Towards higher resolution tomography at the global and regional scales

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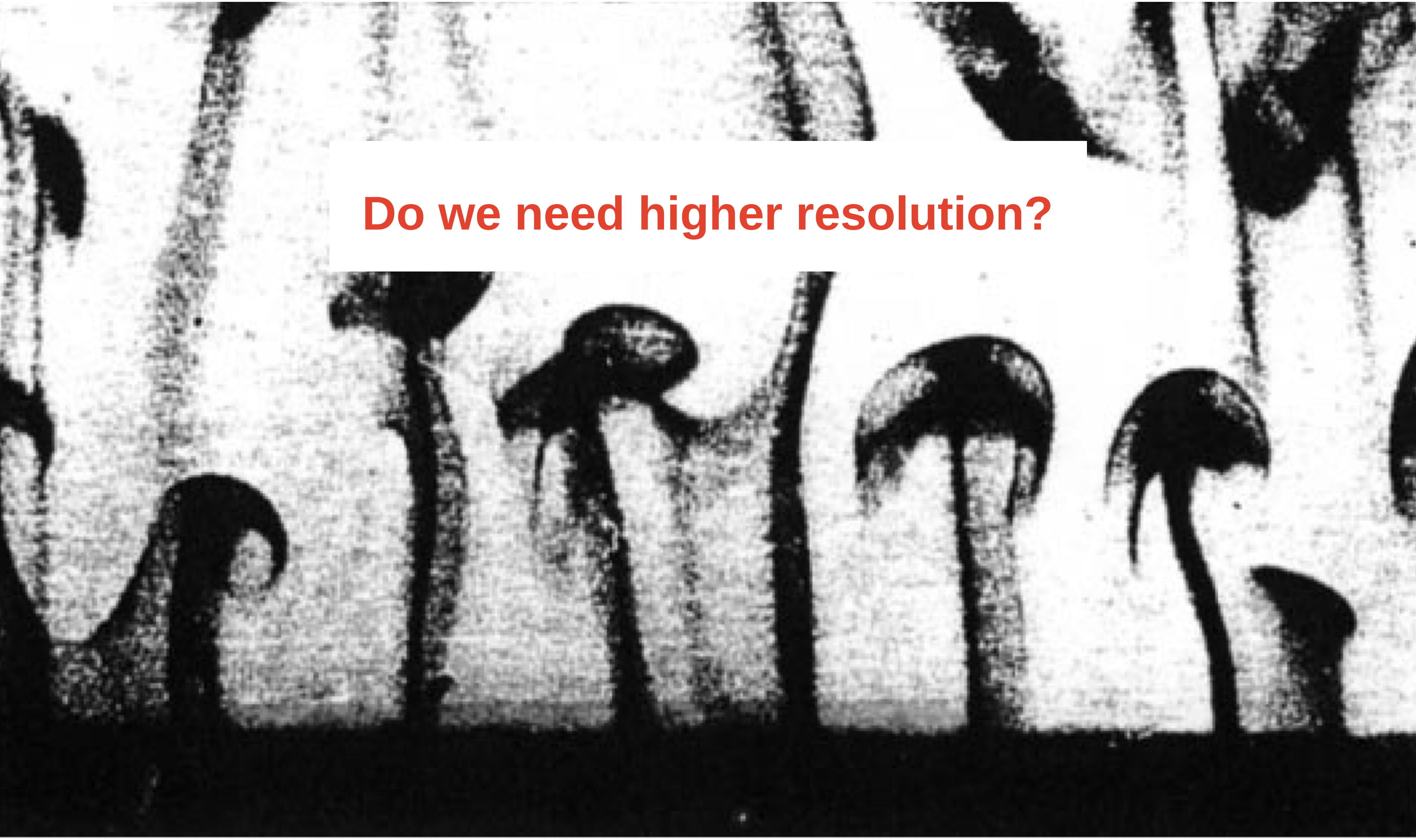
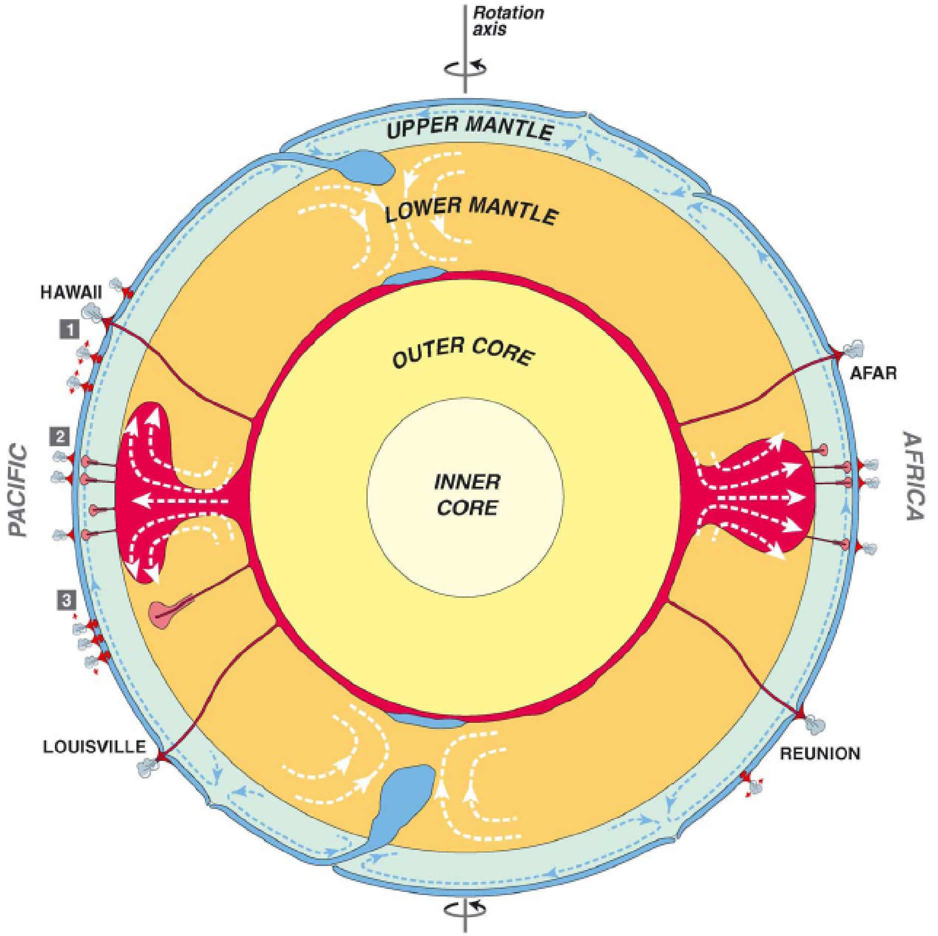
Do we need higher resolution?



Thermal plumes rising from an unstable thermal boundary layer in wate
w. The boundary layer has been colored, using an electrochemical tec

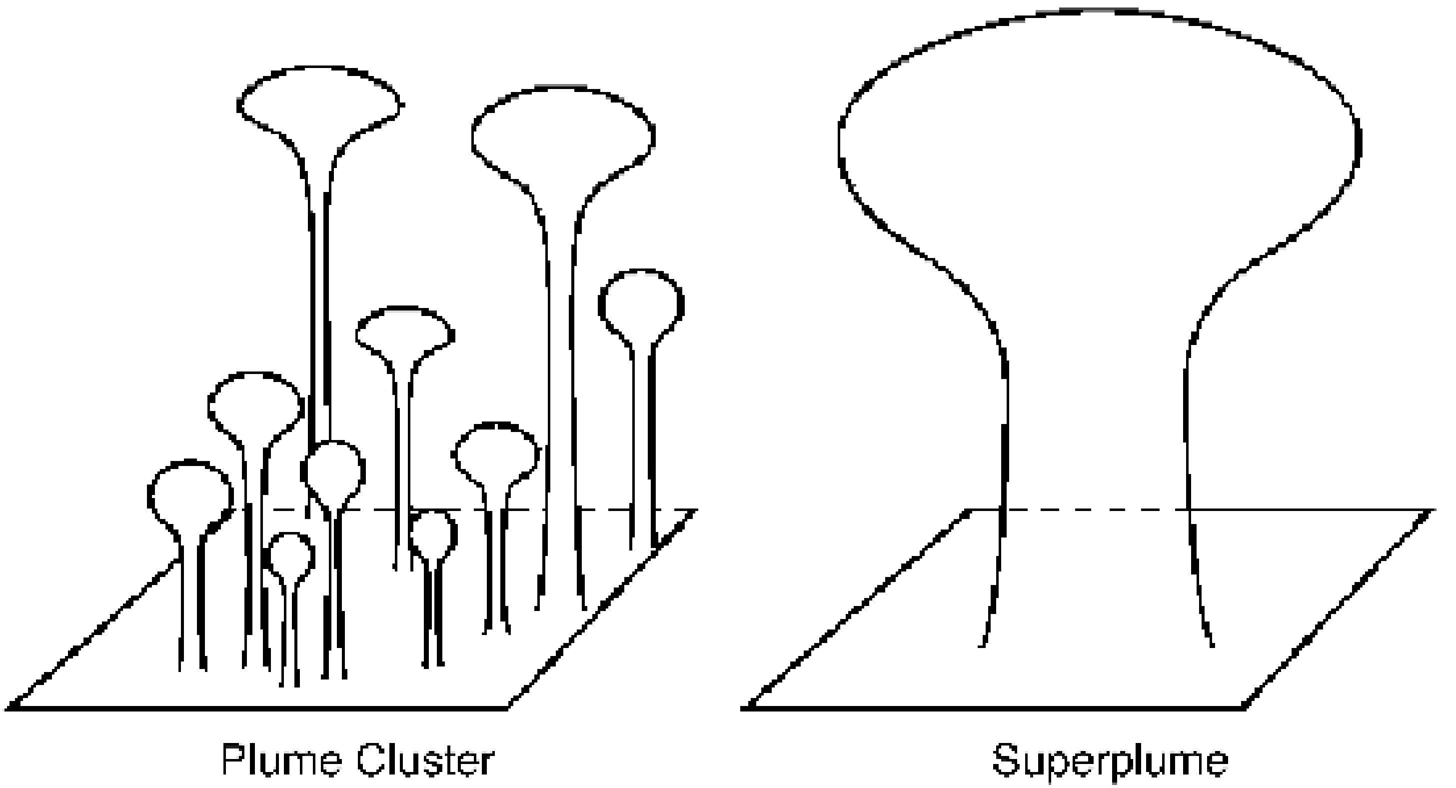
The origin of hotspots

- Courtillot *et al. (2003) distinguish hotspots as being caused by*
    1. *Deep, narrow plumes*
    2. *Plumes rising from plume-farms at 660*
    3. *"Andersonian" crack-like features*

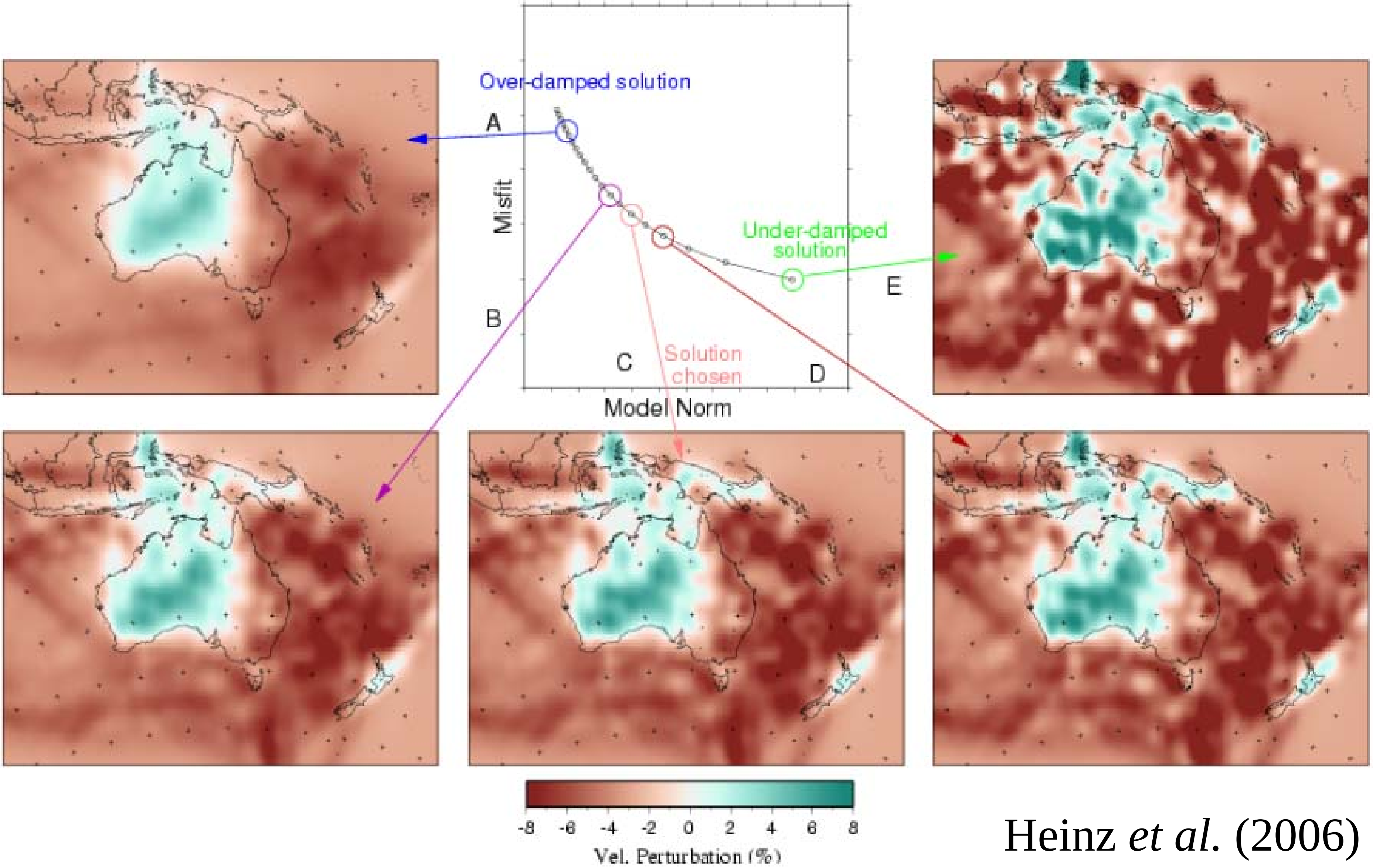


Schubert et al (2004): Plume clusters

G. Schubert et al. / Physics of the Earth and Planetary Interiors 146 (2004) 147–162



Tomography results are non-unique



Heinz *et al.* (2006)

