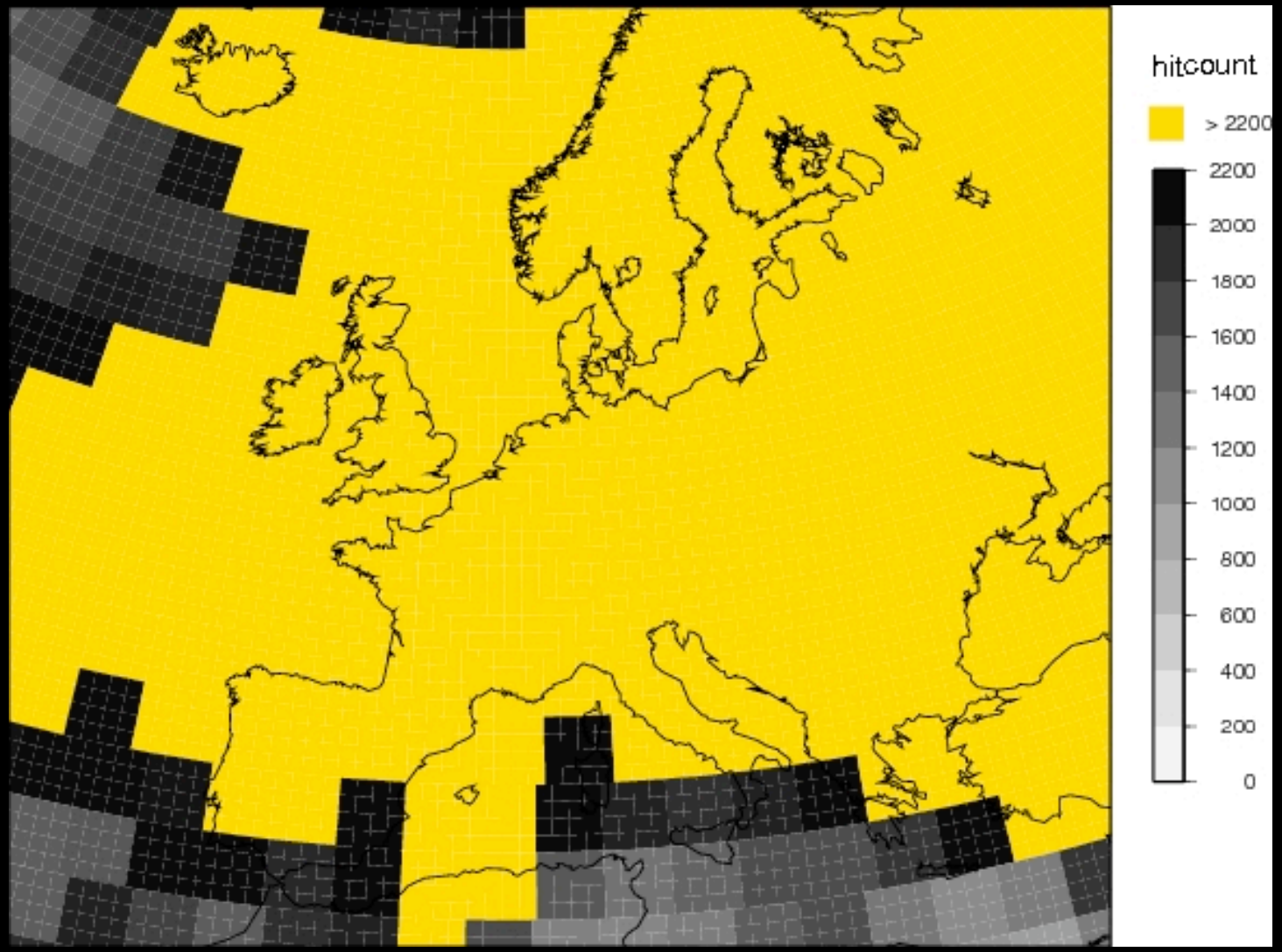




European tomography: state of the art

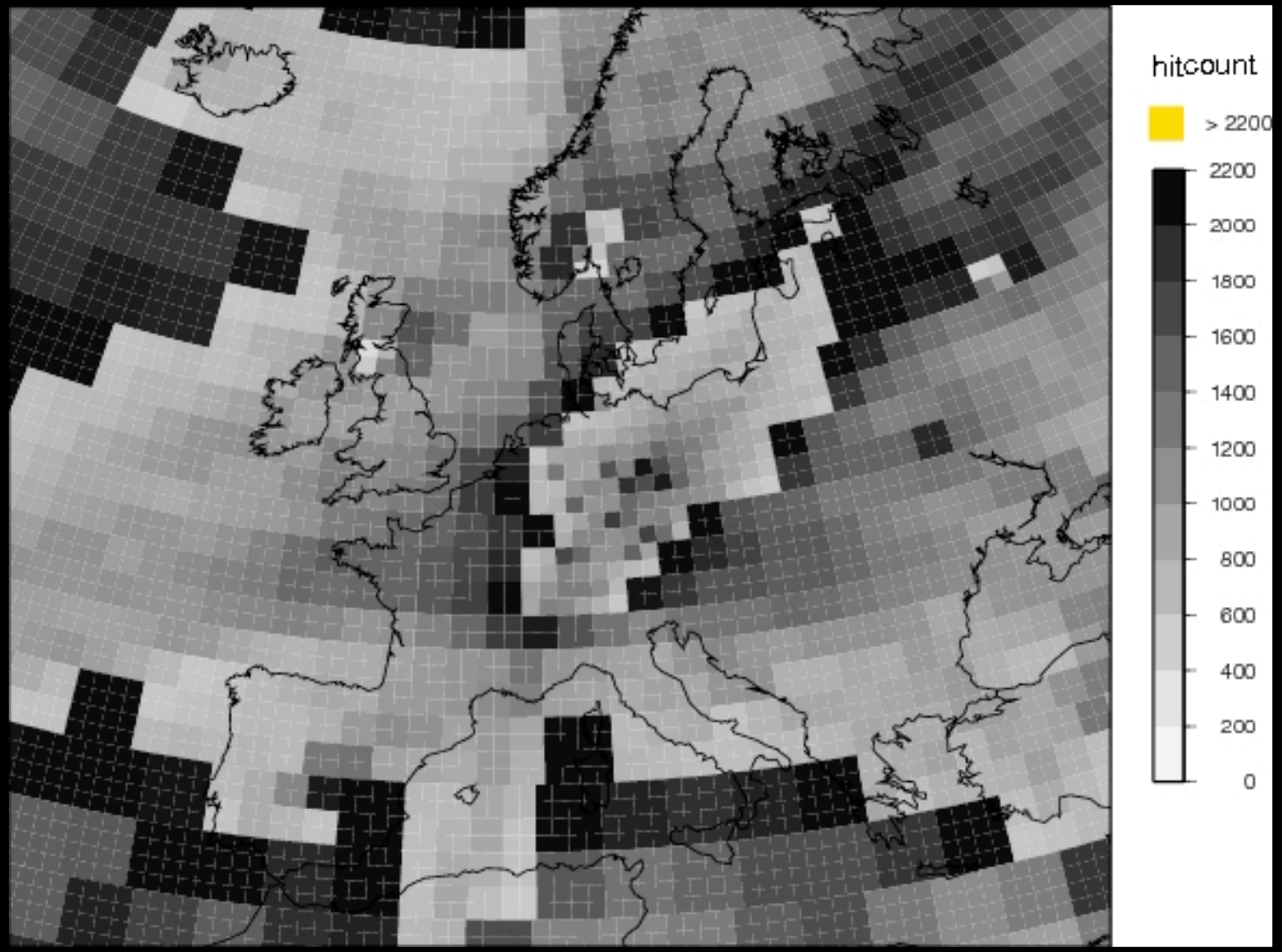


adaptive-resolution tomography



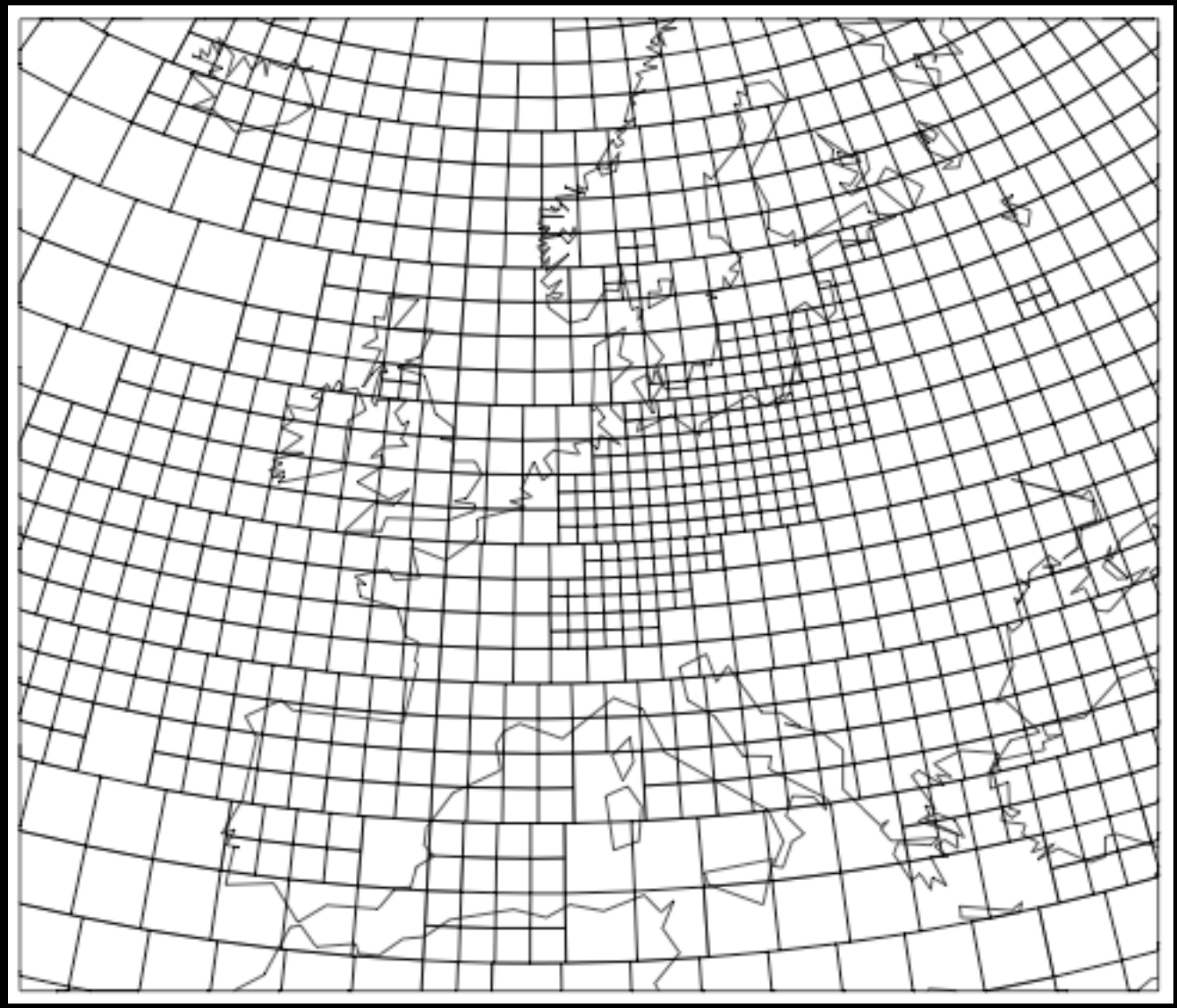
Julia Schäfer, 2009

adaptive-resolution tomography



Julia Schäfer, 2009

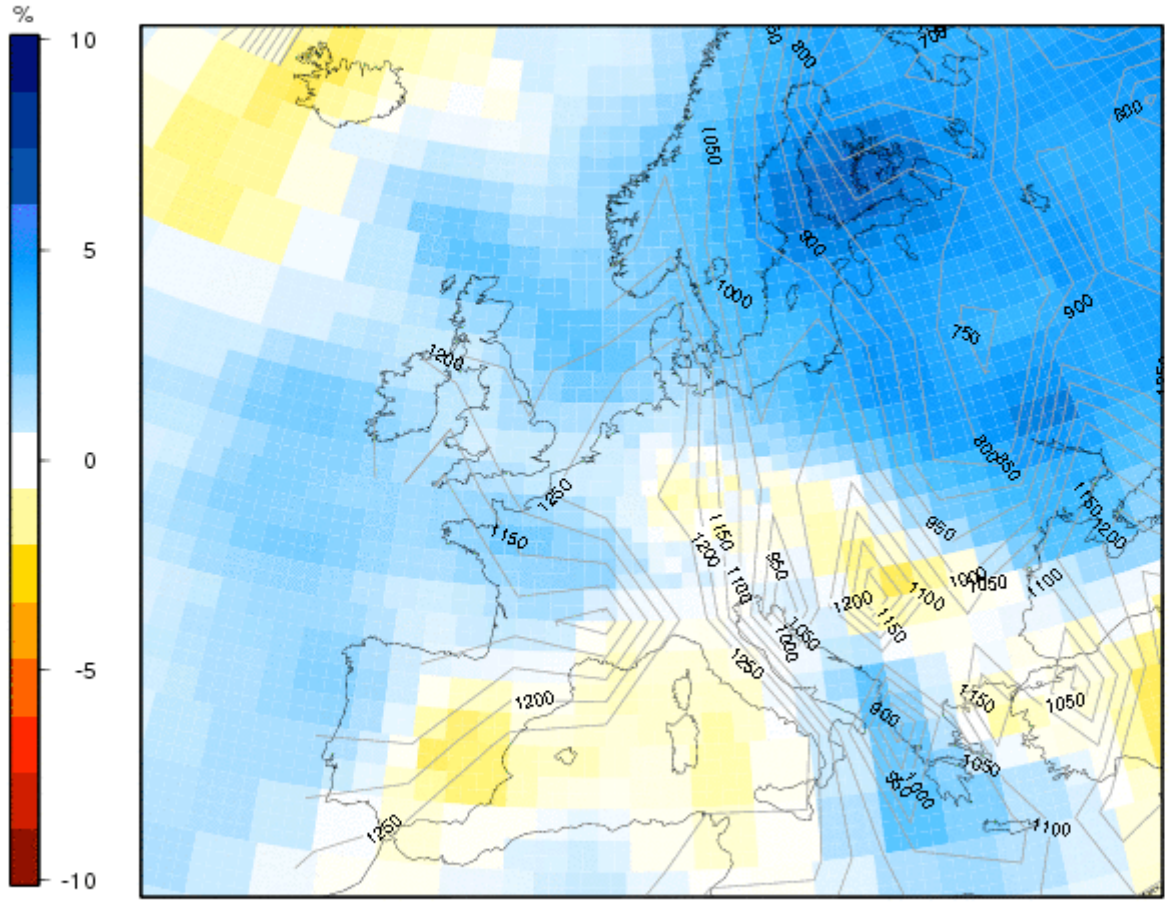
adaptive-resolution tomography



Julia Schäfer, 2009

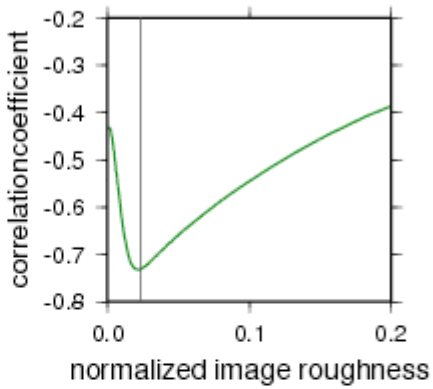
adaptive-resolution tomography

Rayleigh 75s and thermal thickness of lithosphere

