Mechanical thickness of the continents worldwide: A re-analysis

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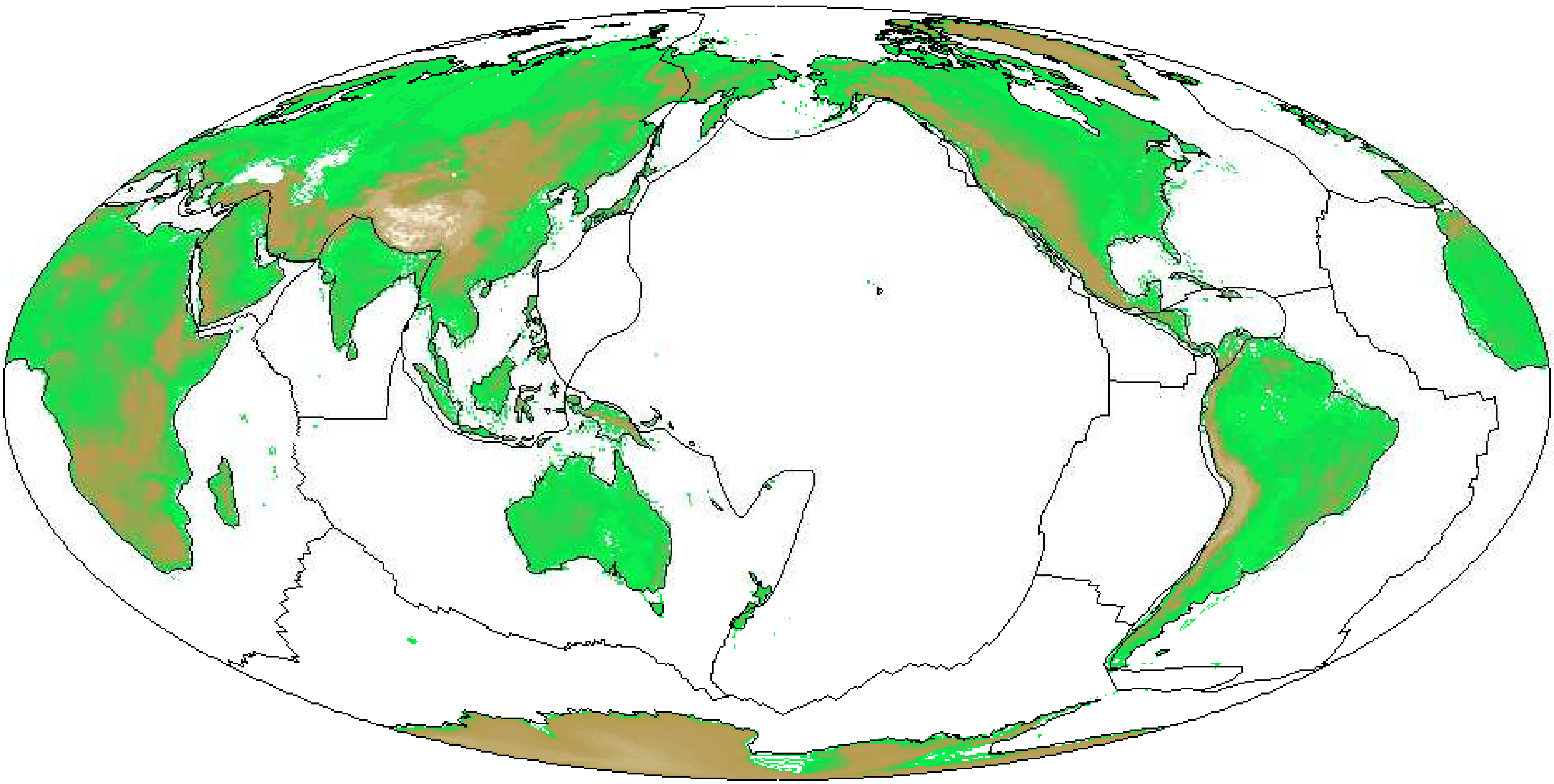
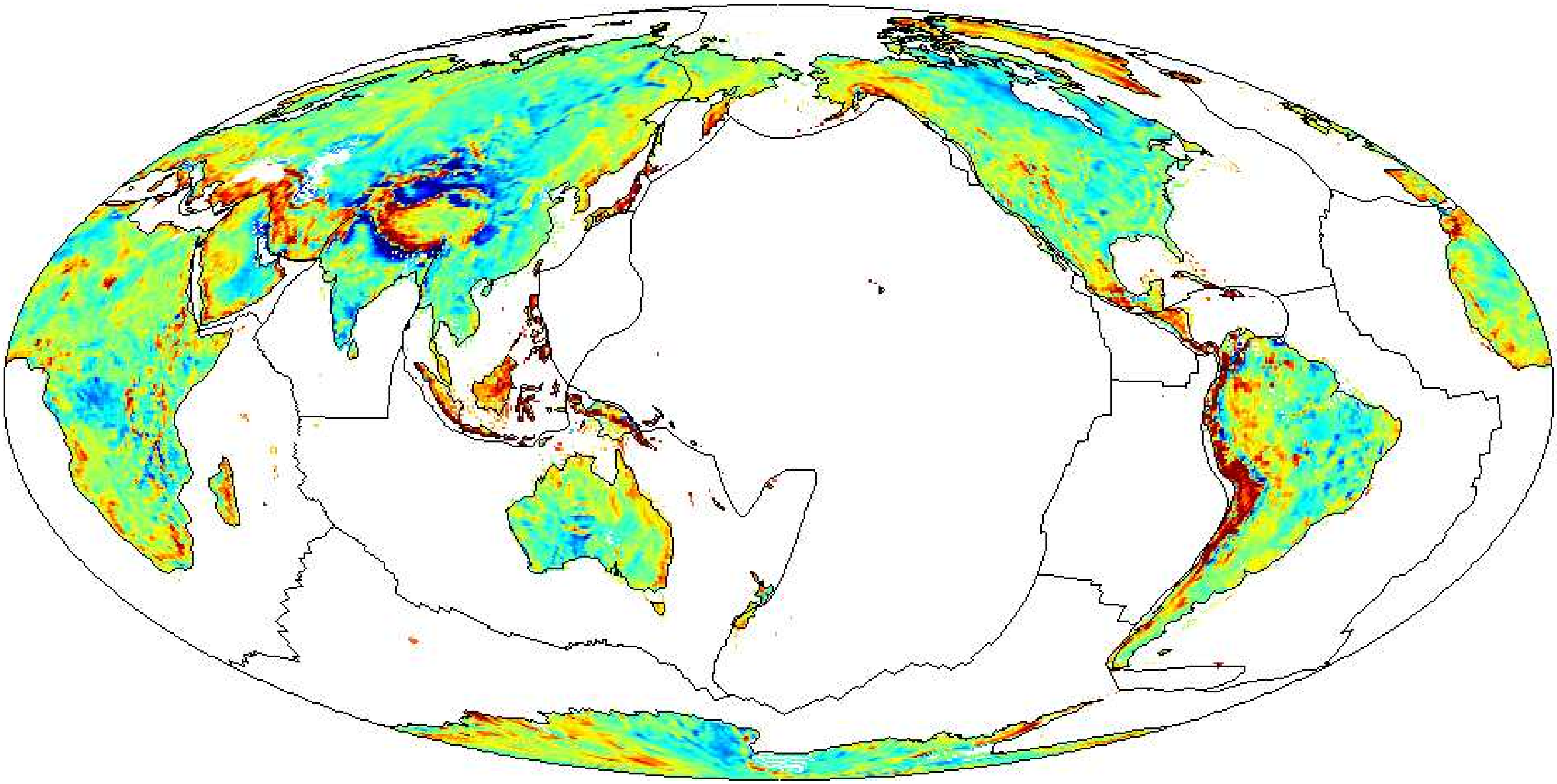