Tomography results are non-unique

QuickTime™ and a
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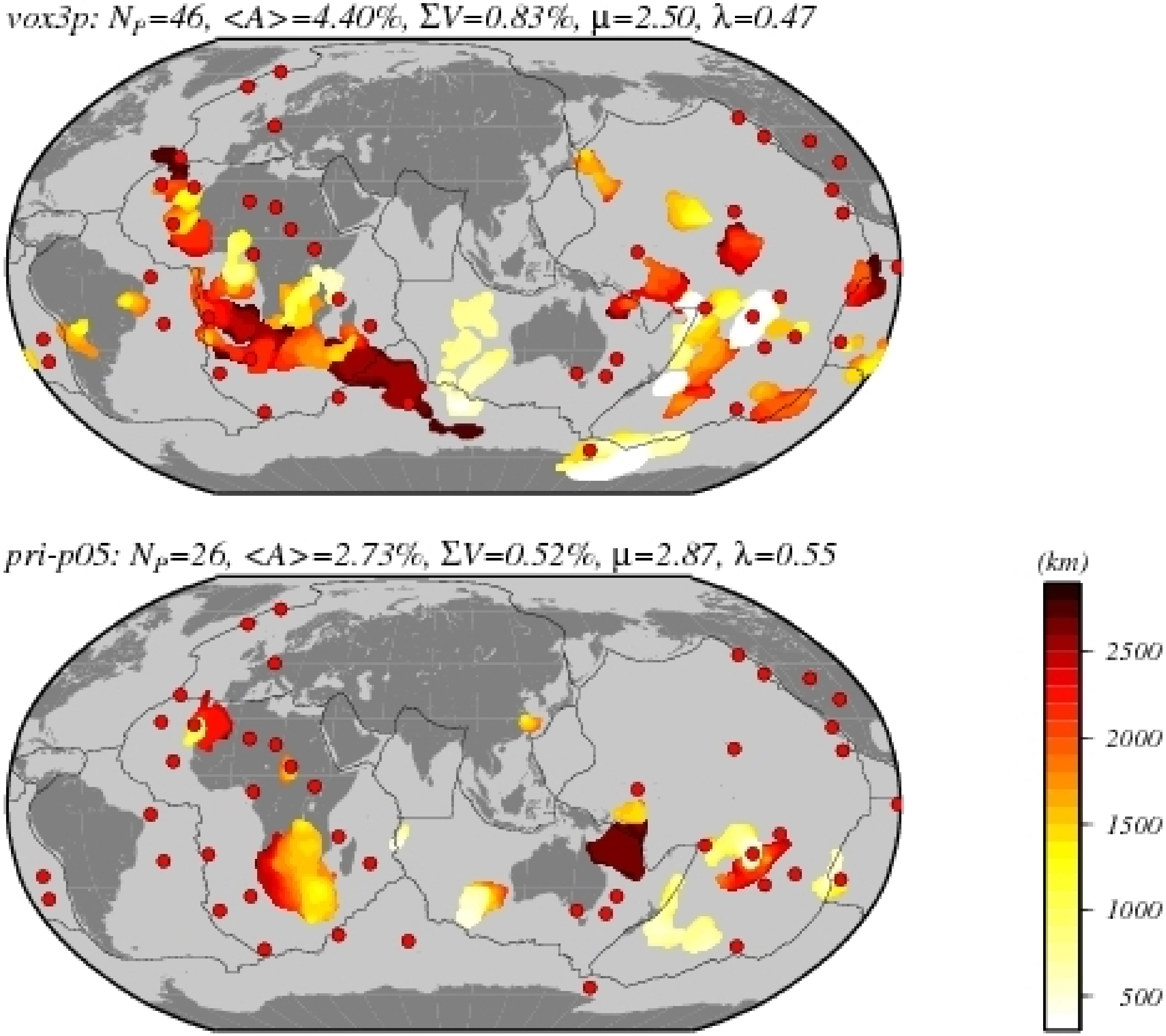
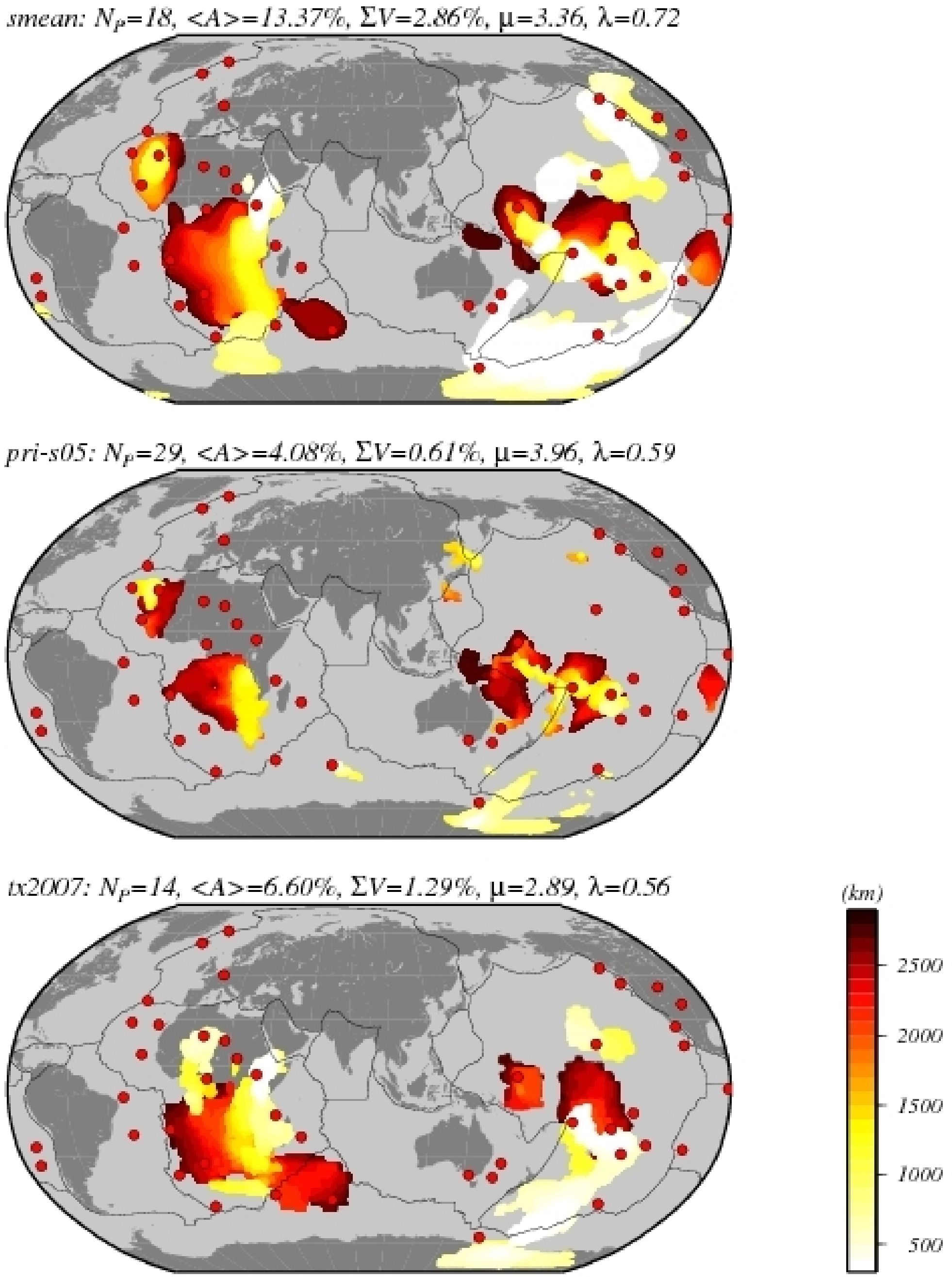
are needed to see this picture.

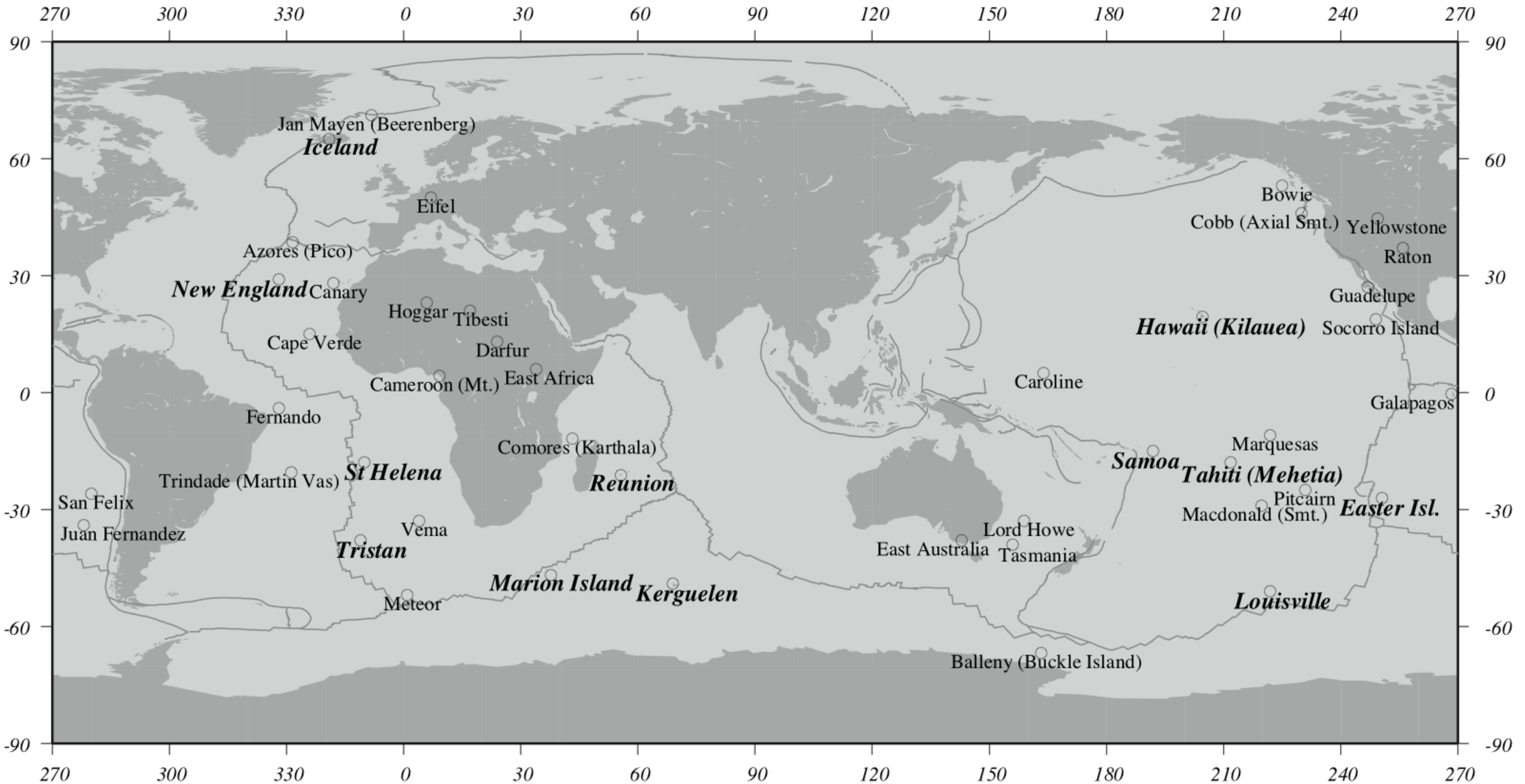
plume detection algorithm applied to two P-wave tomographic models