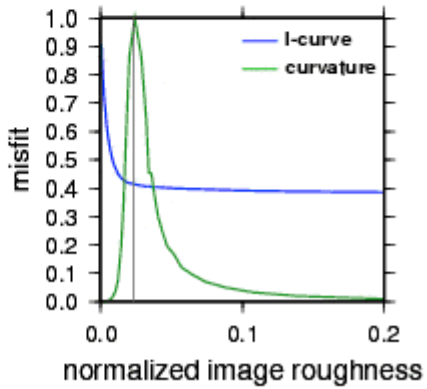


isolines represent temperature at 100 km depth
(geothermal data: TC 1, Artemieva, 2006)

correlation with temperature at 100km depth

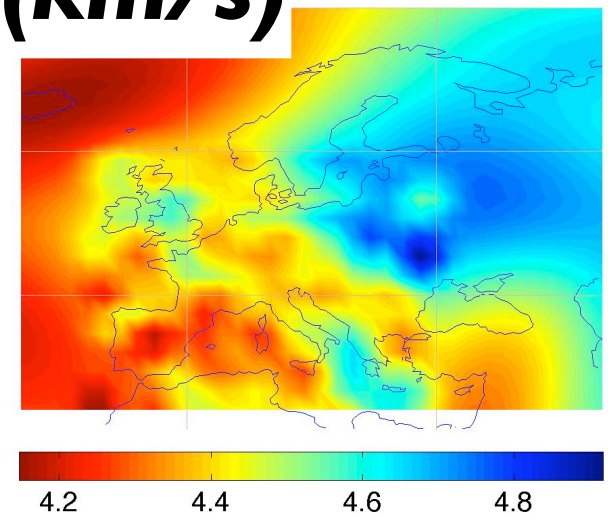


l-curve



Julia Schäfer, 2009

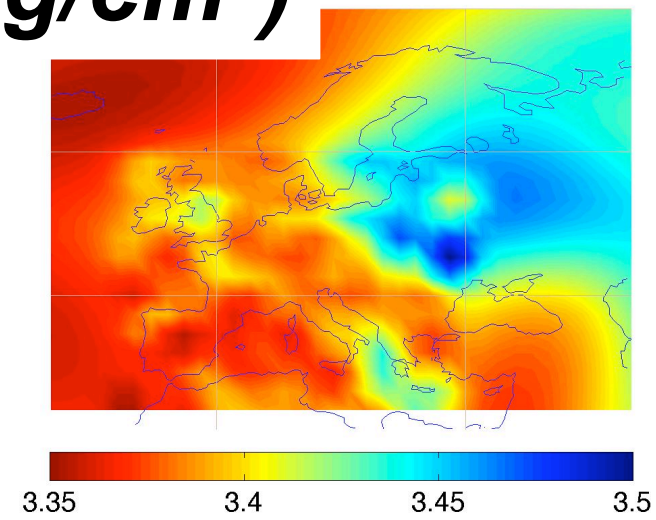
V_S (km/s)



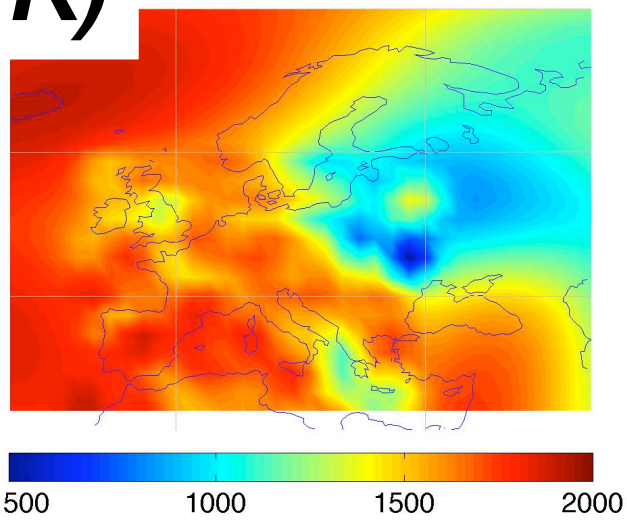
identifying temperature and density distributions

150 km depth

ρ (g/cm^3)



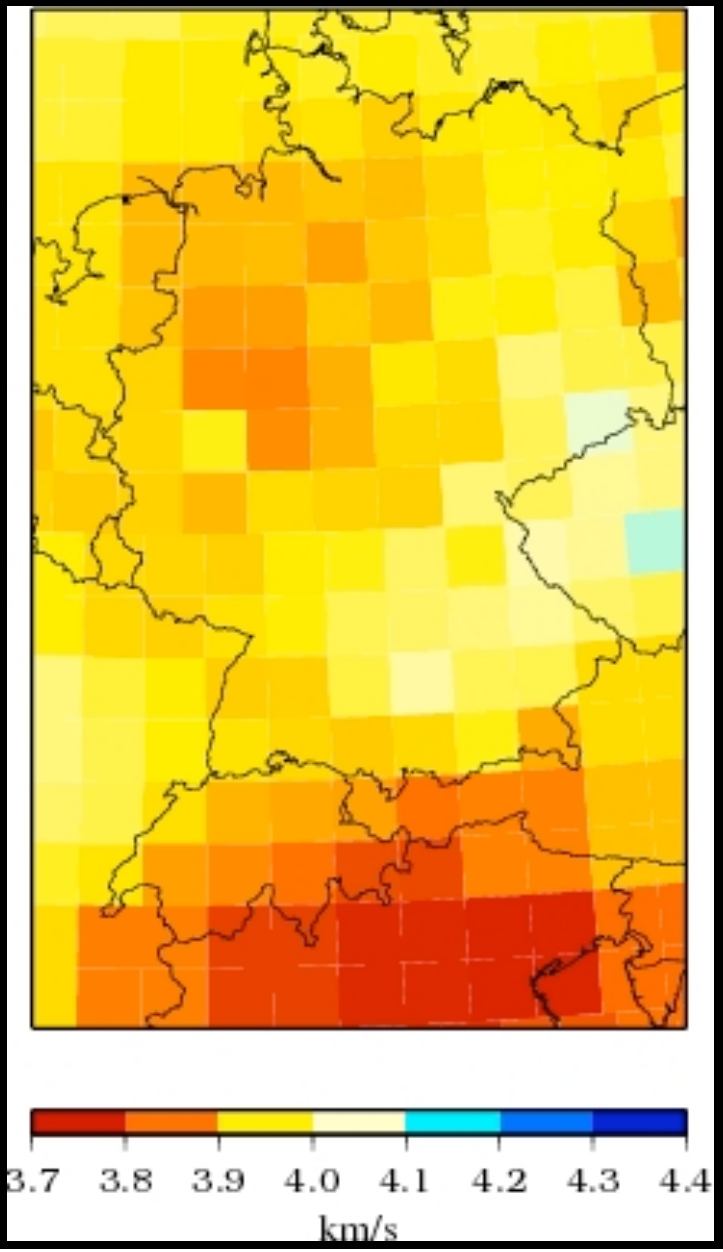
T (°K)