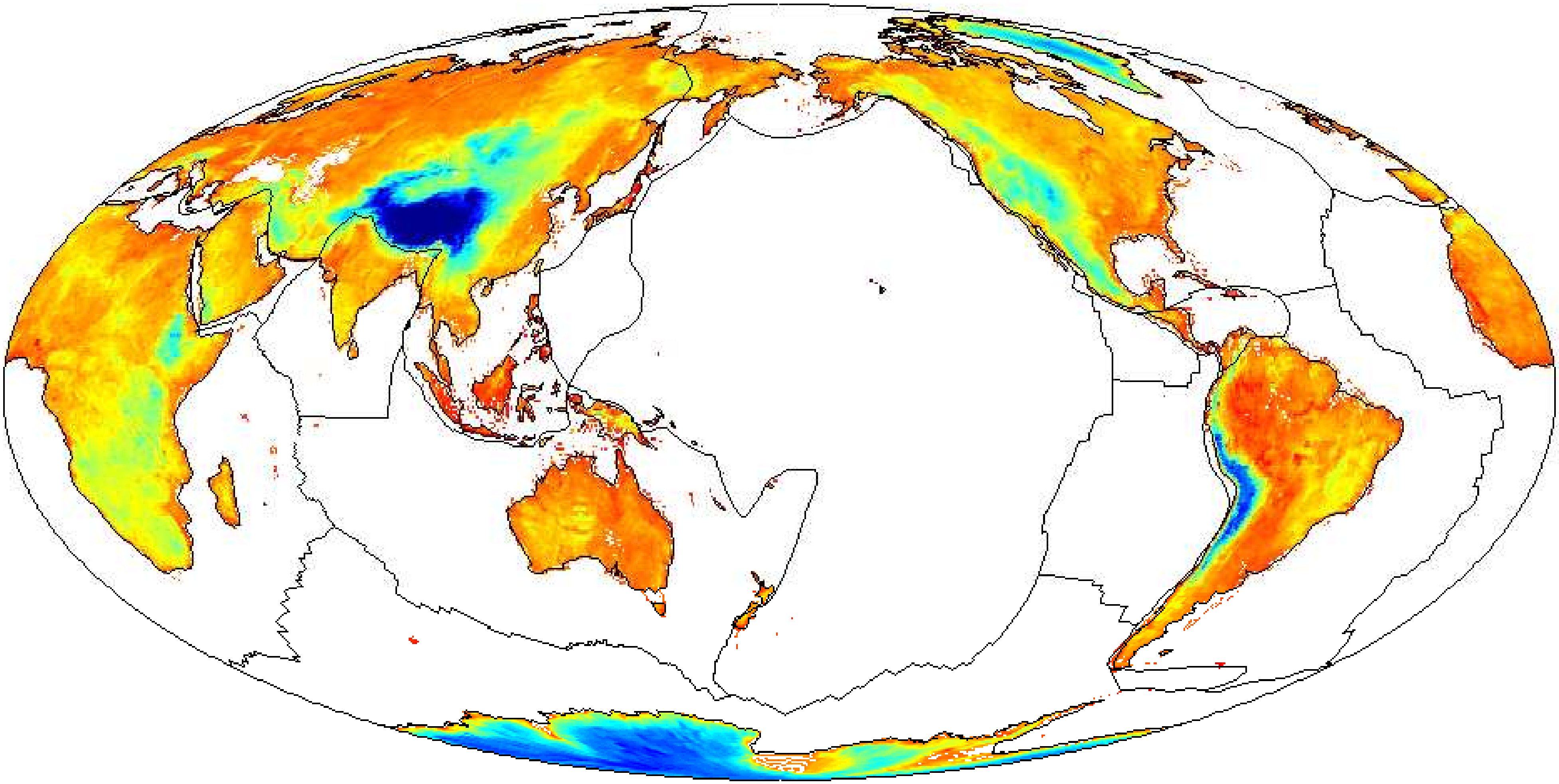
Ingredient 1: Topography



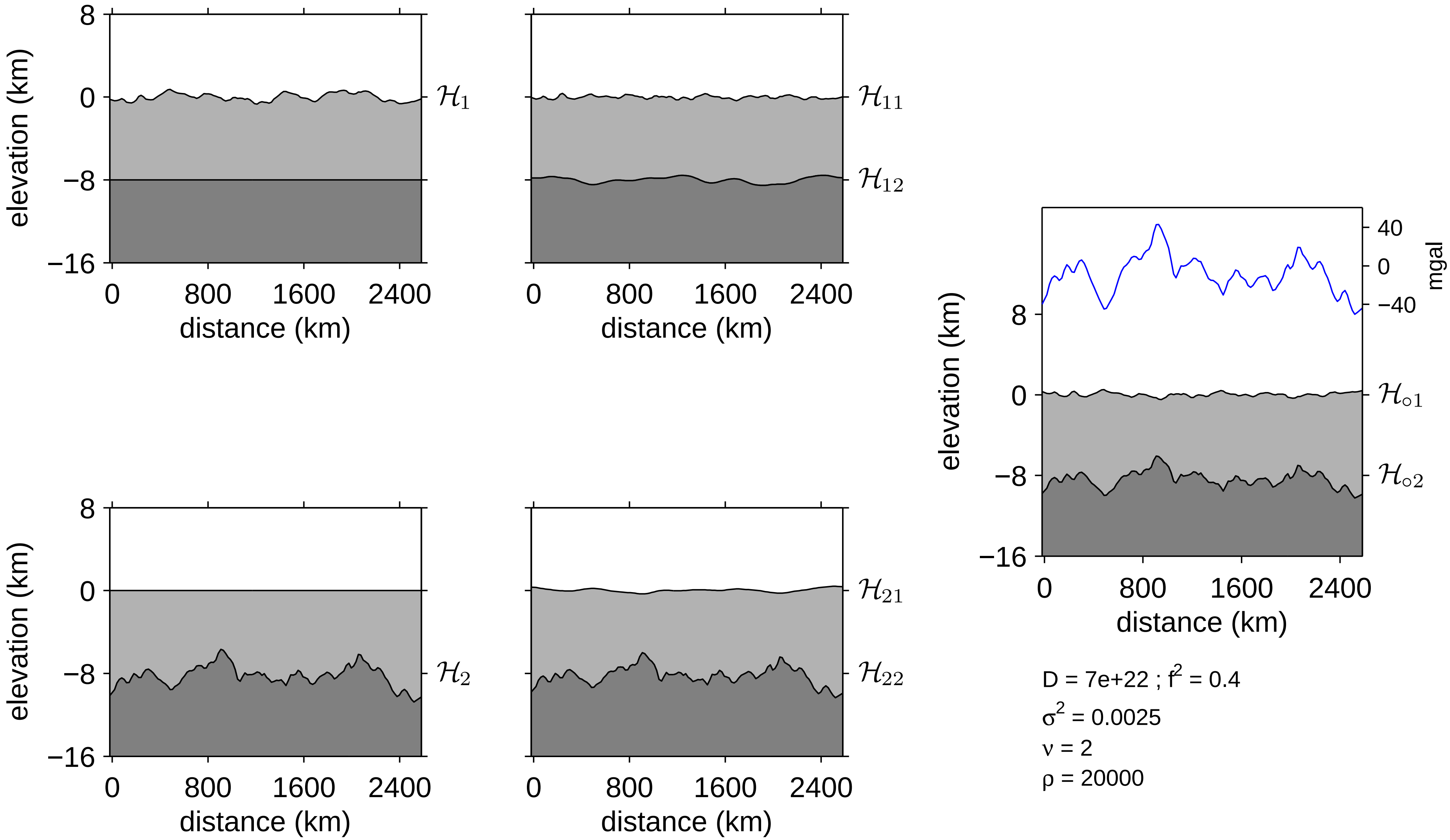