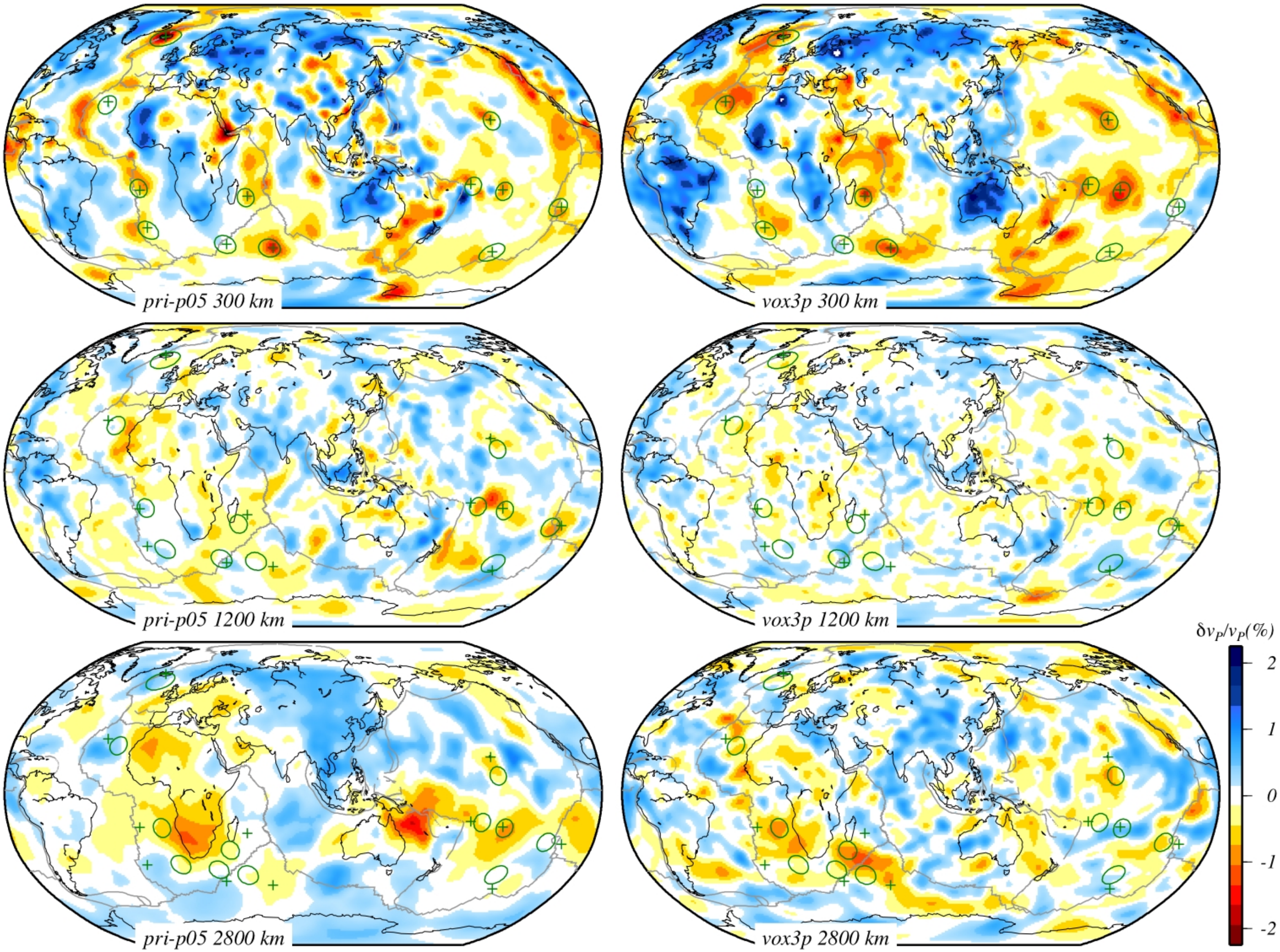
plume detection algorithm applied to three S-wave models



44 hotspots that we look at. 12 are suspected to originate from deep upwellings



P tomographic models; 12 likely deep plumes; advection vs. no advection



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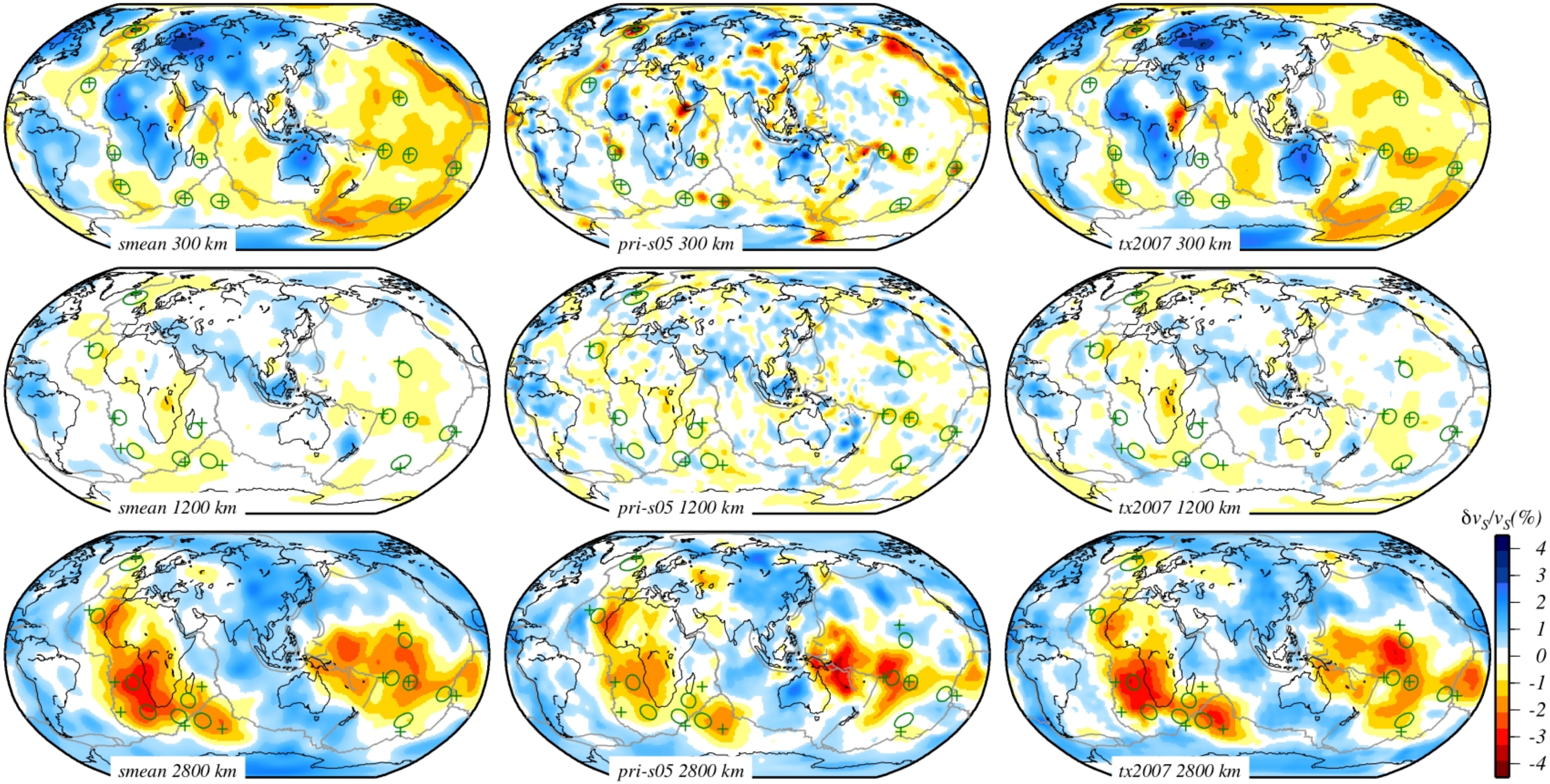
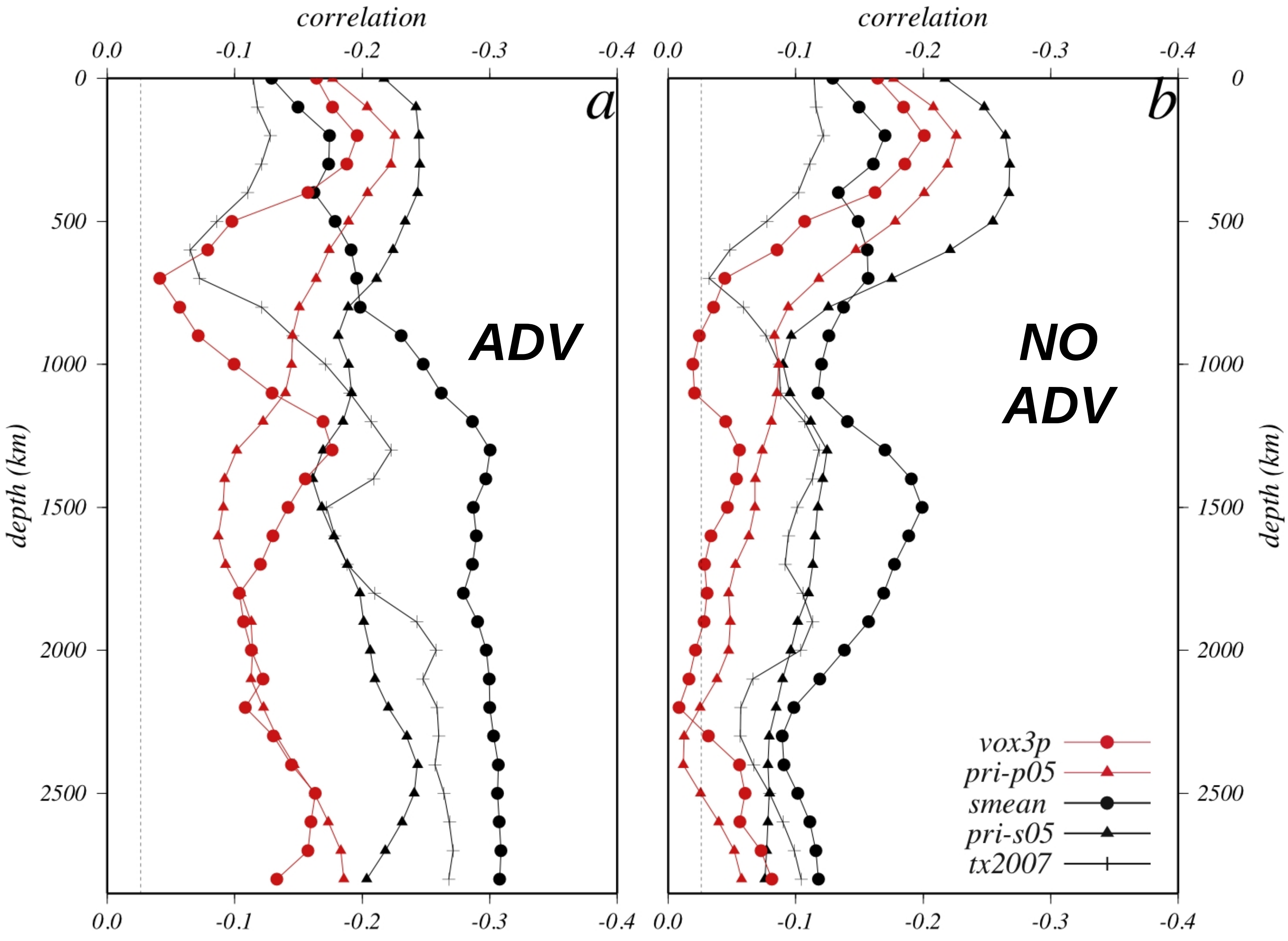
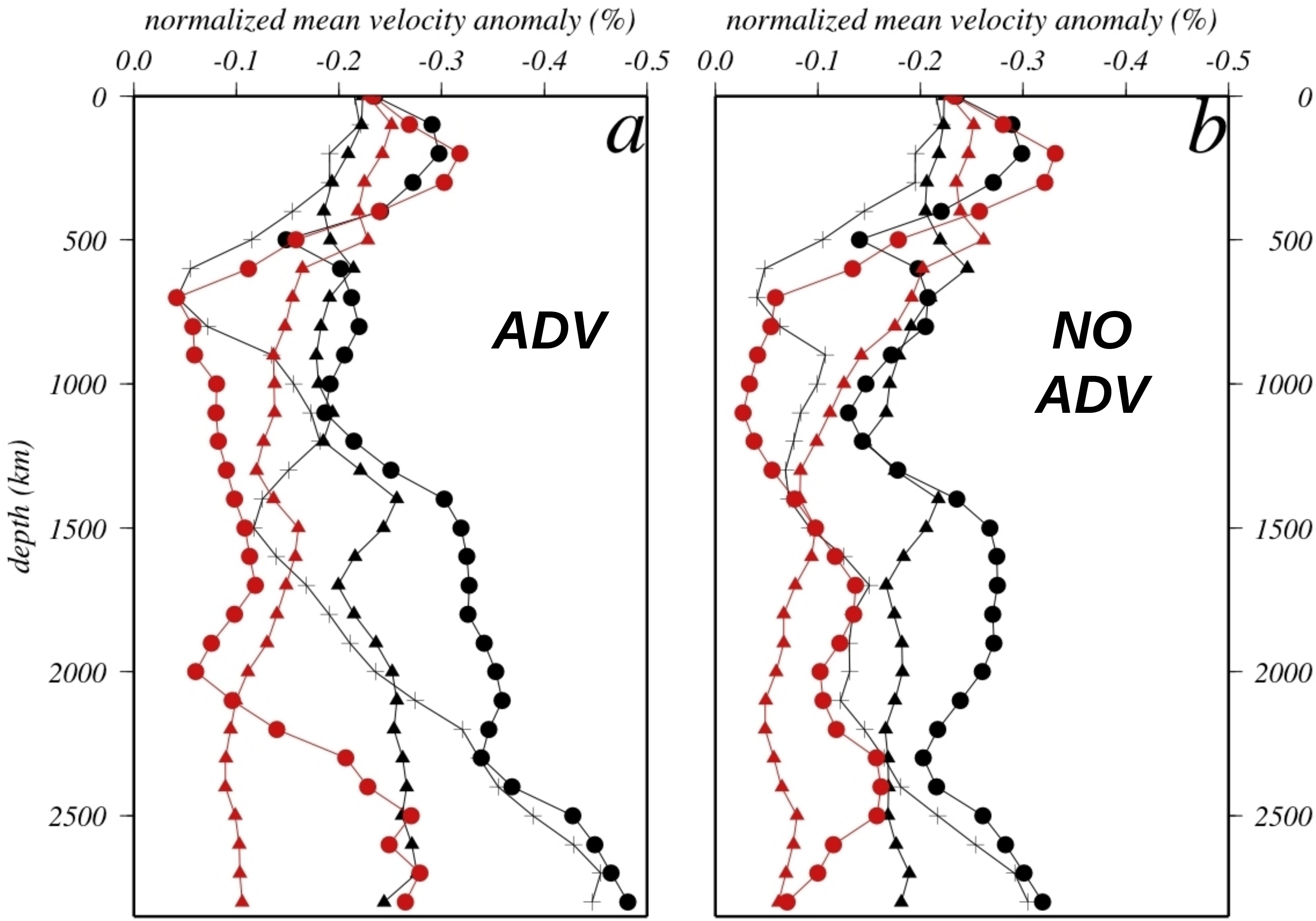


Are similarities statistically significant?