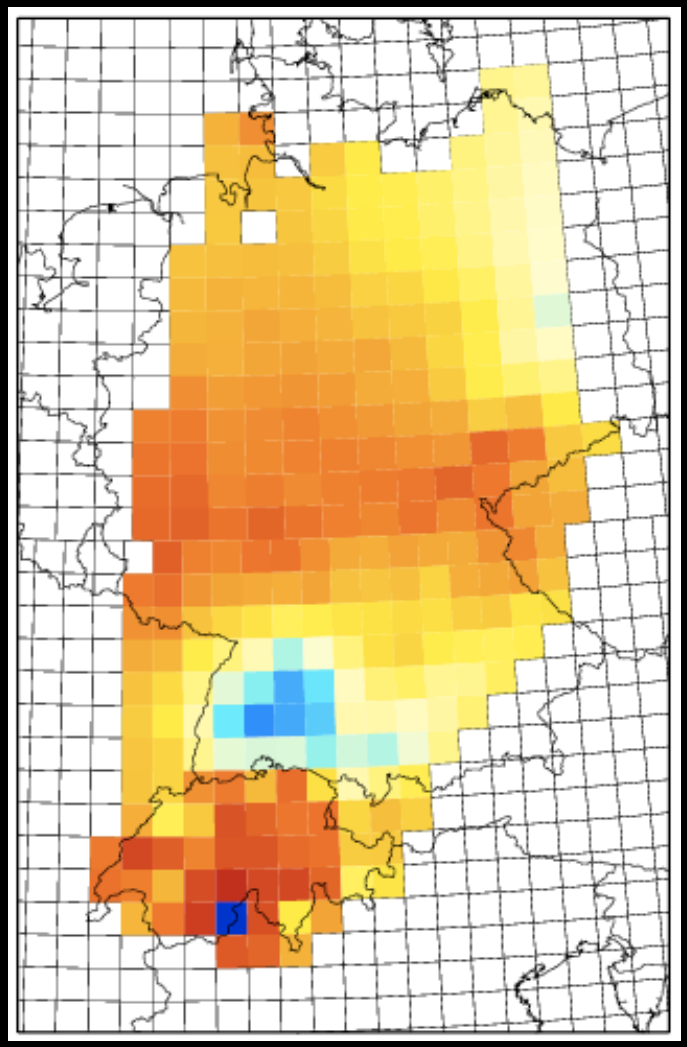
collaboration with F. Cammarano

contribution from ambient noise data

teleseismic data



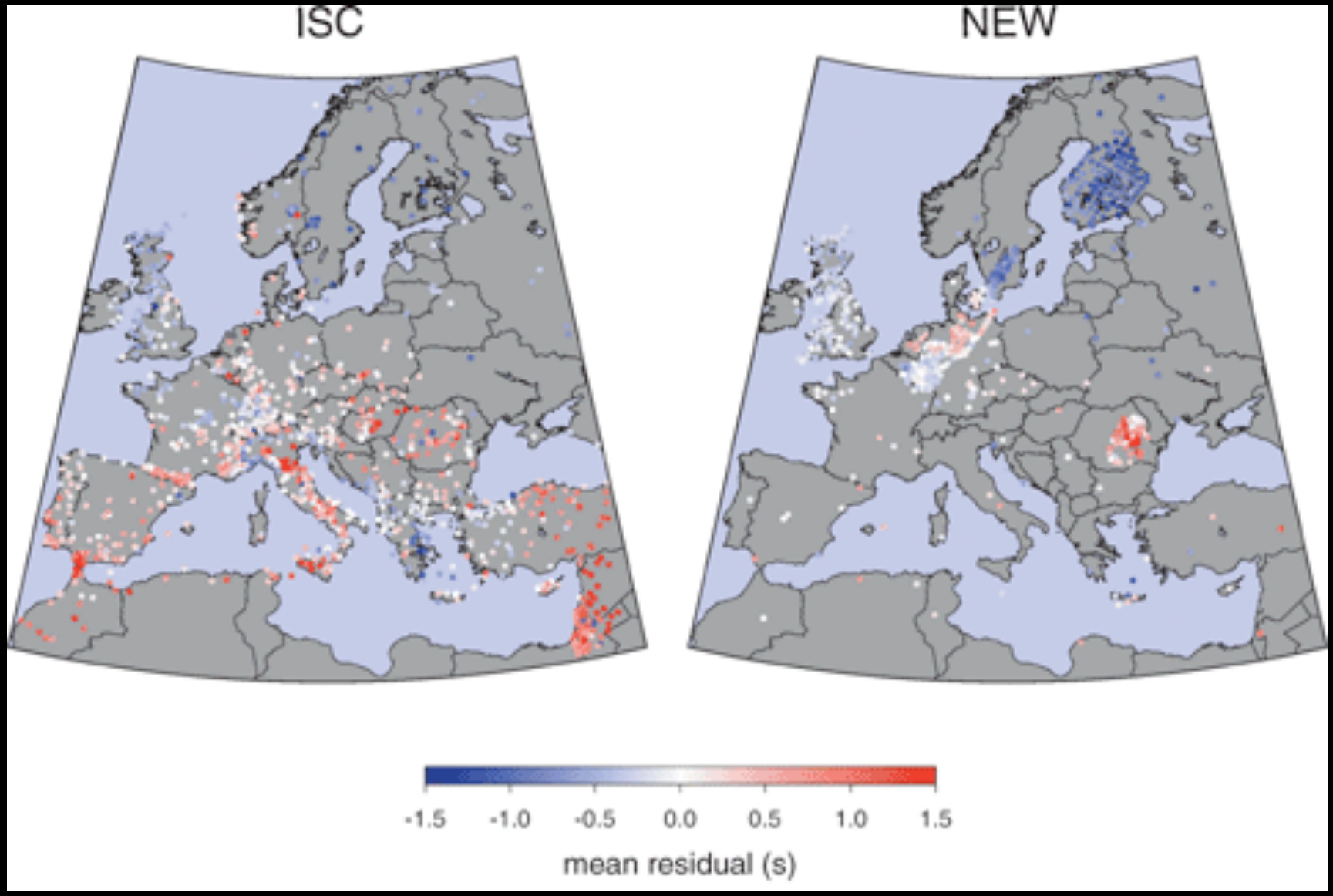
ambient-noise data



Rayleigh 35s phase velocity

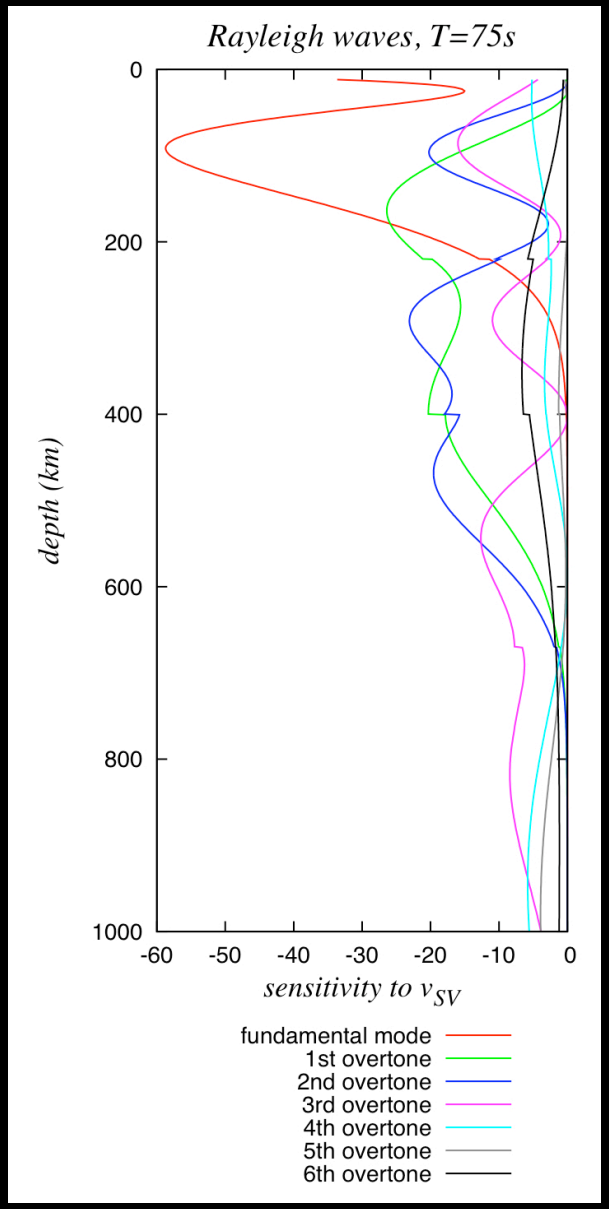
Julie Verbeke, Edi Kissling

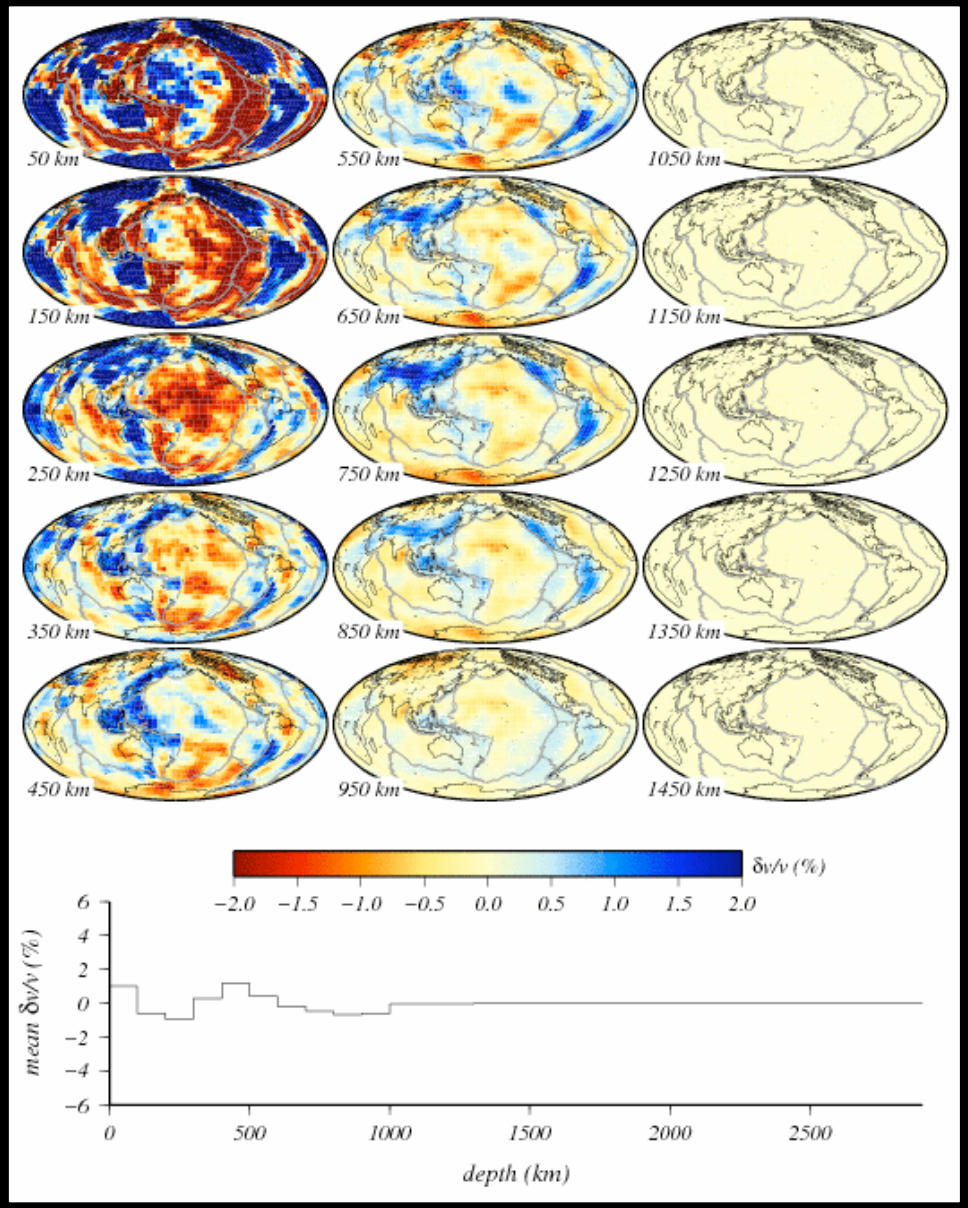
contribution from body-wave data



Amaru, Kissling and others 2008

contribution from surface-wave overtone data



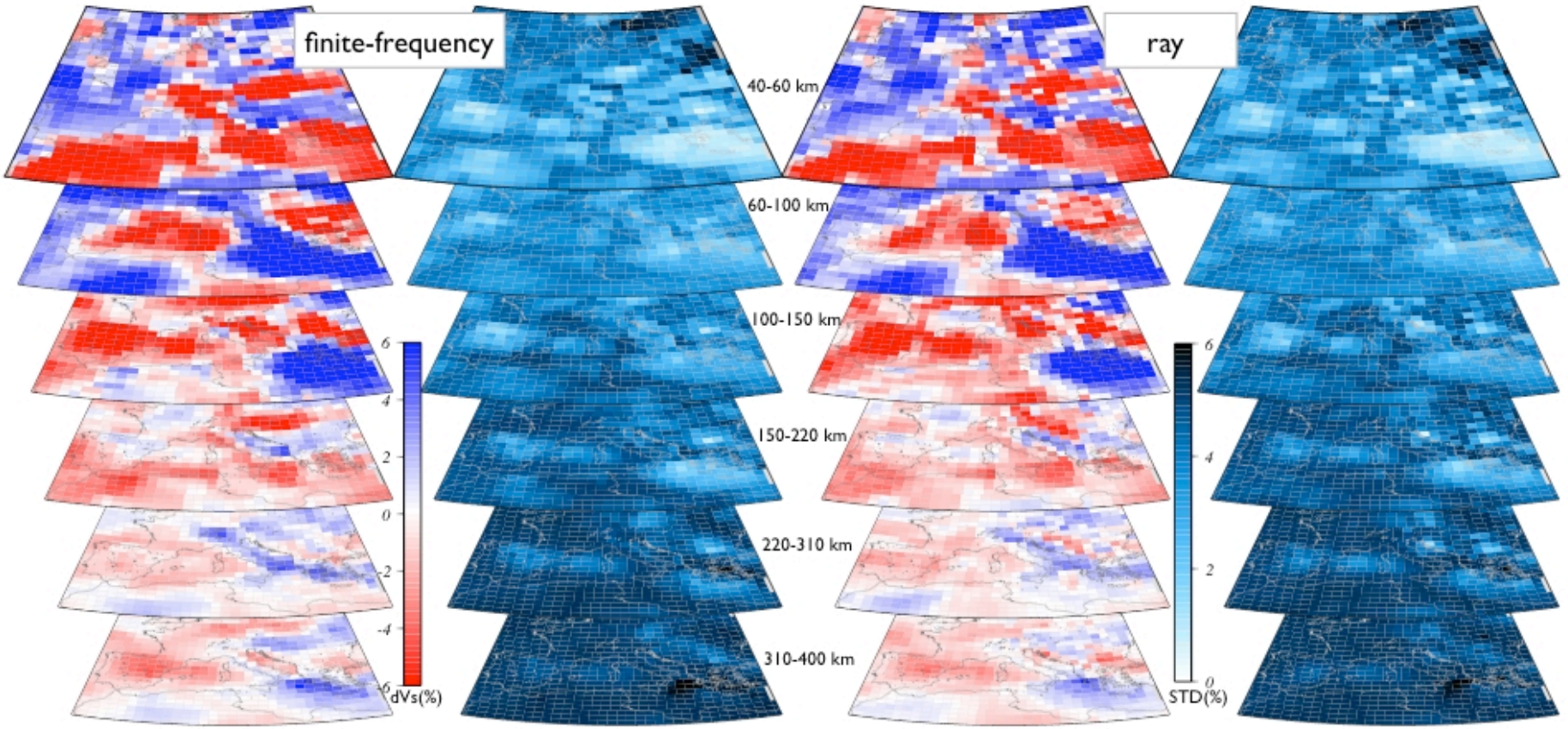


collaboration with J. Trampert

Thank you

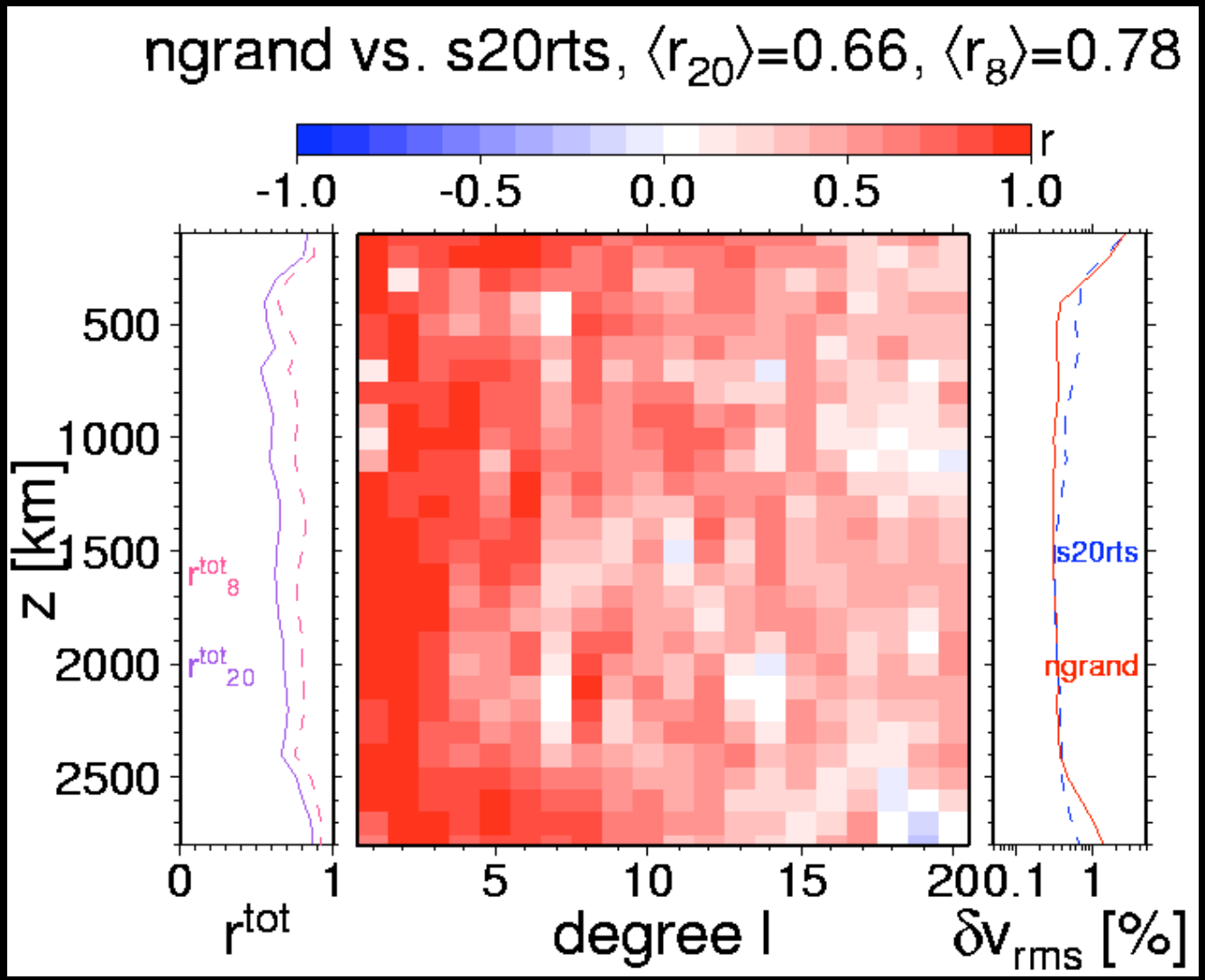
additional slides

ray and adjoint-method modeling of European upper mantle SV velocity



Peter, Fry, Boschi, Deschamps, Ekström, Giardini 2008

Correlation between two Vs models, as a function of depth and harmonic degree



Becker and Boschi, 2002-present

Next Up Previous
Next: 6. Summary of average **Up:** Becker & Boschi: Comparison **Previous:** 4. Radial correlation

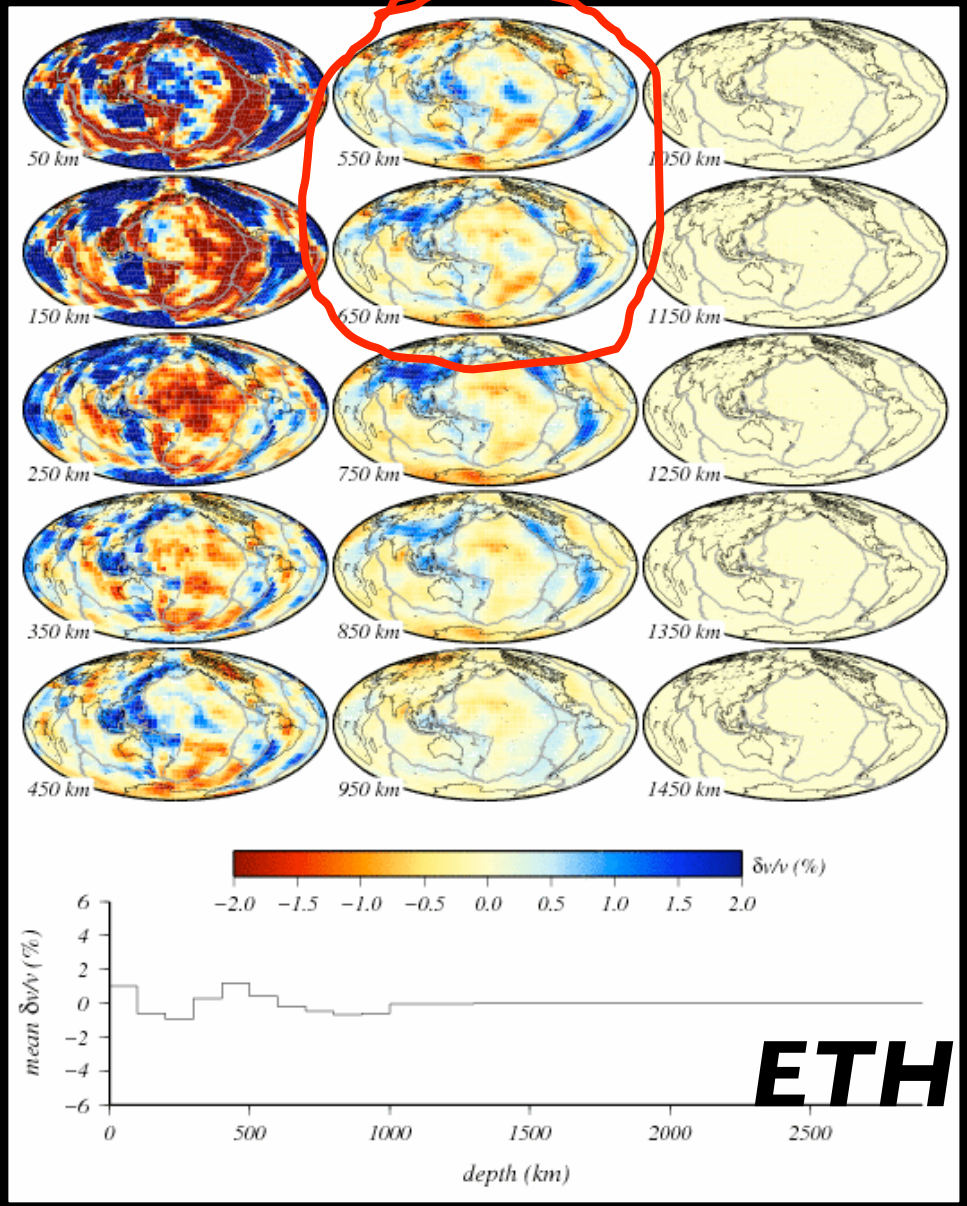
5. Cross-model correlation plot matrix

The following matrix makes all combinations of cross-model correlation plots available. Click on the icons to bring up the corresponding correlation plot.