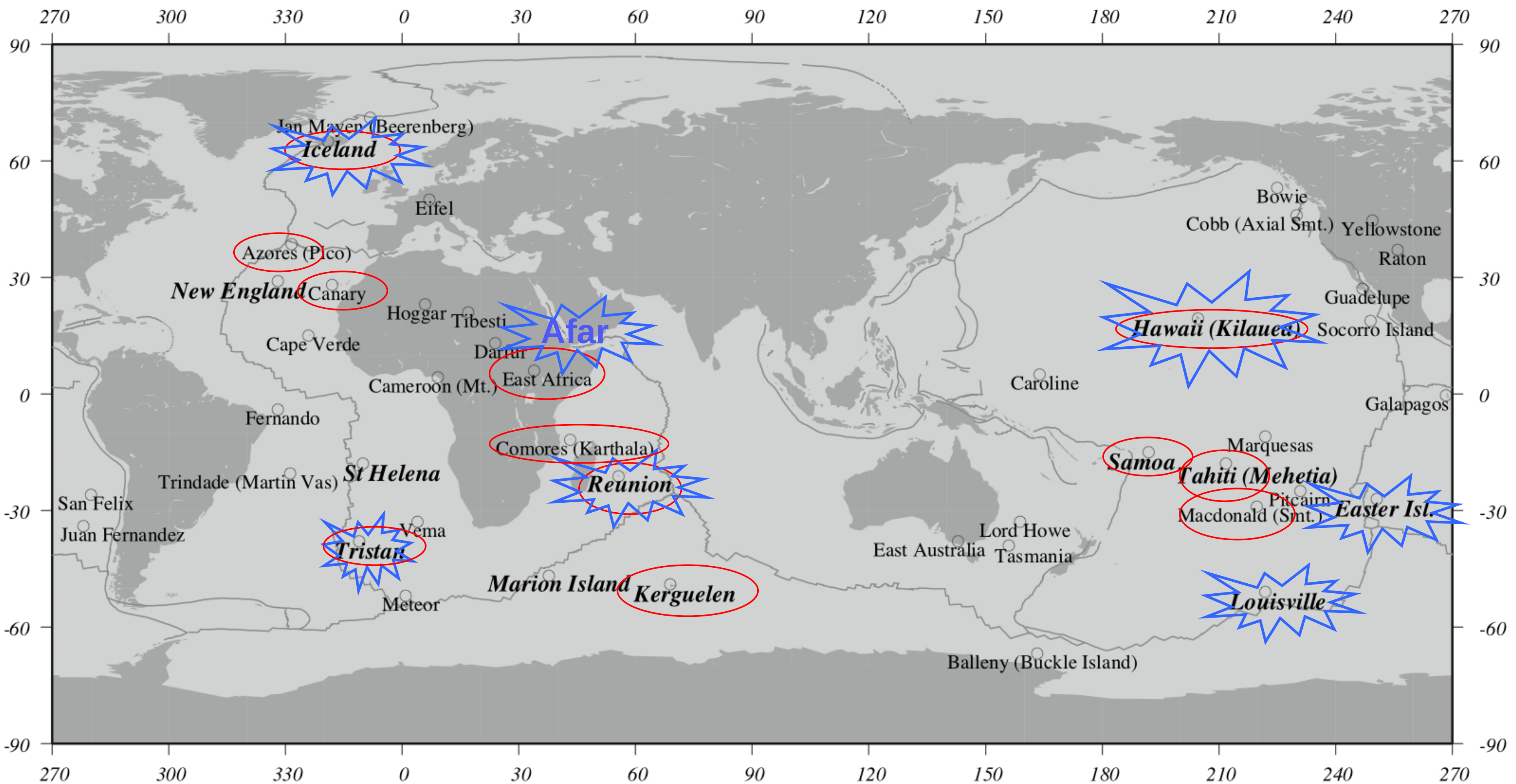
correlation



another way of “measuring” plumes in a tomographic model:
mean velocity anomaly within dynamically modeled plume conduits



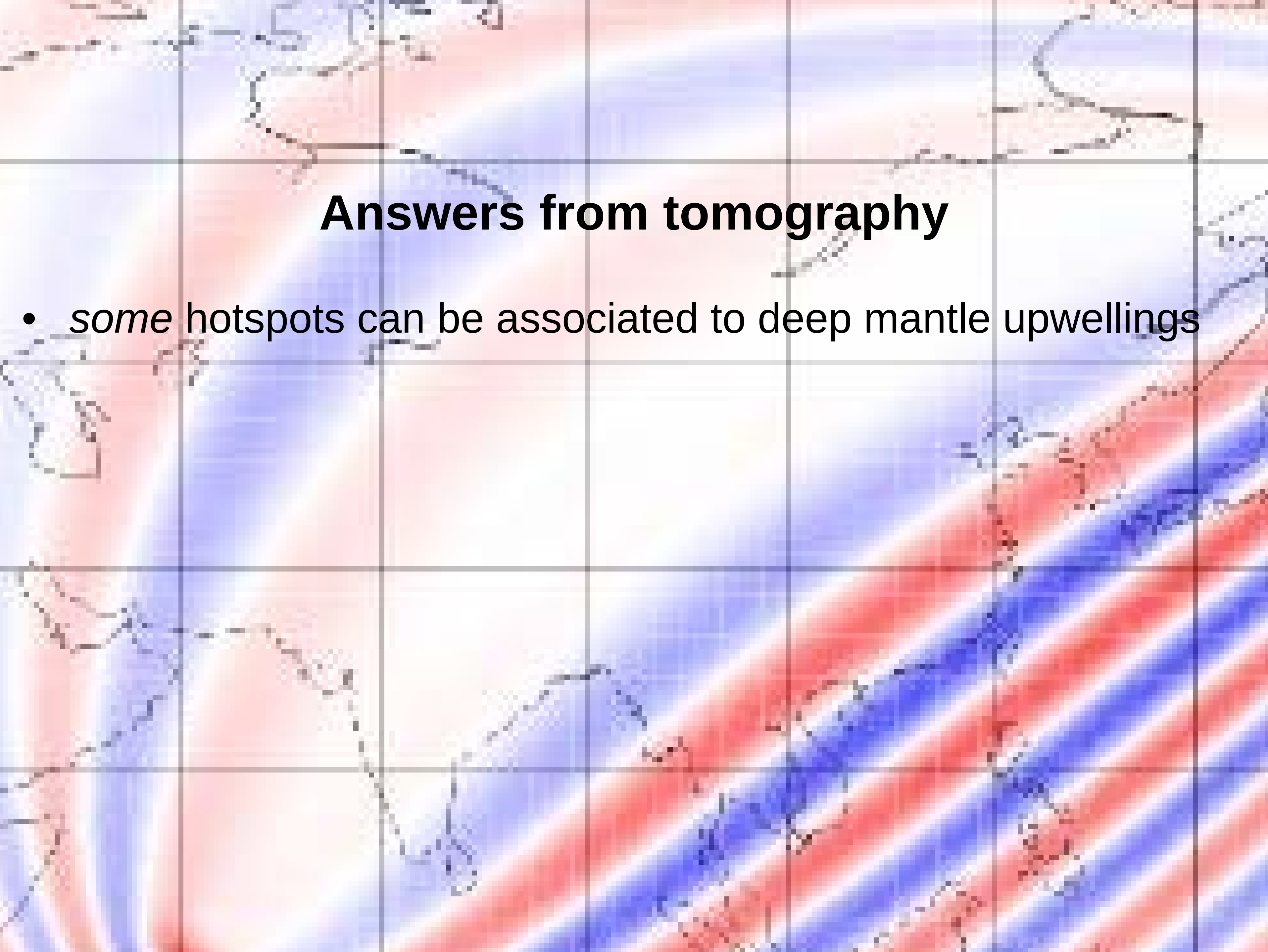
where are the hotspots likely to form from deep plumes?



Courtillot et al. 2003

Answers from tomography

- *some* hotspots can be associated to deep mantle upwellings



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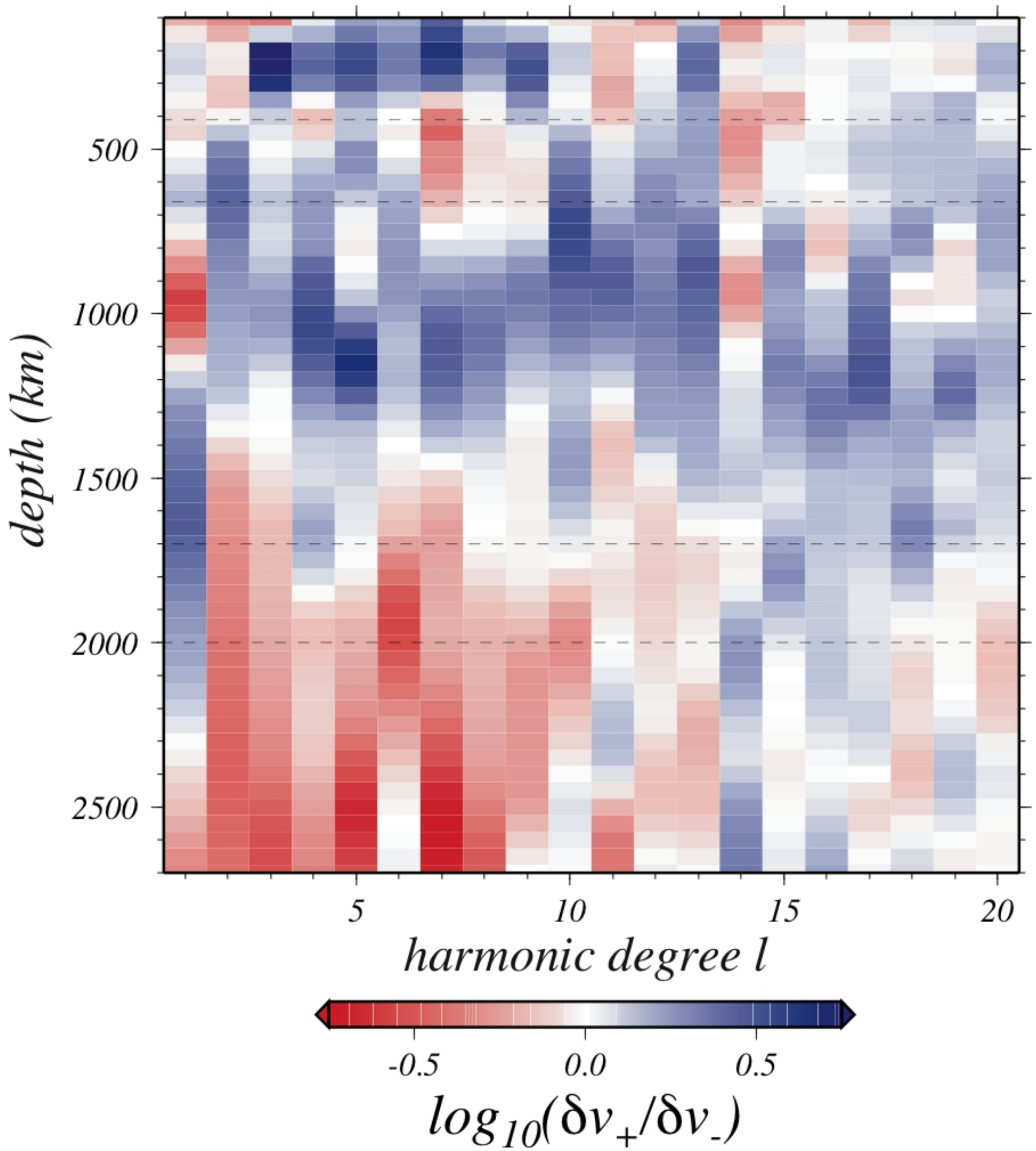
- Hence, superplume-dome and plume-forest models are likely
- Can we resolve between the two?

Reif & Williams (2007) compare the spectrum of positive vs. negative velocity anomalies. We apply their analysis to Becker & Boschi's (2002) model smean

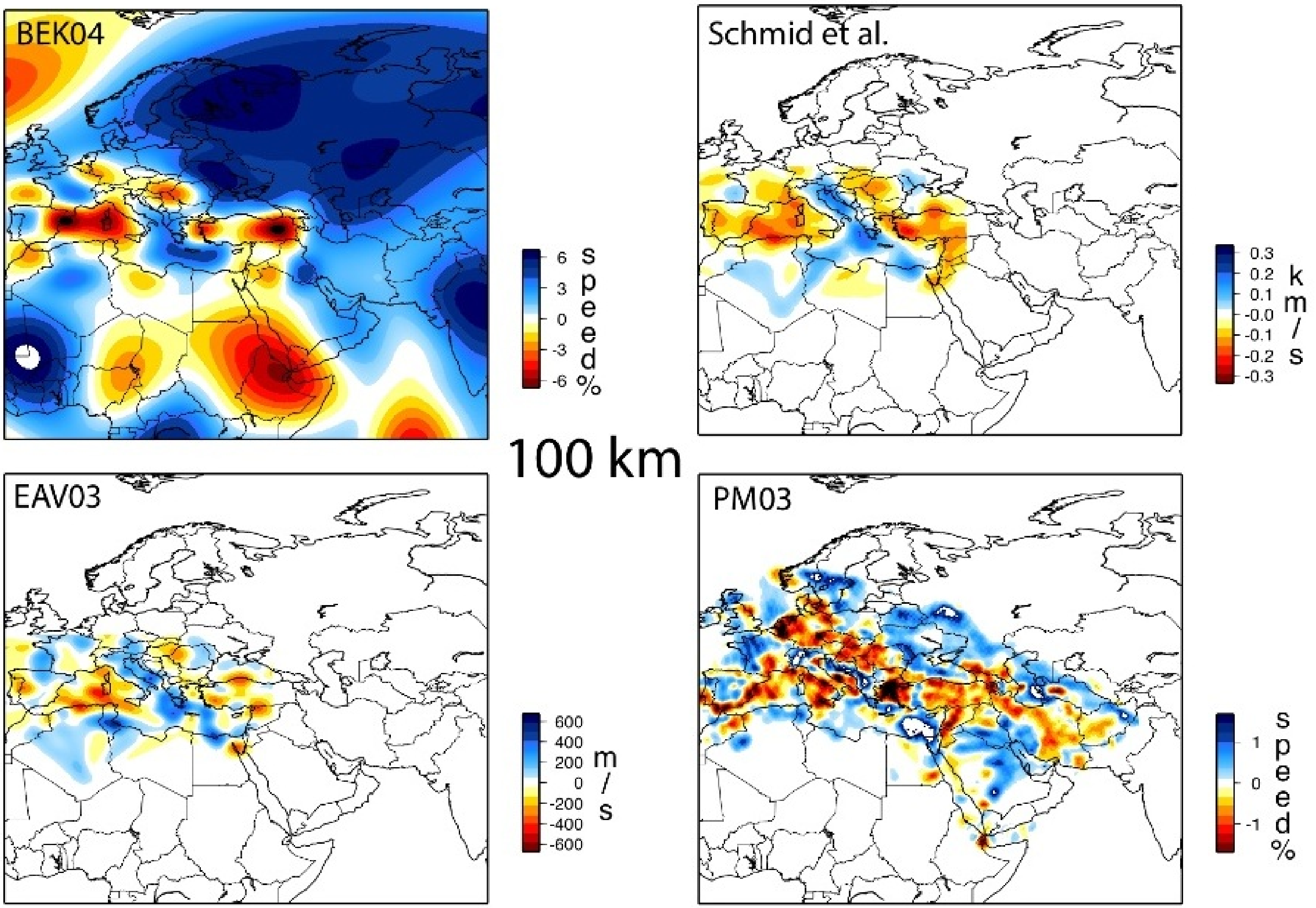


Plume farms vs plume forests

- Depth dependence of dv+/dv-
- Geographic distribution of hotspots
- detected vertically coherent tomographic anomalies merge at depth

- Significant correlation between modeled plume conduits and tomography
- Icelandic hotspot

Local Model “agreement”



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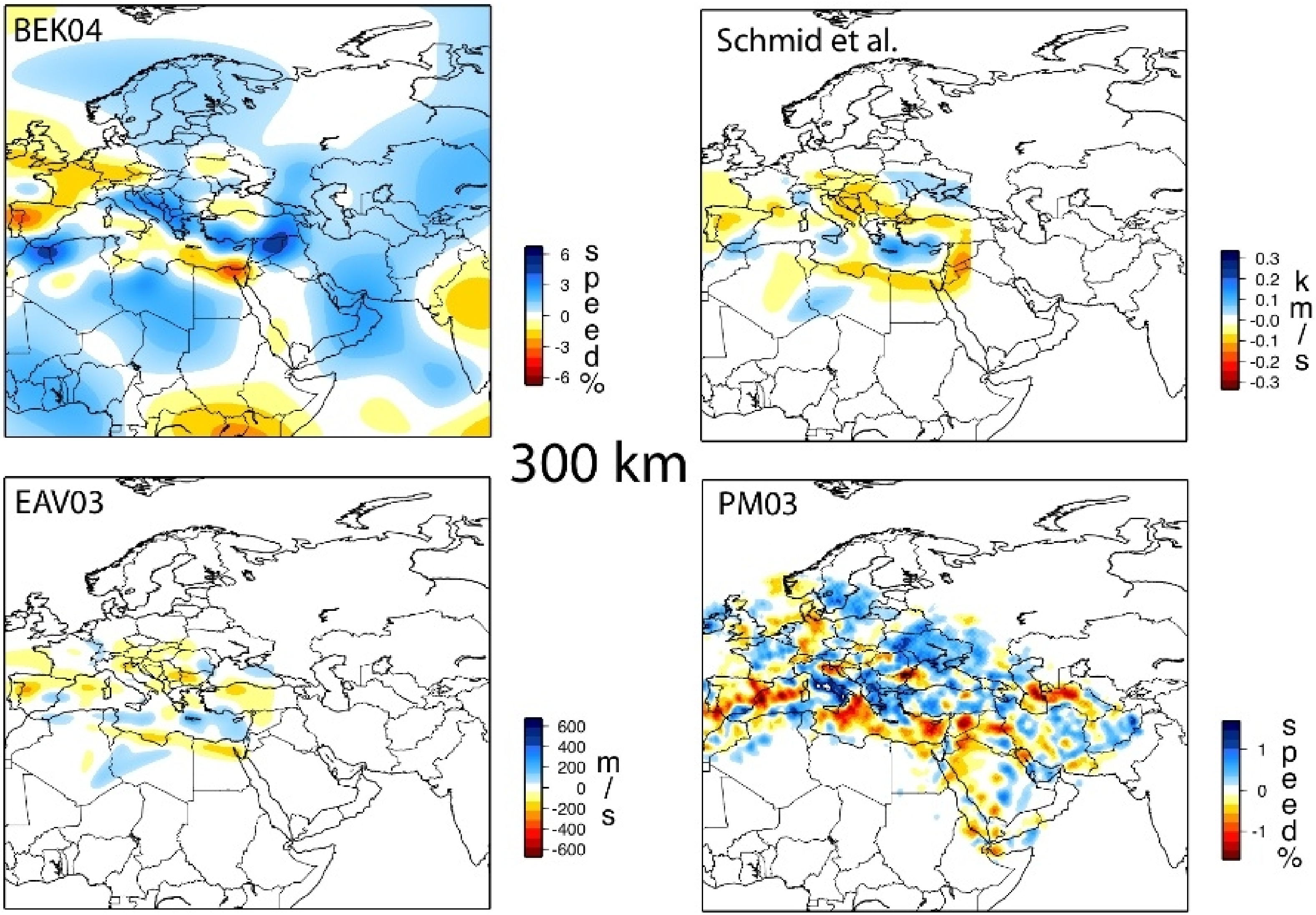
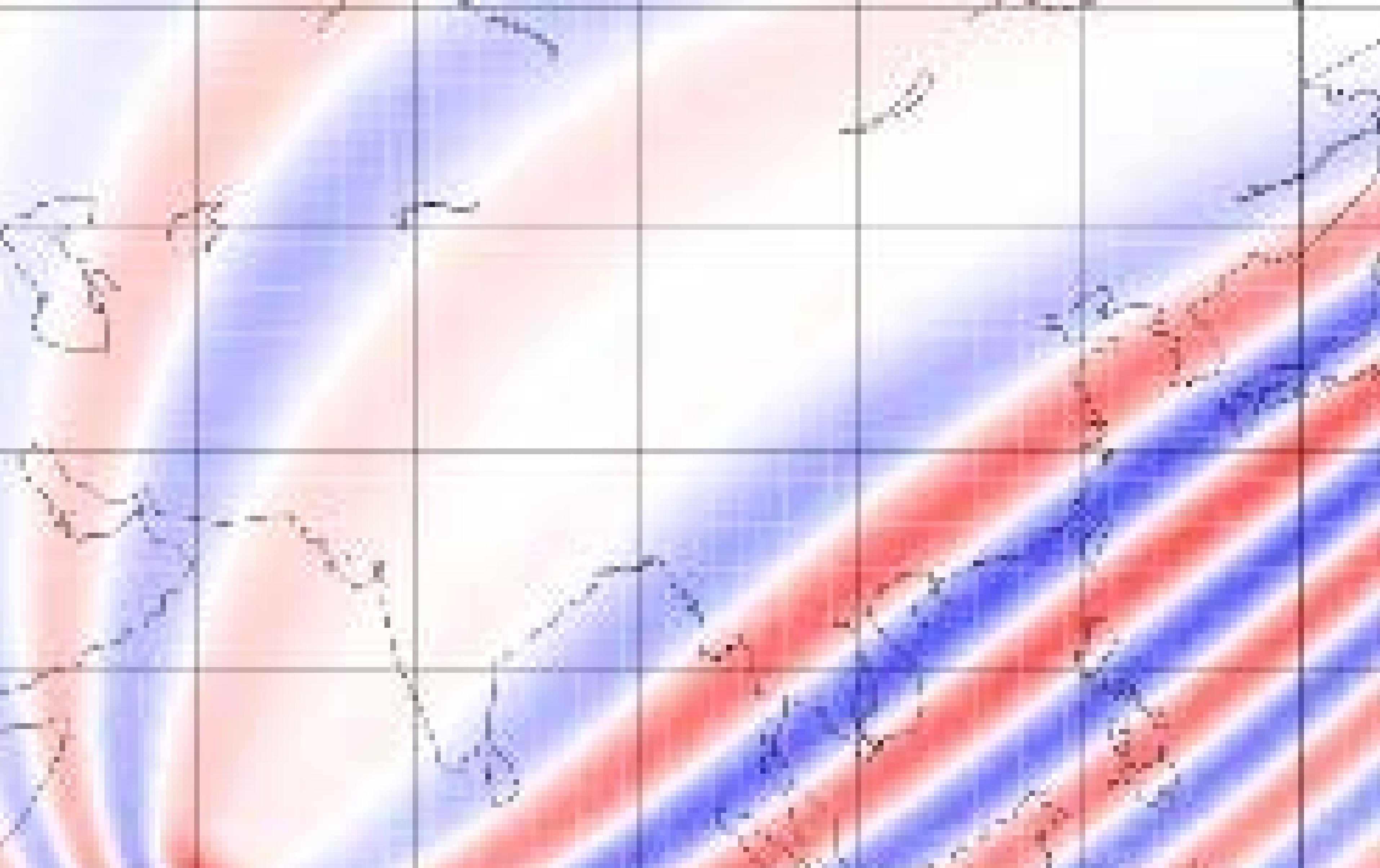


Improvements in tomographic resolution/model quality are achieved by means of:



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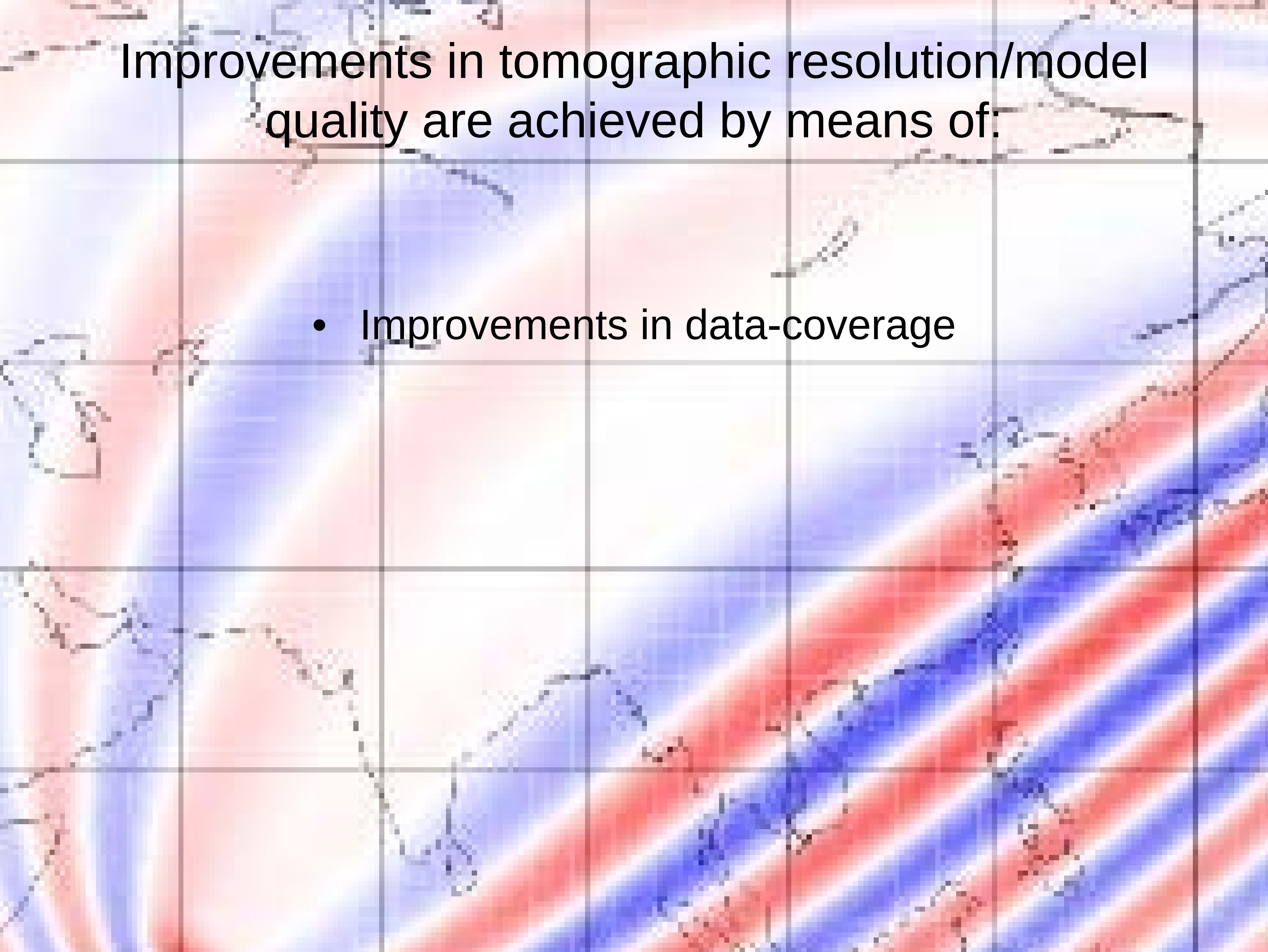
- Improvements in data-coverage



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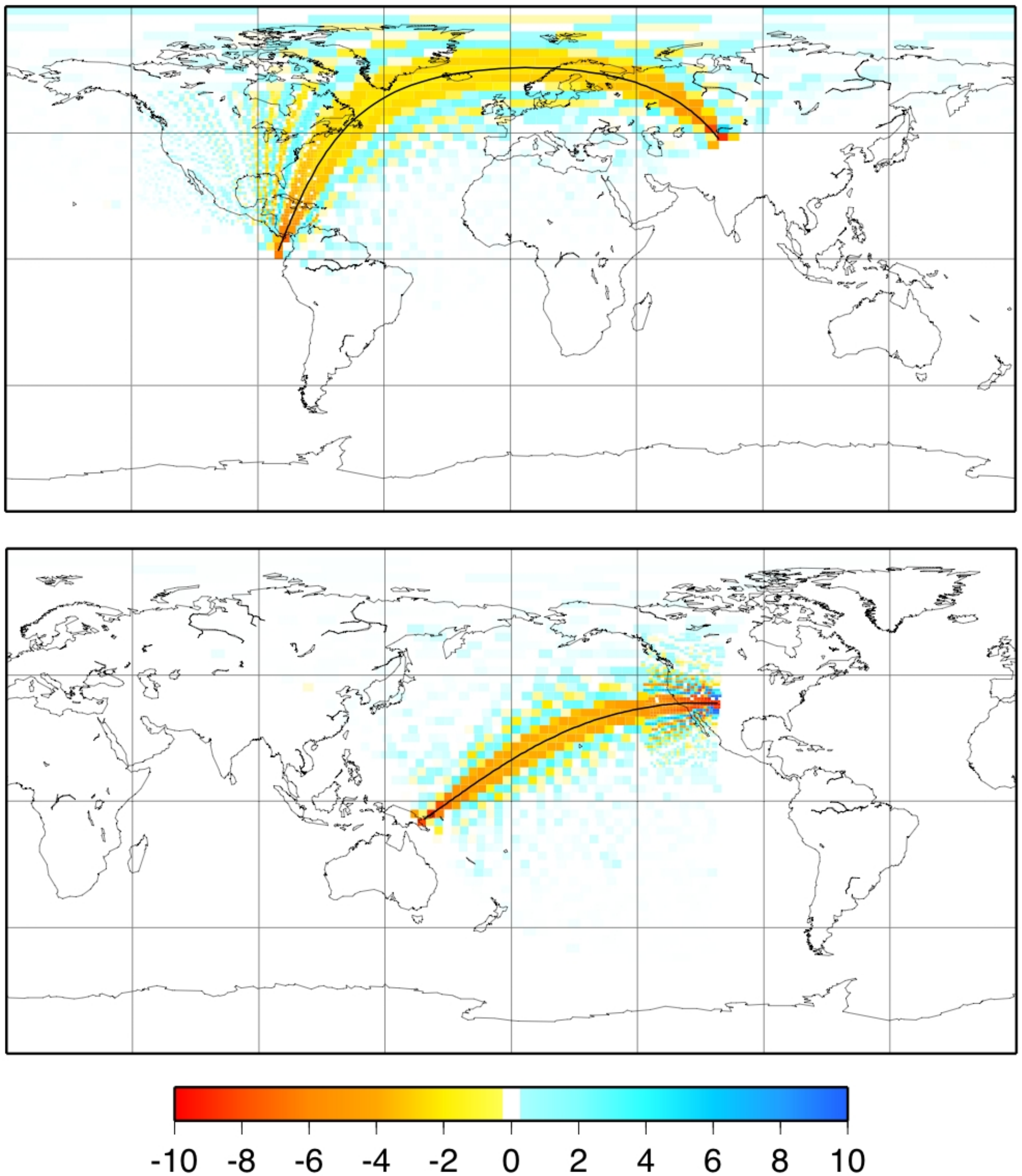
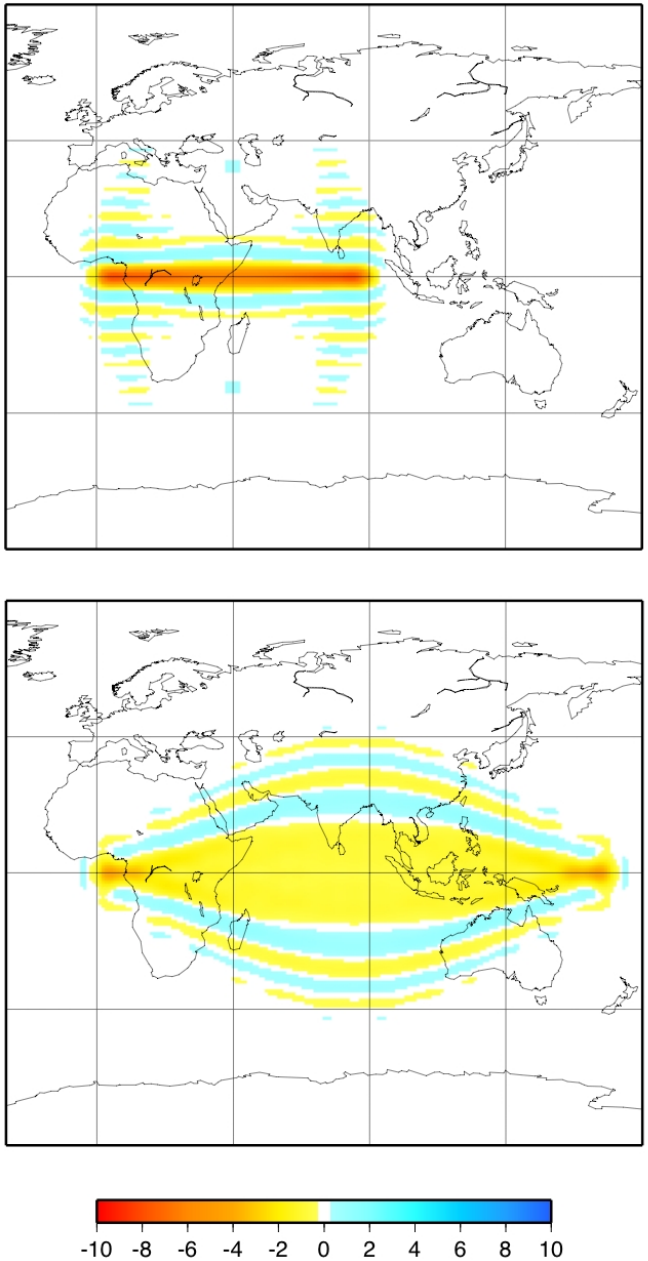
these factors are all coupled with each other from ray theory to finite frequency theory, and from uniform to multi-resolution parameterization