	pmean	hwe97p	kh00p	bdp98	bdp00	pb10l18	smean	grand	ngrand	s20rts	saw24b16	sb10l18	sb4l18	s20a	s362d1	rum	lrr98d	stb00d
pmean	-																	
hwe97p	plot	-																
kh00p	plot	plot	-														
bdp98	plot	plot	plot	-													
bdp00	plot	plot	plot	plot	-												
pb10l18	plot	plot	plot	plot	plot	-											
smean	plot	plot	plot	plot	plot	plot	-										
grand	plot	plot	plot	plot	plot	plot	plot	-									
ngrand	plot	plot	plot	plot	plot	plot	plot	plot	-								
s20rts	plot	plot	plot	plot	plot	plot	plot	plot	plot	-							
saw24b16	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	-						
sb10l18	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	-					
sb4l18	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	-				
s20a	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	-			
s362d1	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	-		
rum	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	-		
lrr98d	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	-	
stb00d	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	plot	-

Becker and Boschi, 2002-present

contribution from surface-wave overtone data



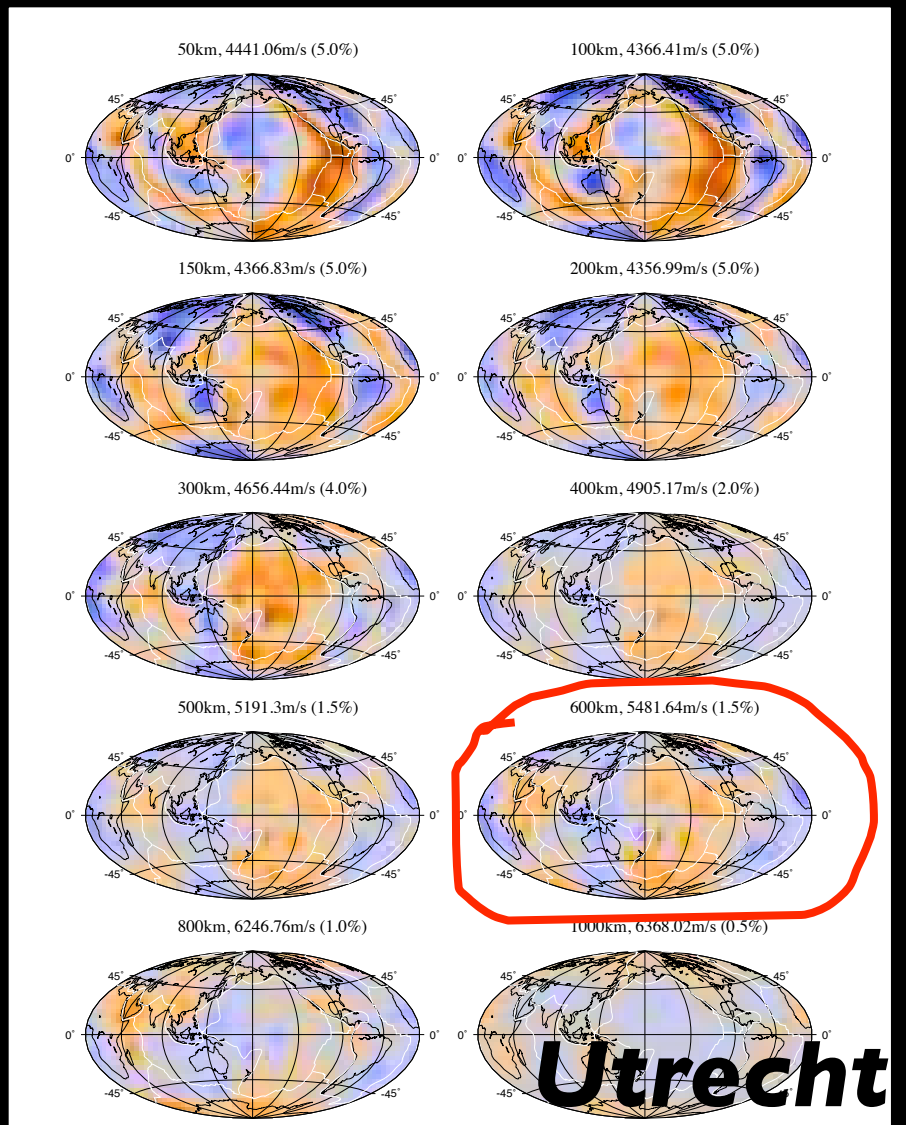
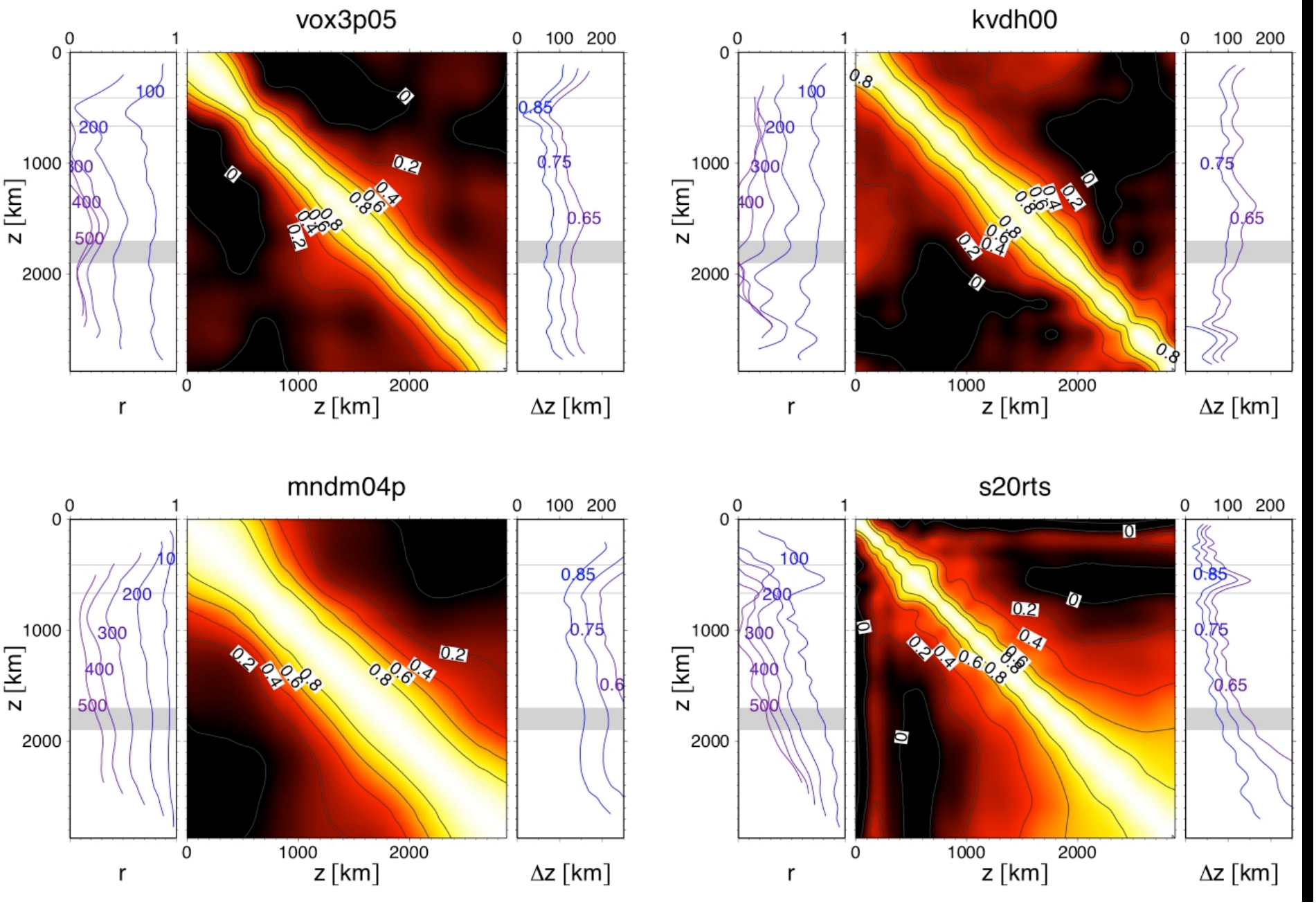