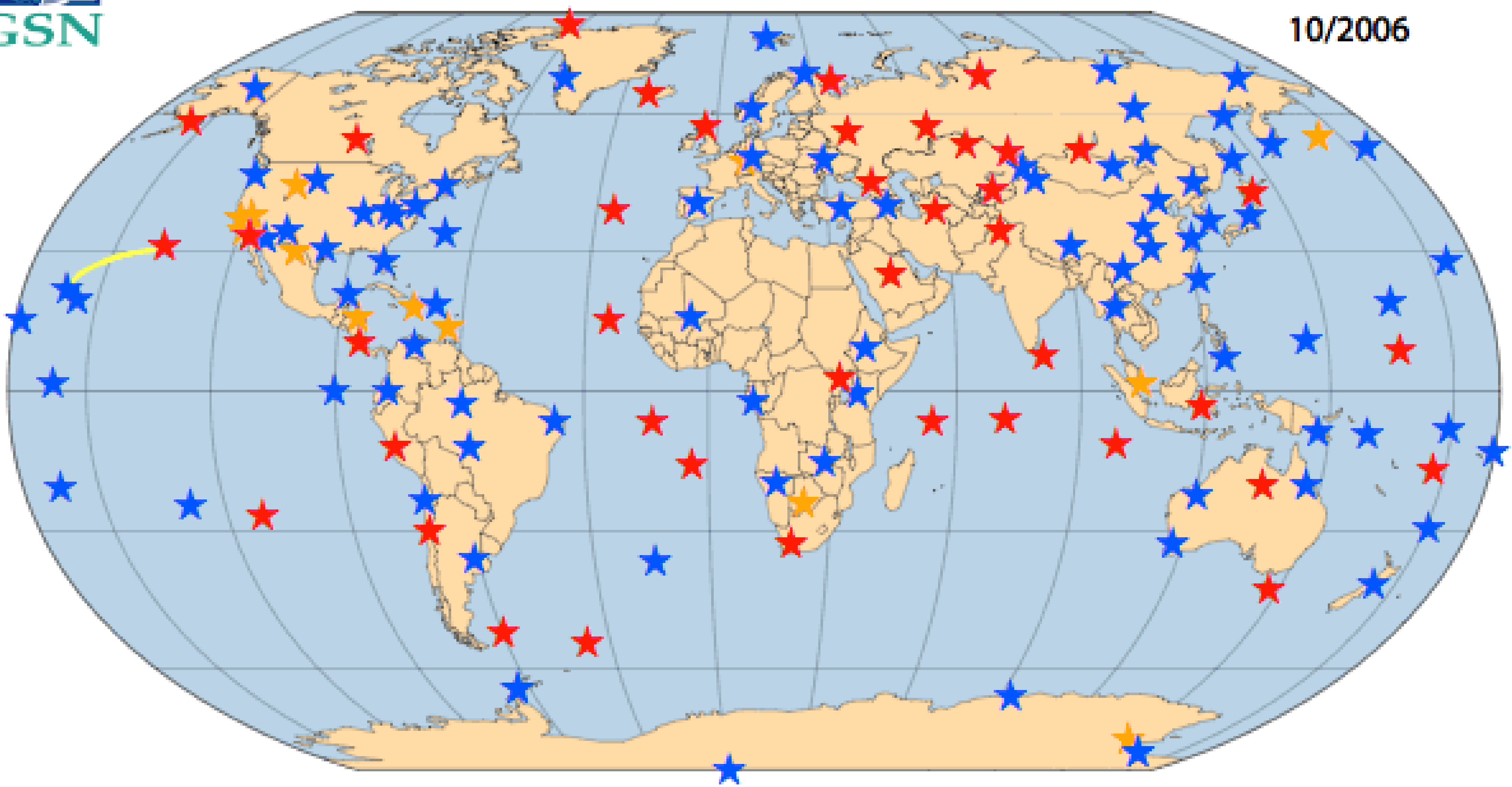


Uniform resolution parameterization: degree 40 harmonics

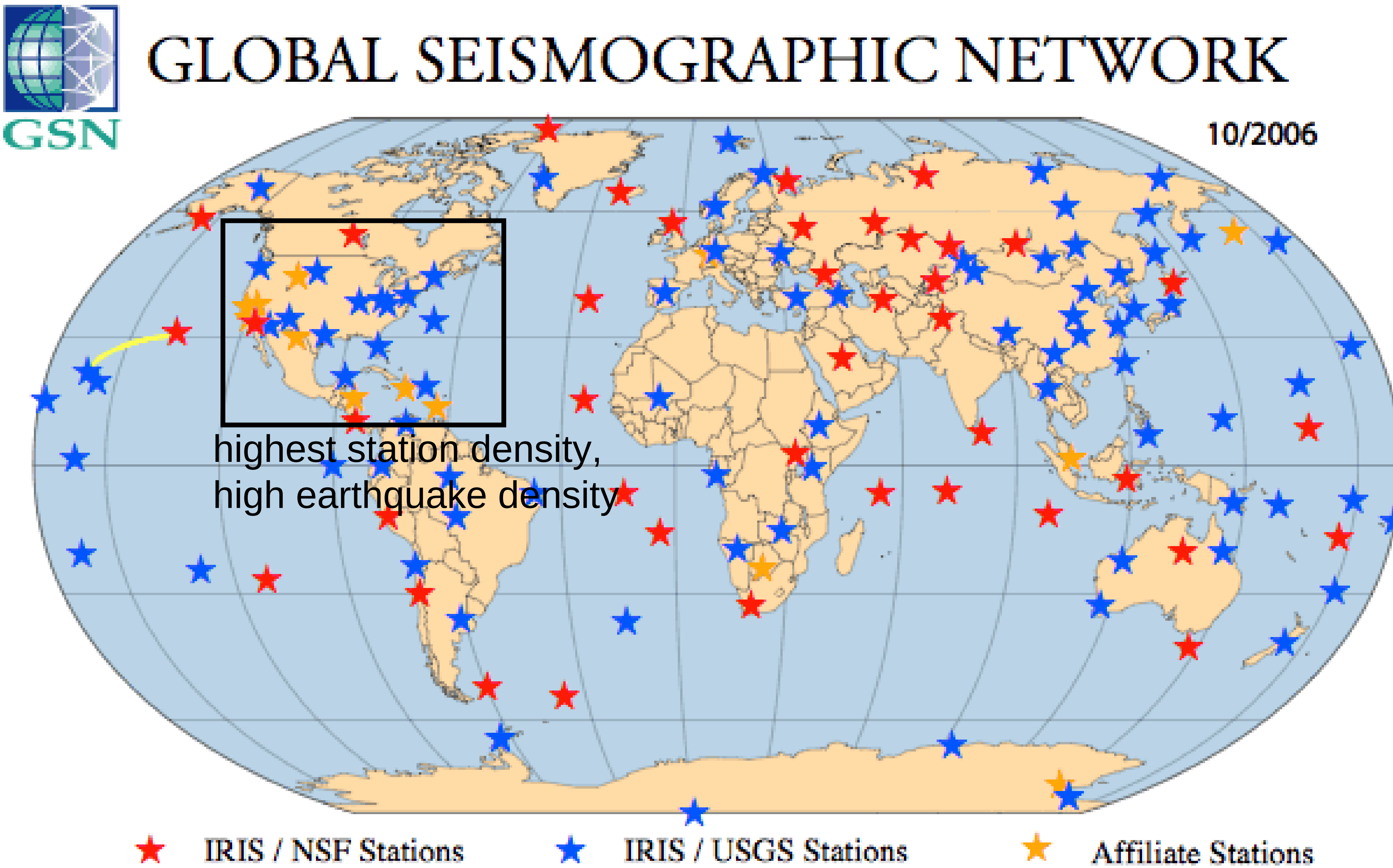


GSN

GLOBAL SEISMOGRAPHIC NETWORK



★ IRIS / NSF Stations ★ IRIS / USGS Stations ★ Affiliate Stations


GSN
GLOBAL SEISMOGRAPHIC NETWORK
10/2006
highest station density,
high earthquake density
IRIS / NSF Stations
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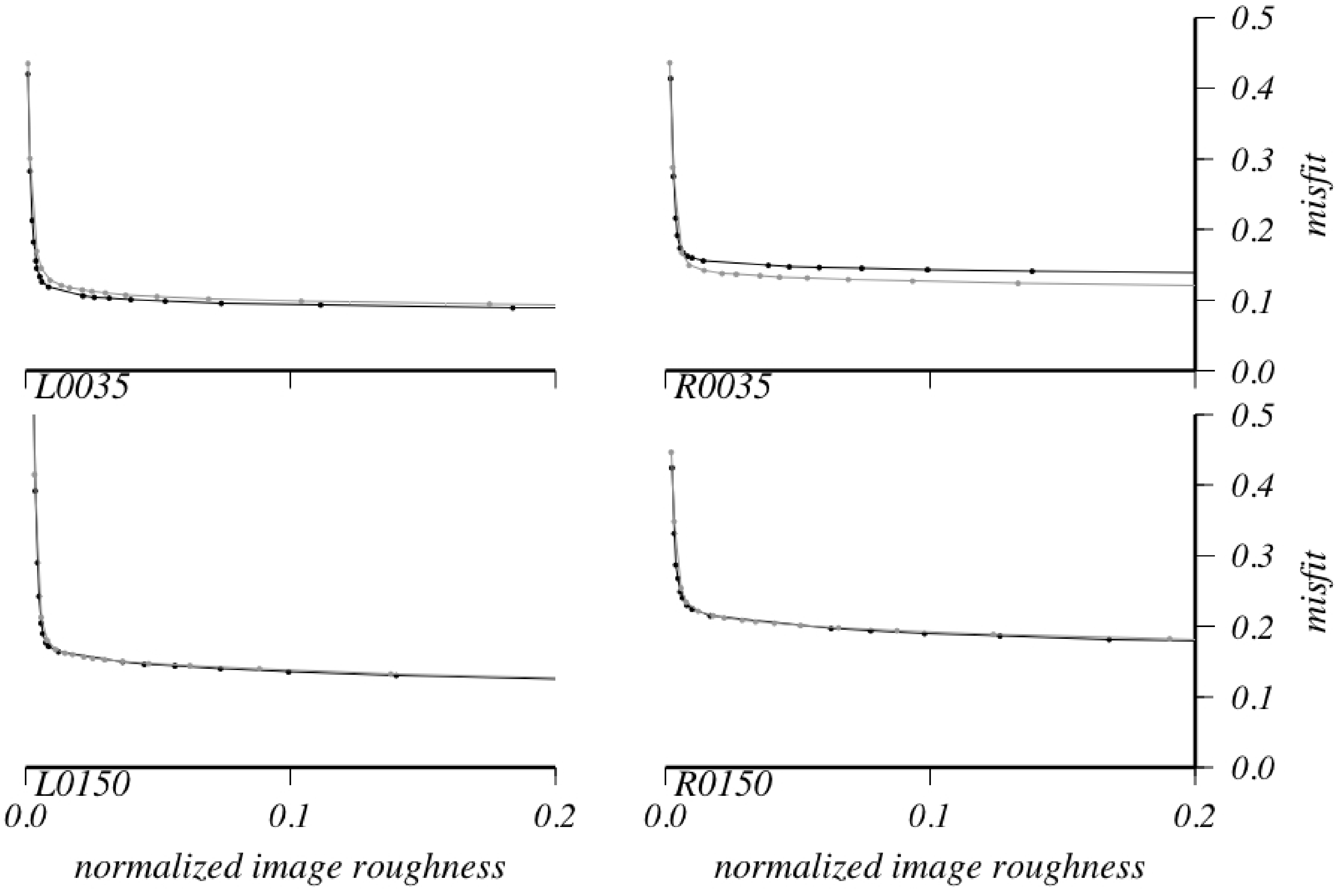
ray- vs. finite-frequency-theory: trade-off (L-curve) analysis



RAY

Love 150s

BORN

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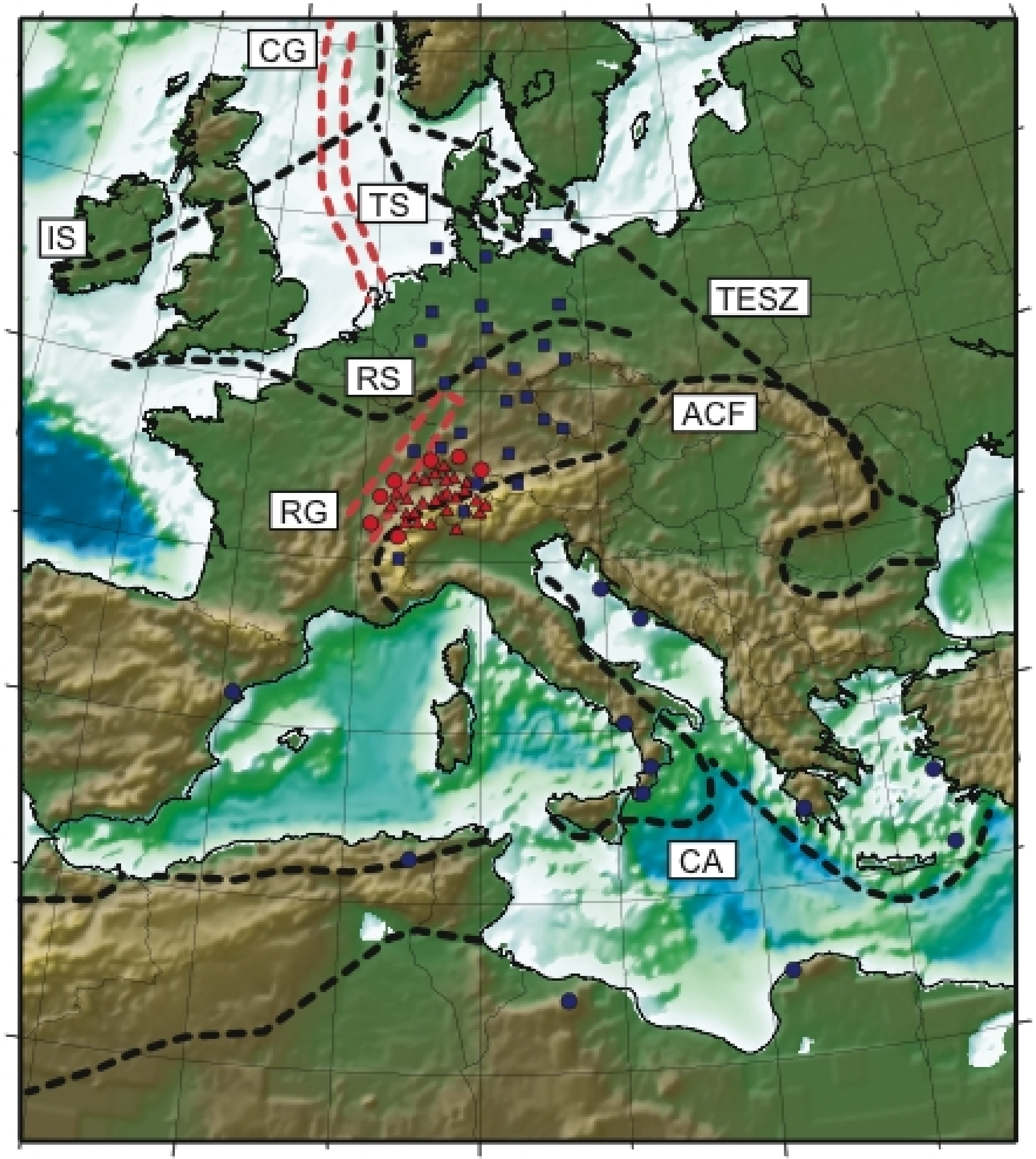
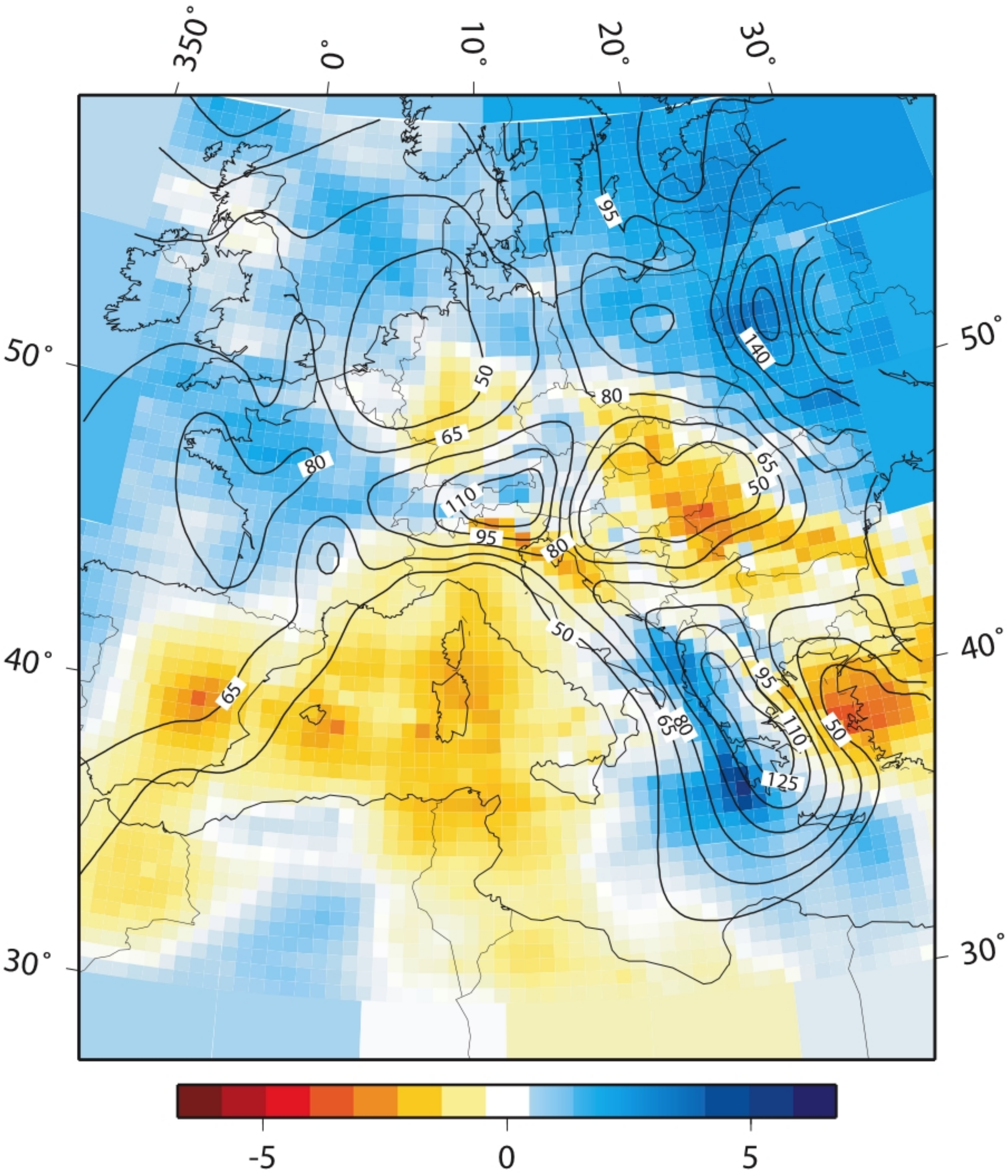
Improving coverage of the European/mediterranean region



50s Rayleigh phase-speed, and depth to 900°C isotherm



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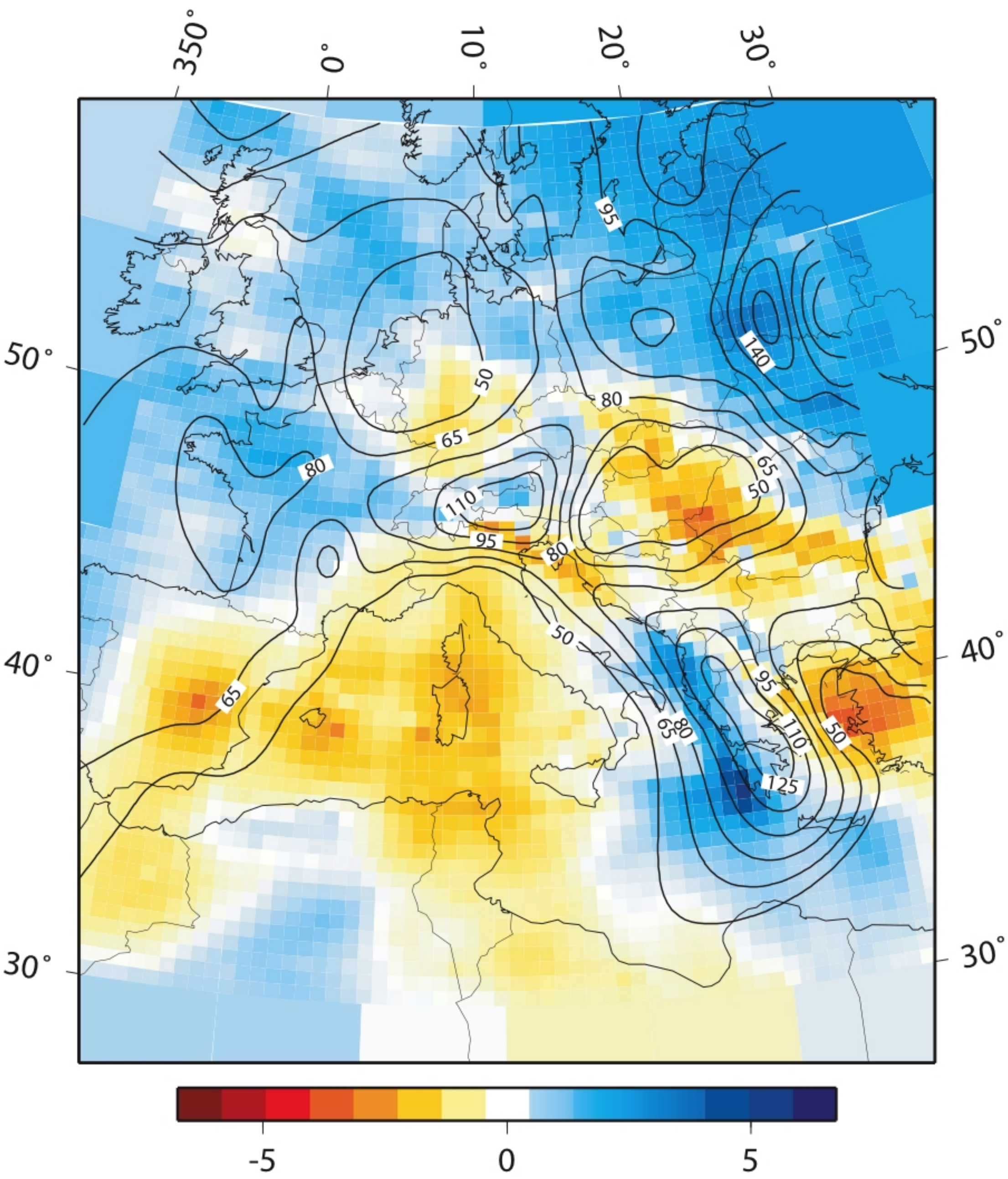
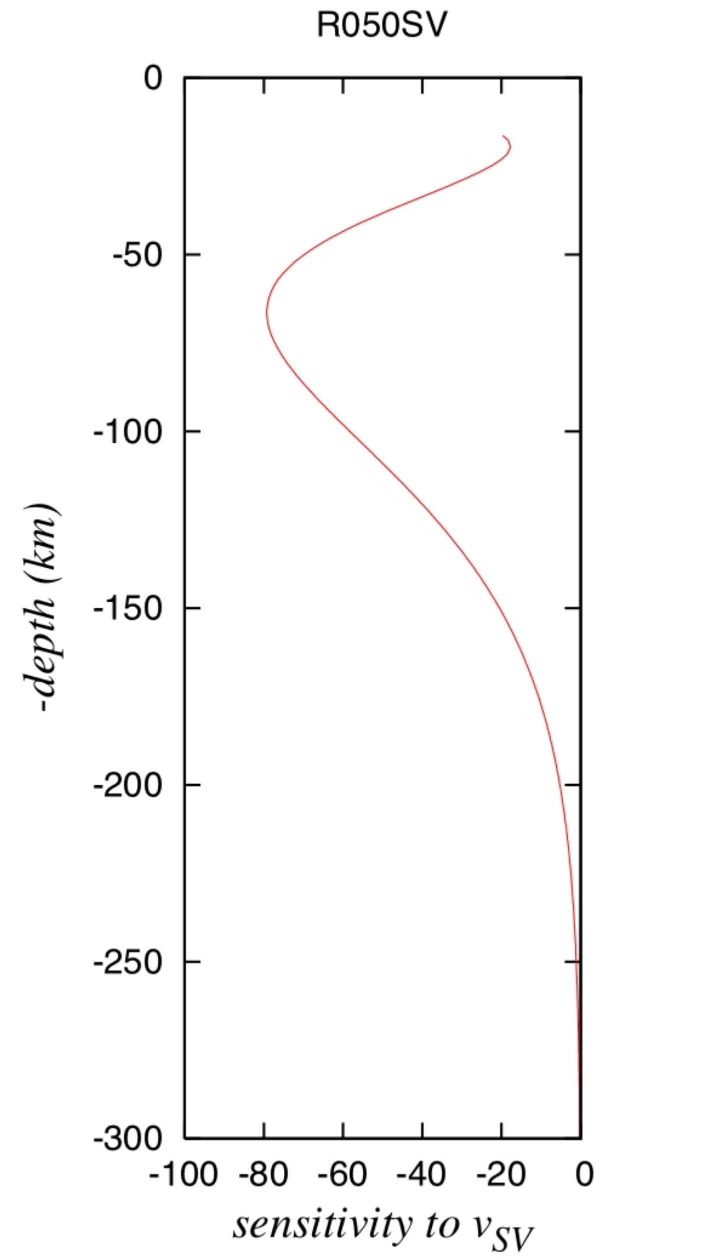
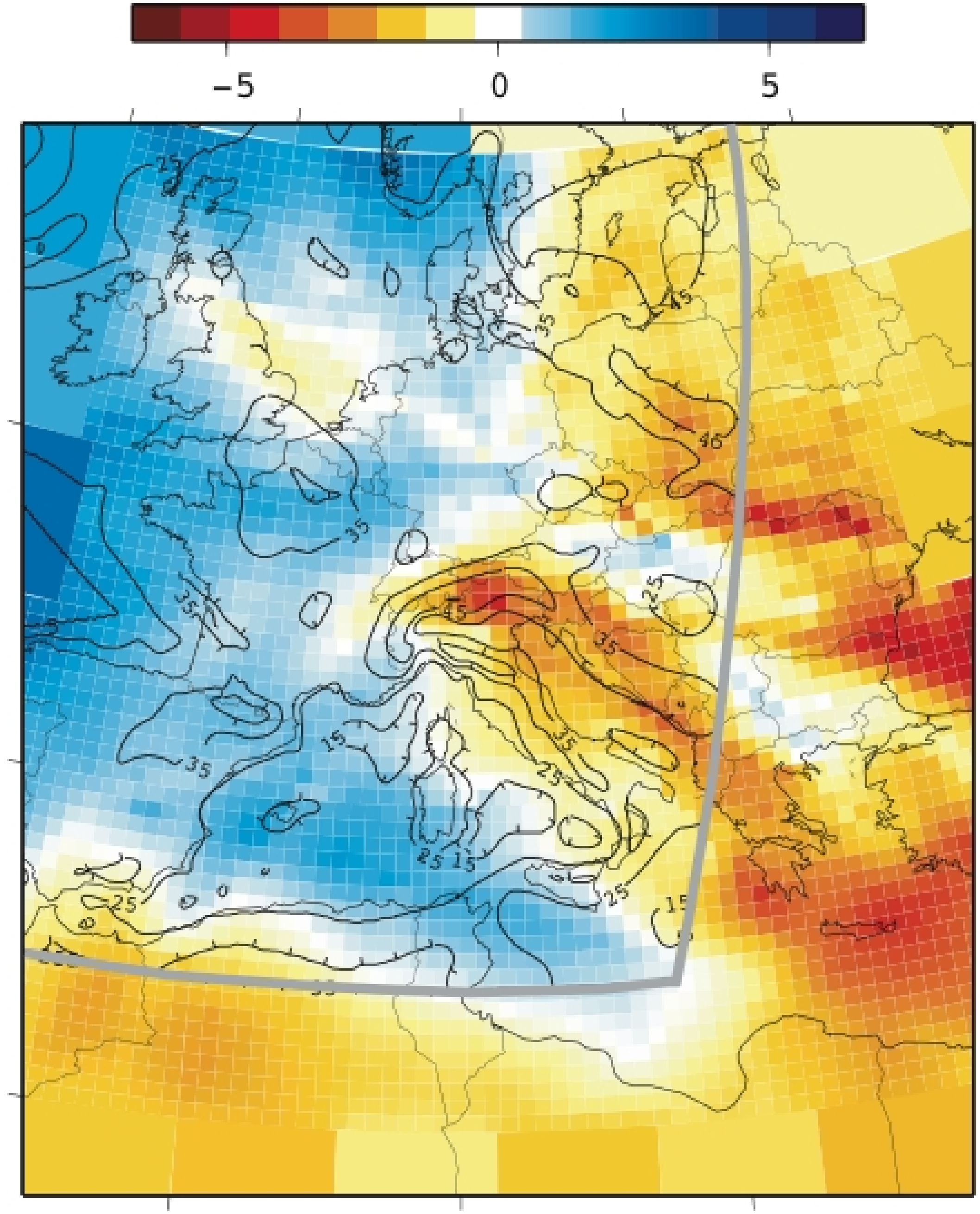




35s Love and Moho depth



RAY

L35

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RAY

R35

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RAY

L150

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Conclusions

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- in our North America experiment (data coverage still not optimal) account of single scattering did not alter tomographic images significantly.
- in our Europe experiment, significant single-scattering effects are noted in at least one surface-wave mode. We are not ready yet to prove that this reflects an improvement in image quality.