Figure C.3: *Relative vertically polarized shear wave velocity maps with respect to the mean as indicated. The maximum amplitude of the color scale is indicates in percent.*

collaboration with J. Trampert

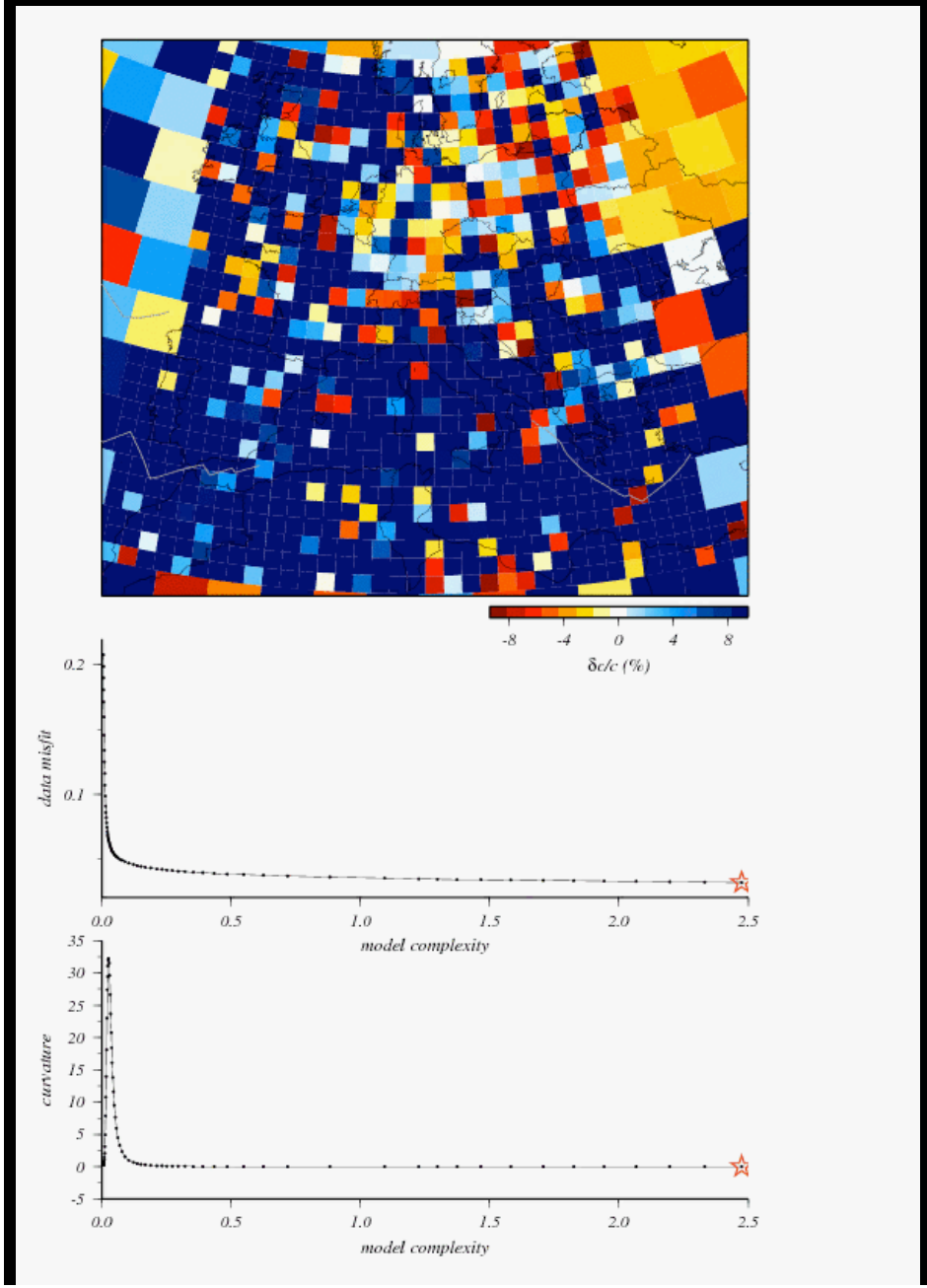
Radial coherence of tomographic images

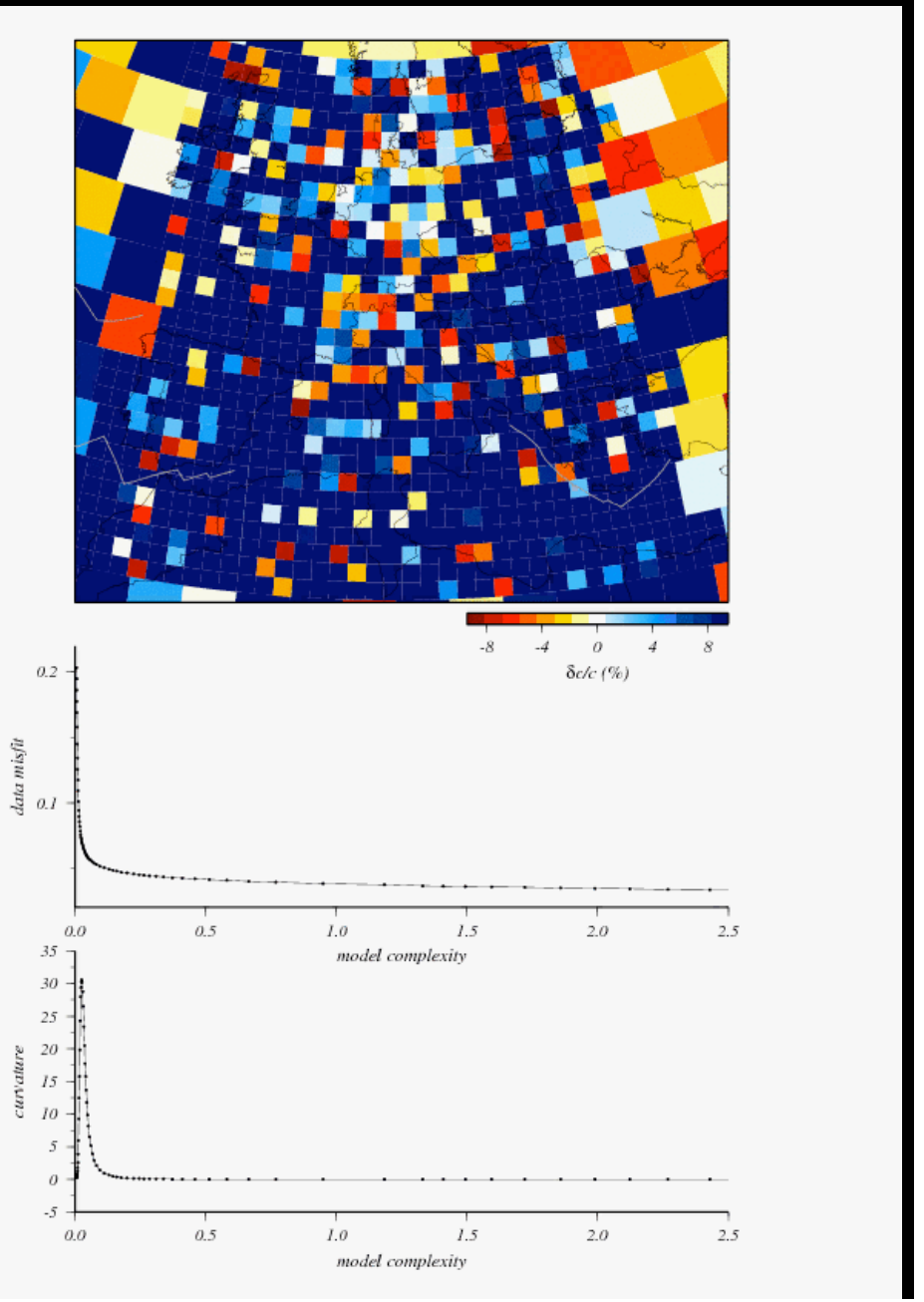


RAY

L35

RYTOV

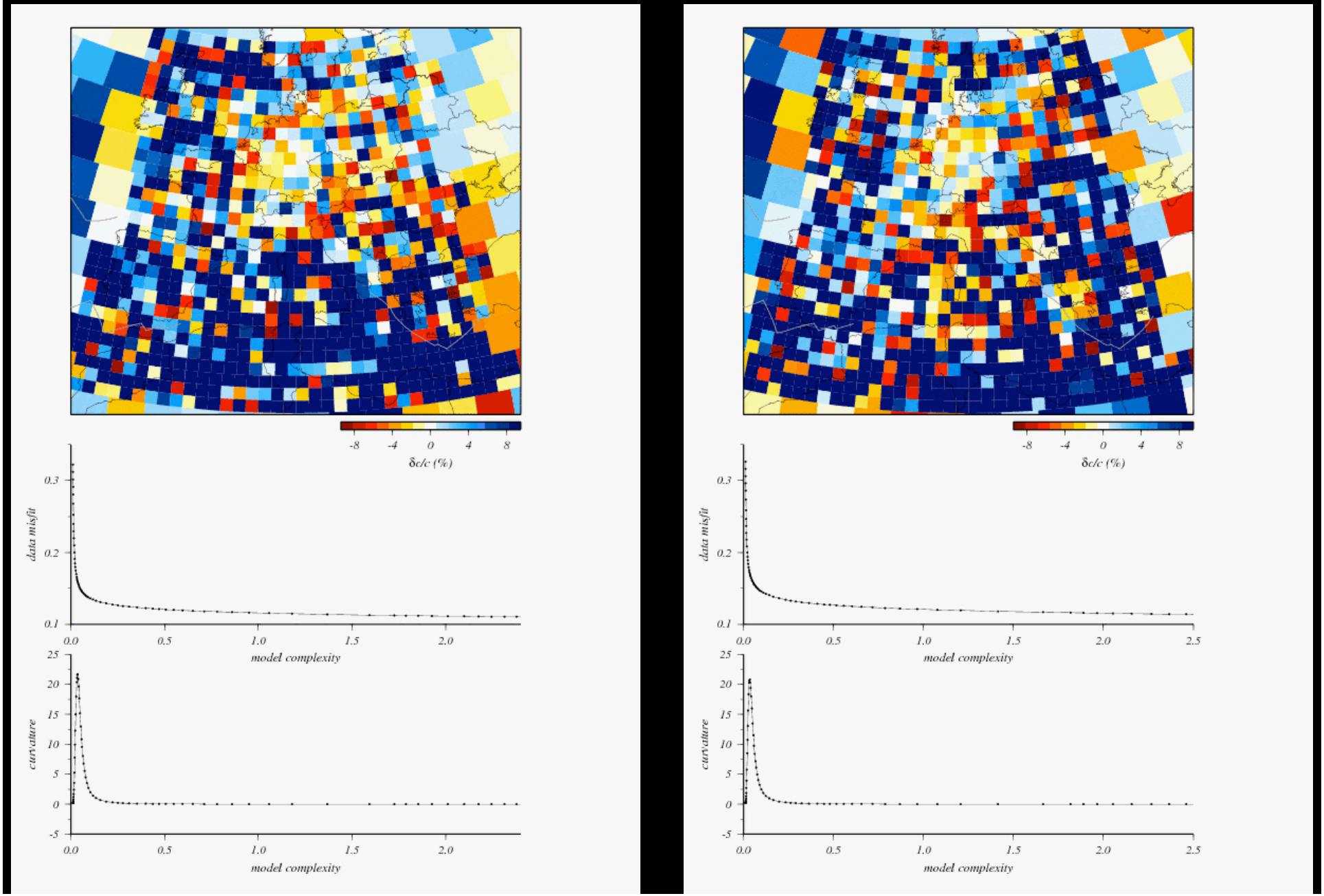




RAY

R35

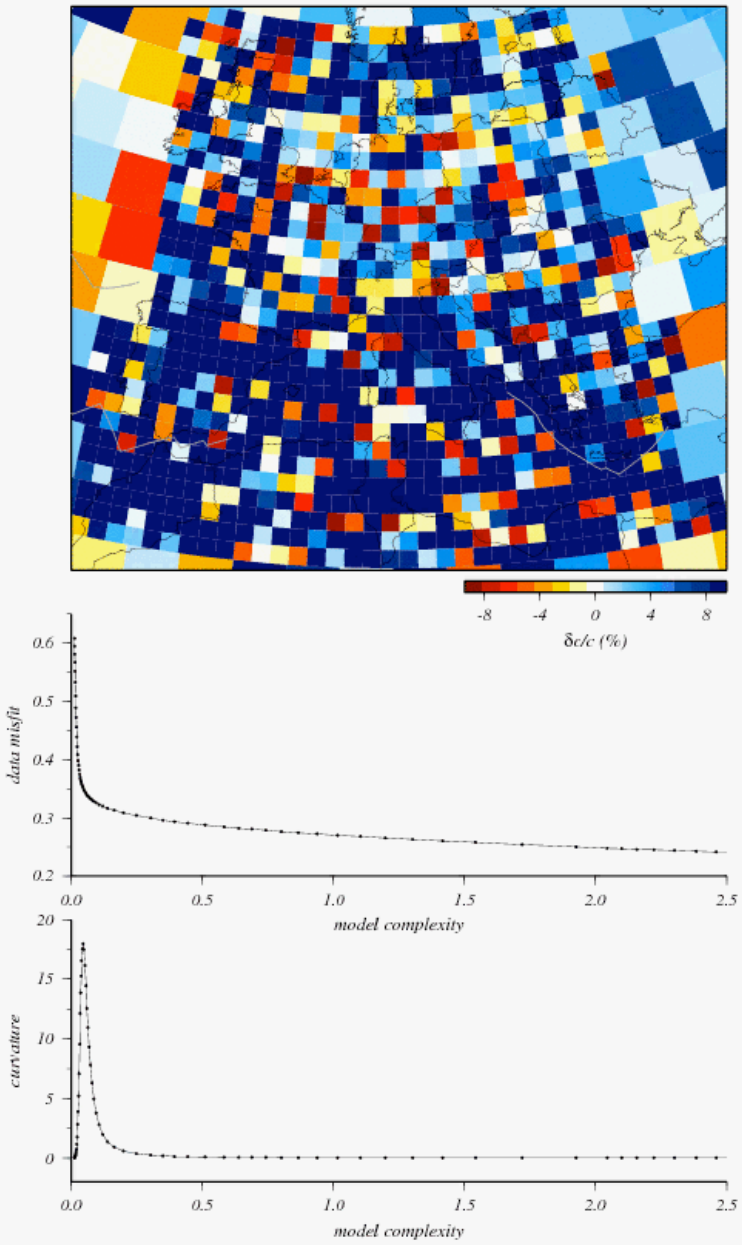
RYTOV

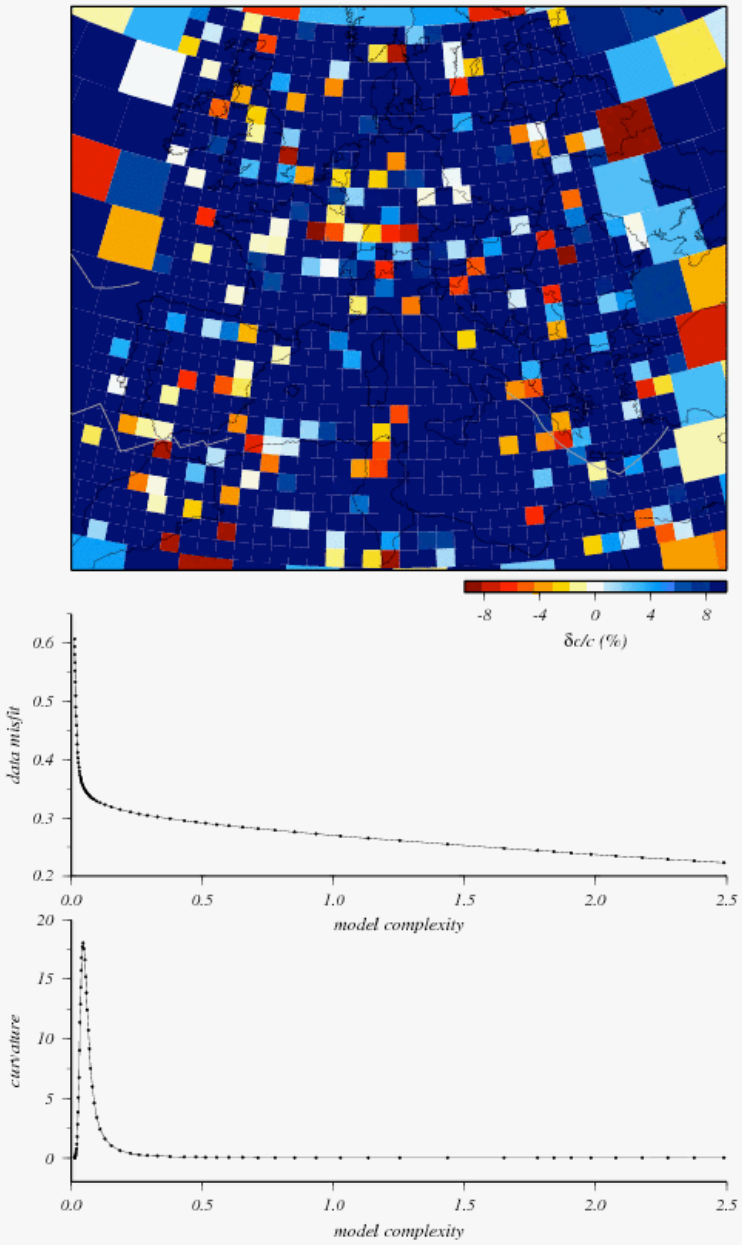


RAY

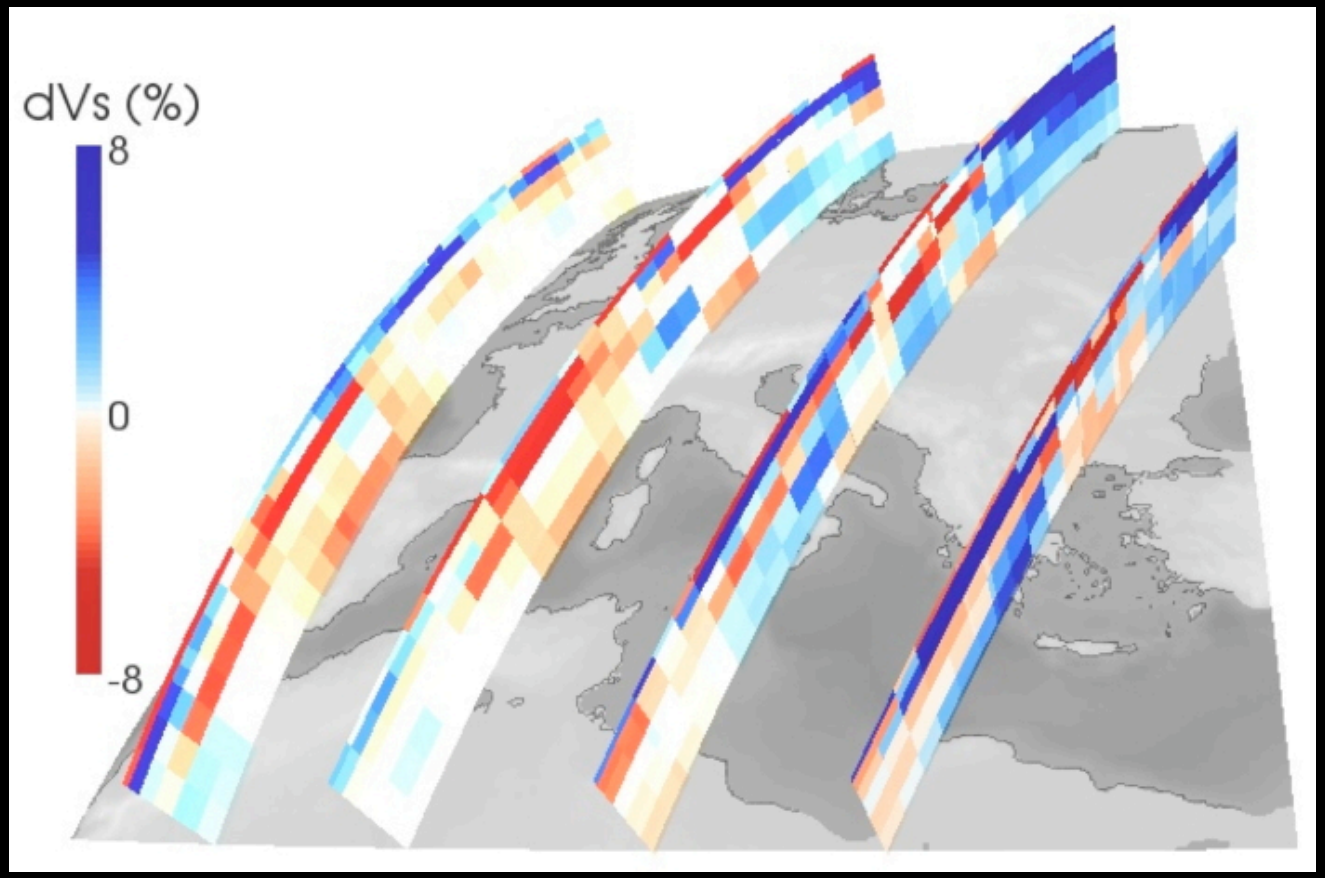
LI50

RYTOV

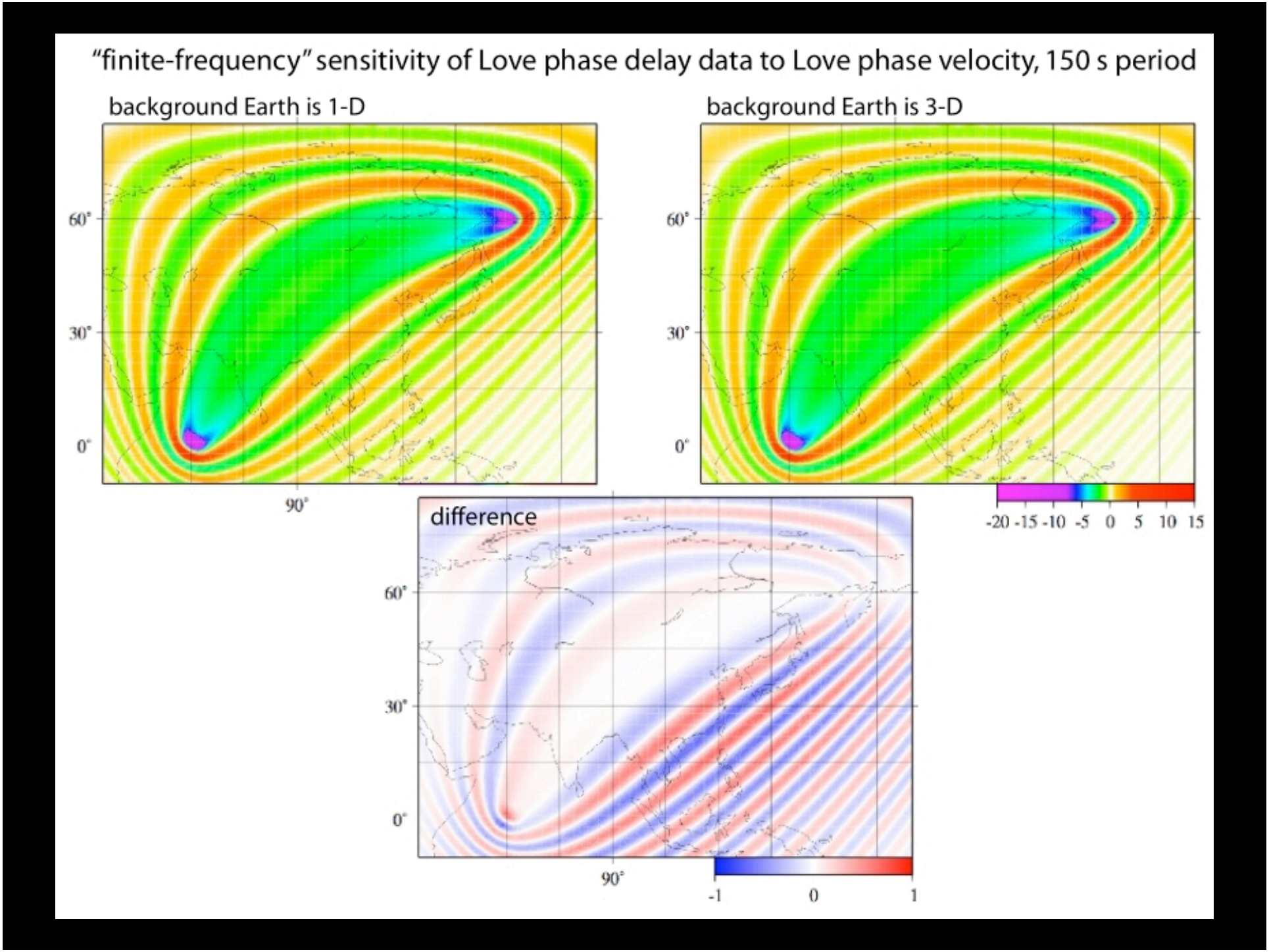


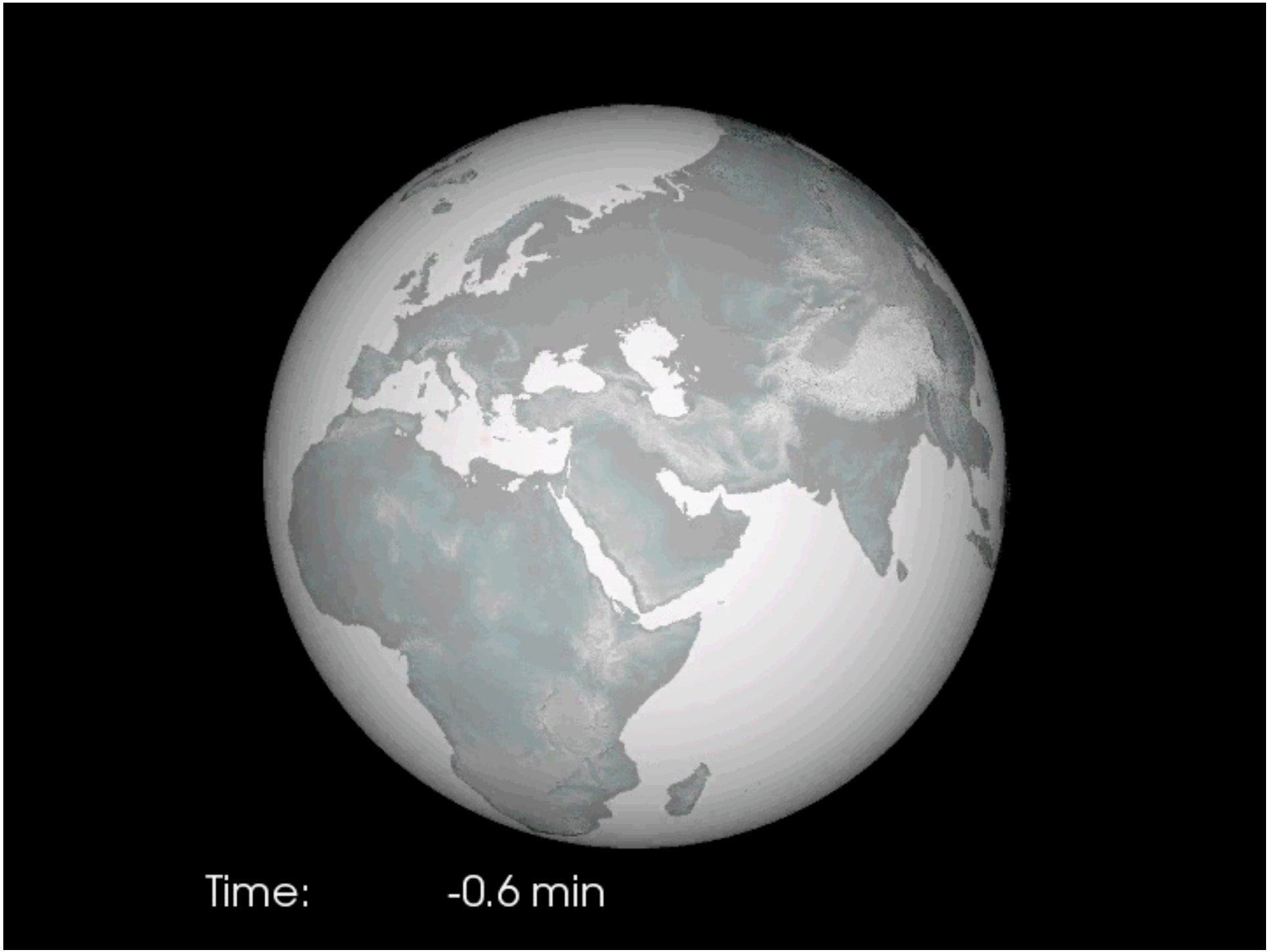


Ray and adjoint-method modeling of European upper mantle SV velocity

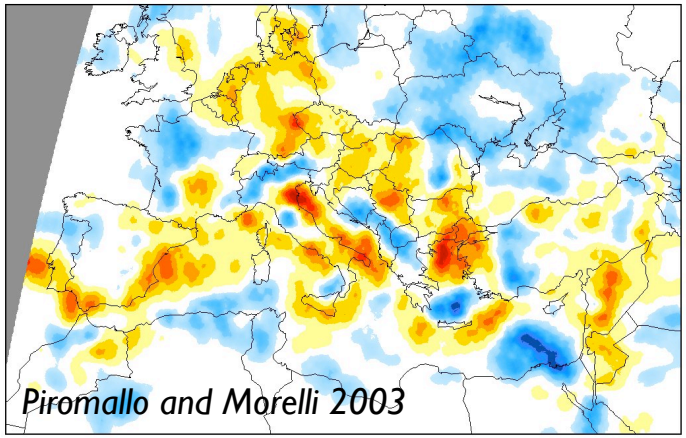


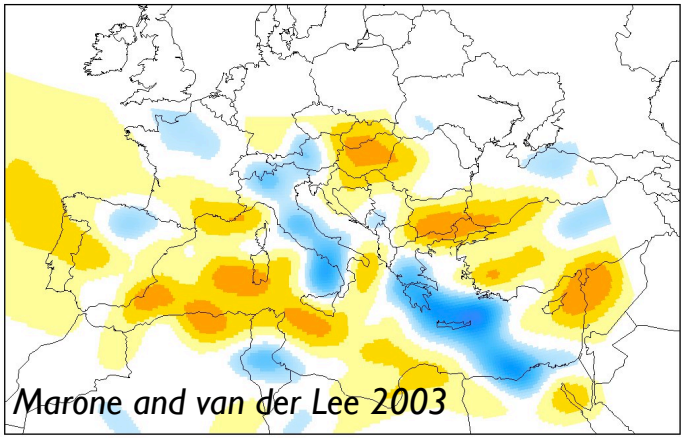
Peter, Fry, Boschi, Deschamps, Ekström, Giardini 2008

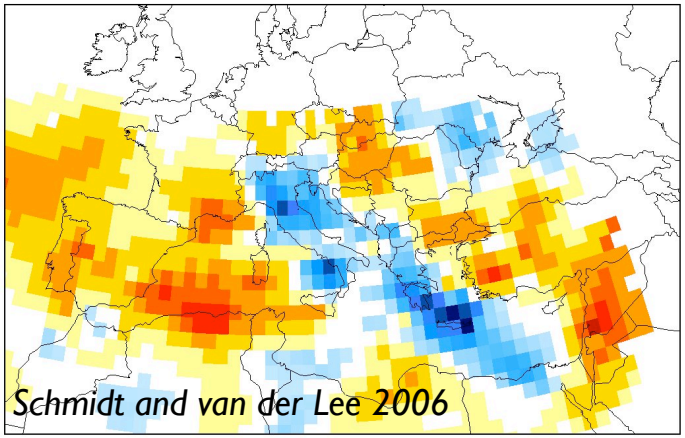

"finite-frequency" sensitivity of Love phase delay data to Love phase velocity, 150 s period
background Earth is 1-D
background Earth is 3-D
difference
60°
30°
0°
90°
-20 -15 -10 -5 0 5 10 15
-1 0 1

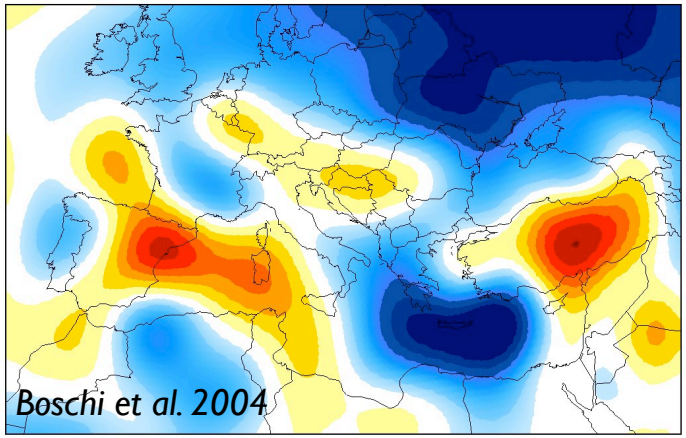

Time: -0.6 min

Vp, Vsv at 150 km depth

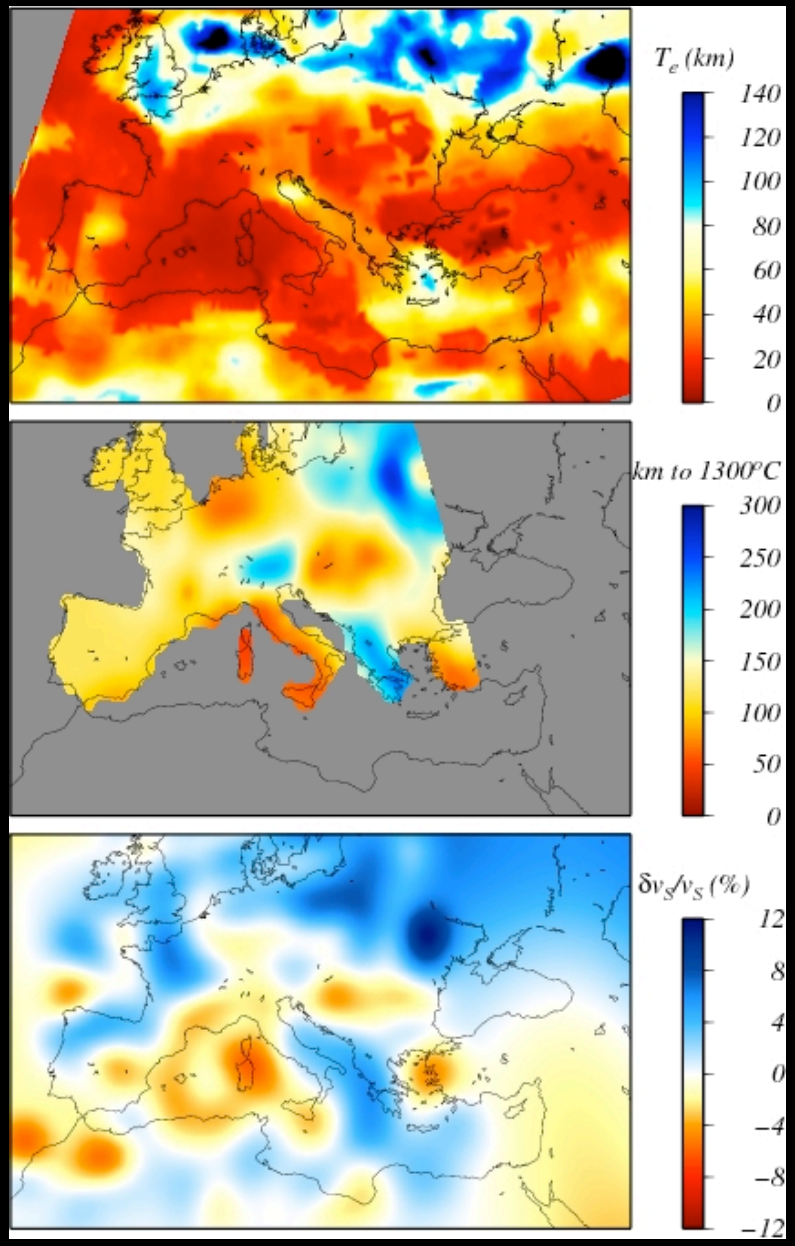






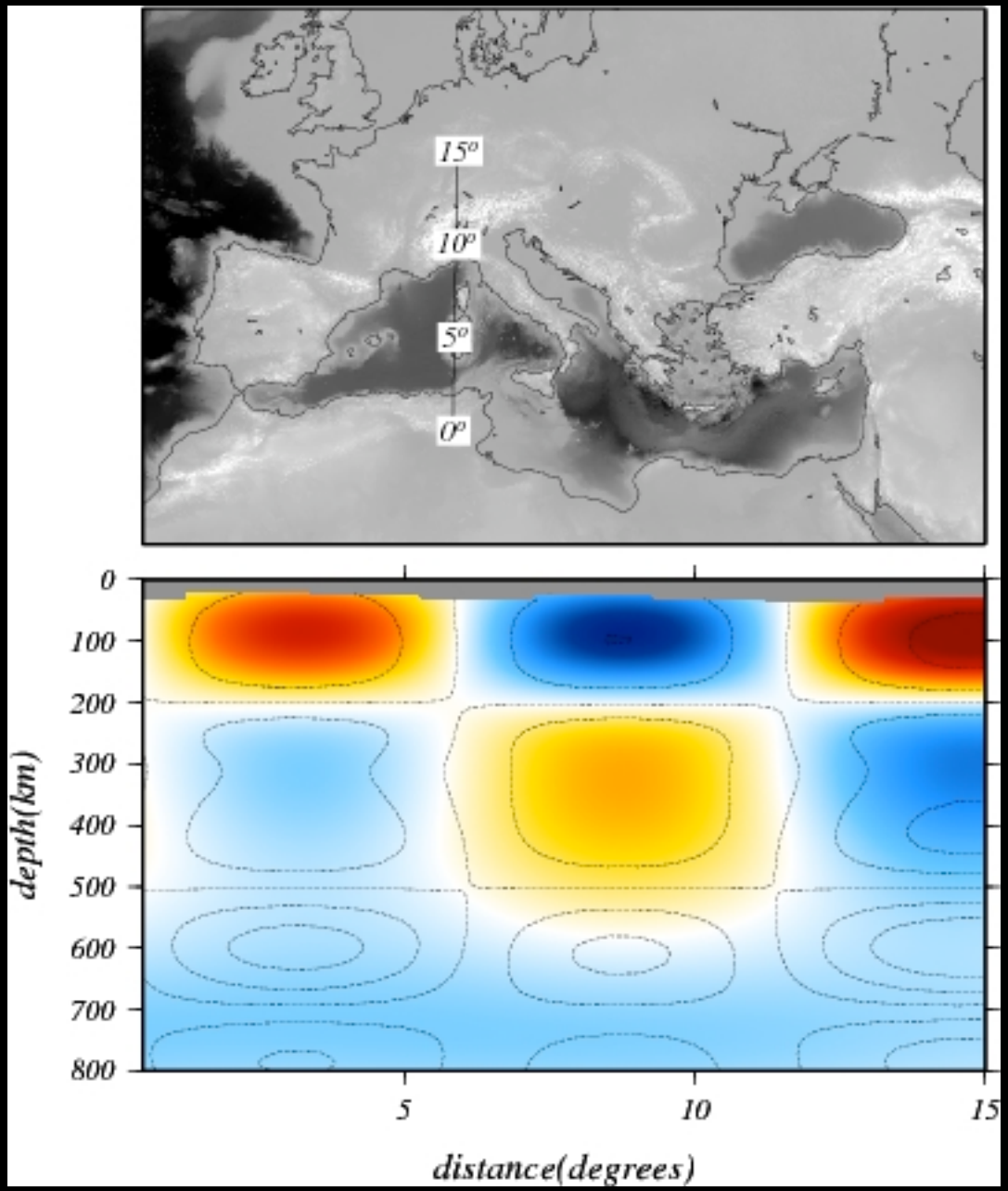


Lithospheric thickness?

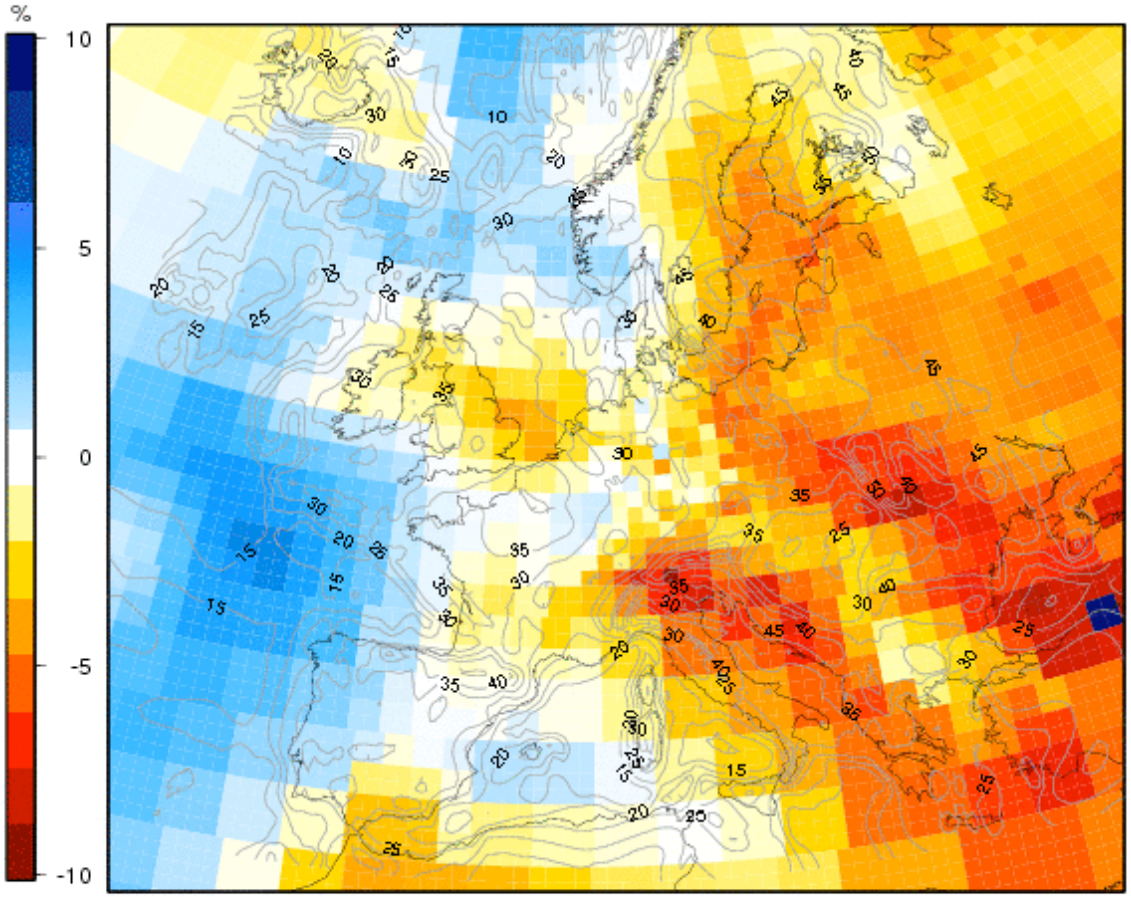


comparison w/ work of Perez, Artemieva

checkerboard test (SV)

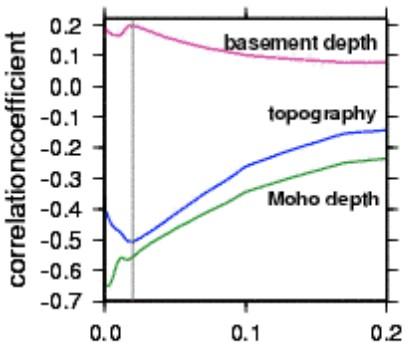


adaptive-resolution tomography

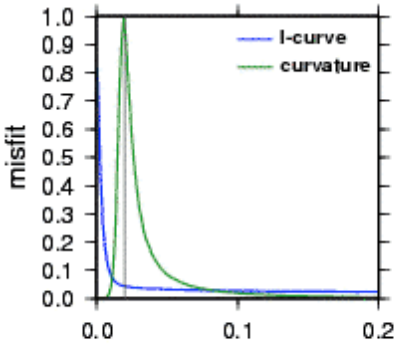


isolines represent crustal thickness
(crustal model: EuCRUST-07, Tesauro, 2008)

correlation with crustal properties

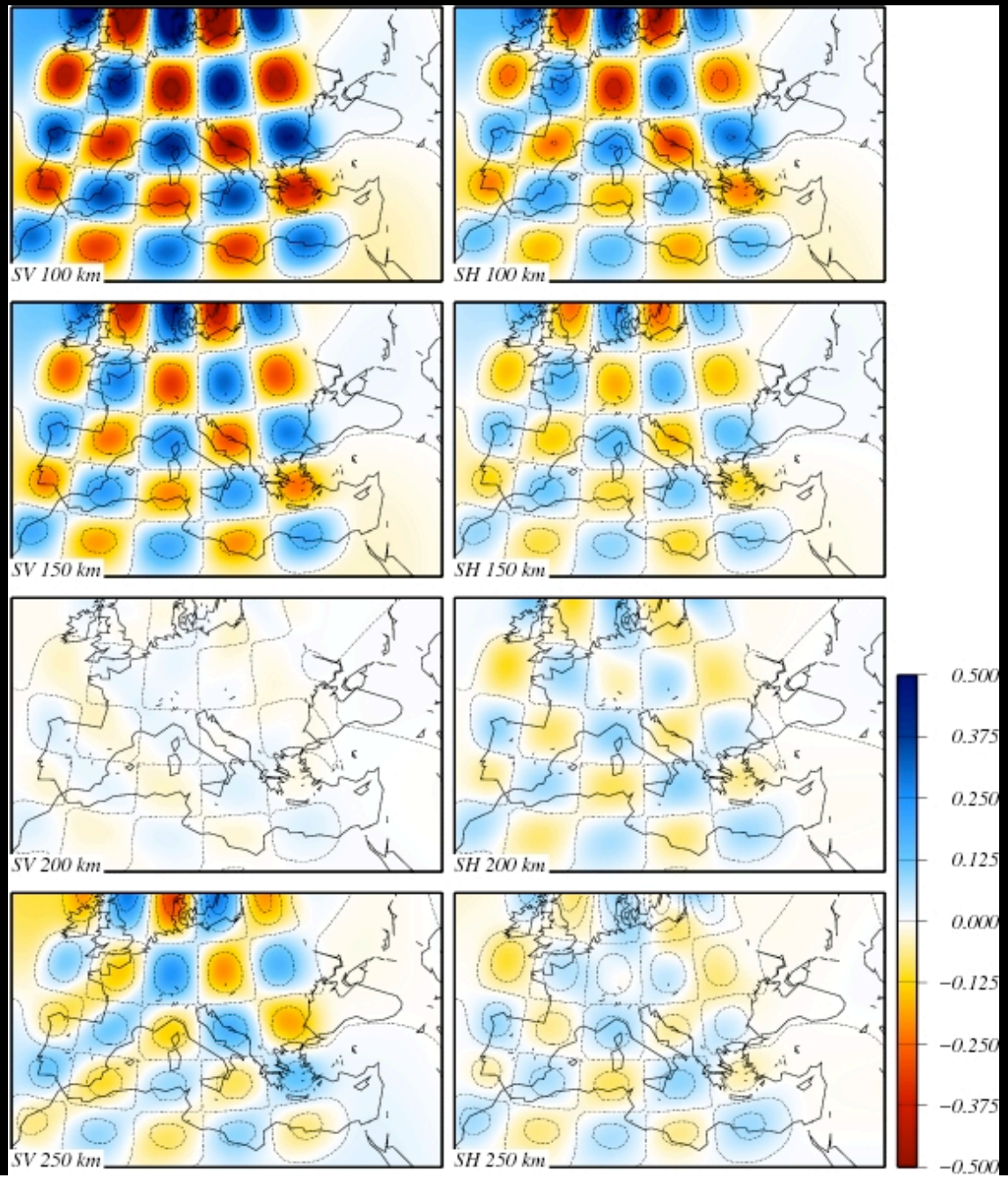


l-curve



Julia Schäfer, 2009

checkerboard test



contribution from ambient noise data

Tomography of the Alpine Region from Observations of Seismic Ambient Noise

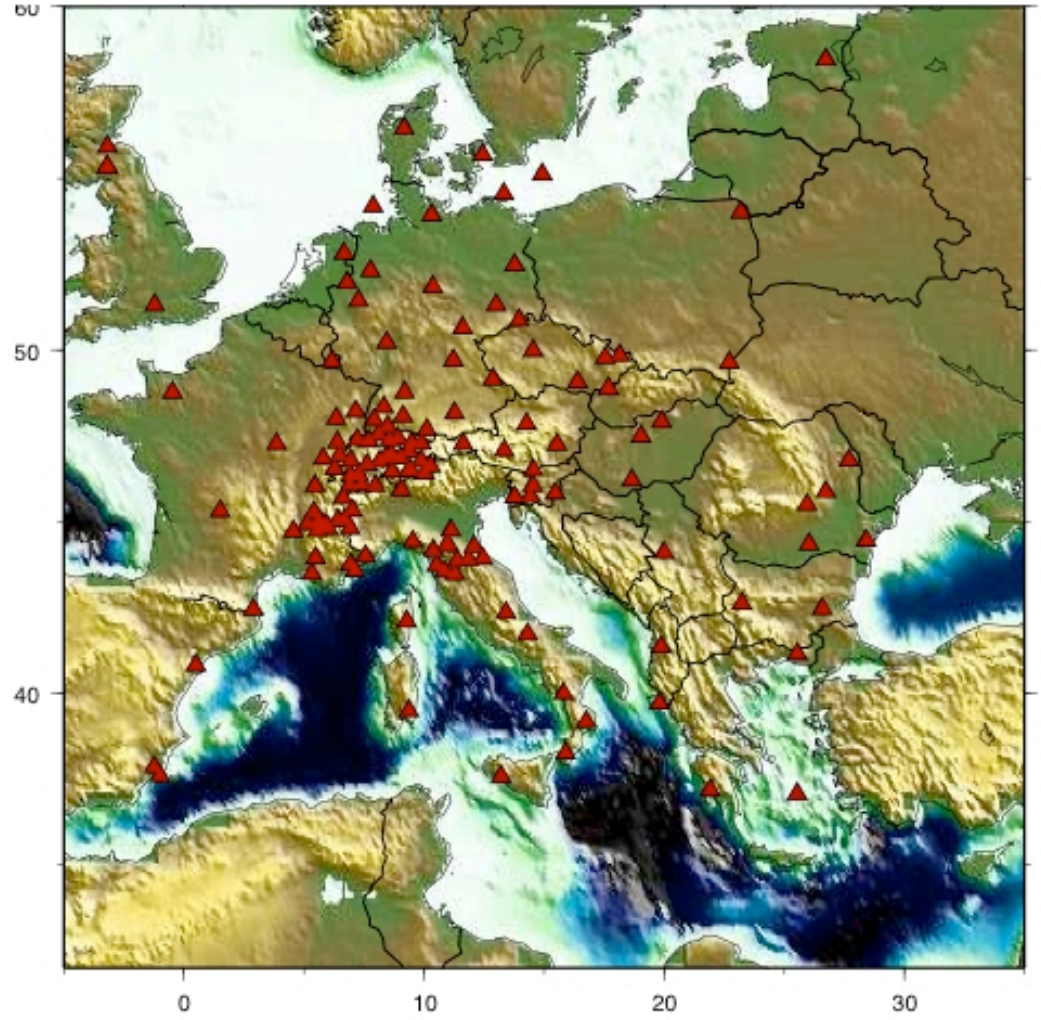


Figure 1. Map showing the location of broadband recorders used for this study.

Stehly, Fry, Campillo, Shapiro, Boschi, Giardini 2009