Ingredient 3: Free-air gravity



Ingredient 3: Bouguer gravity



The standard model



D = 7e+22 ; f^2 = 0.4

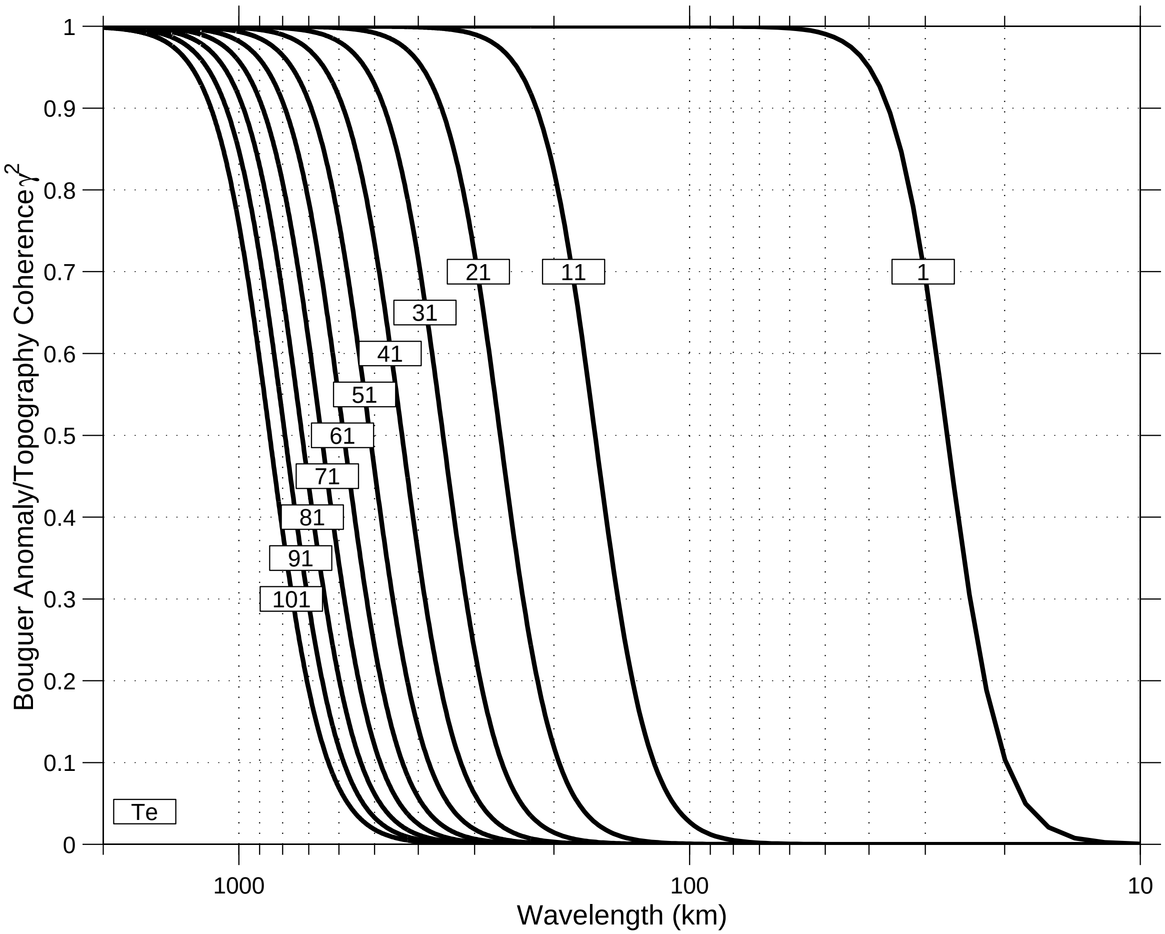
σ^2 = 0.0025

ν = 2

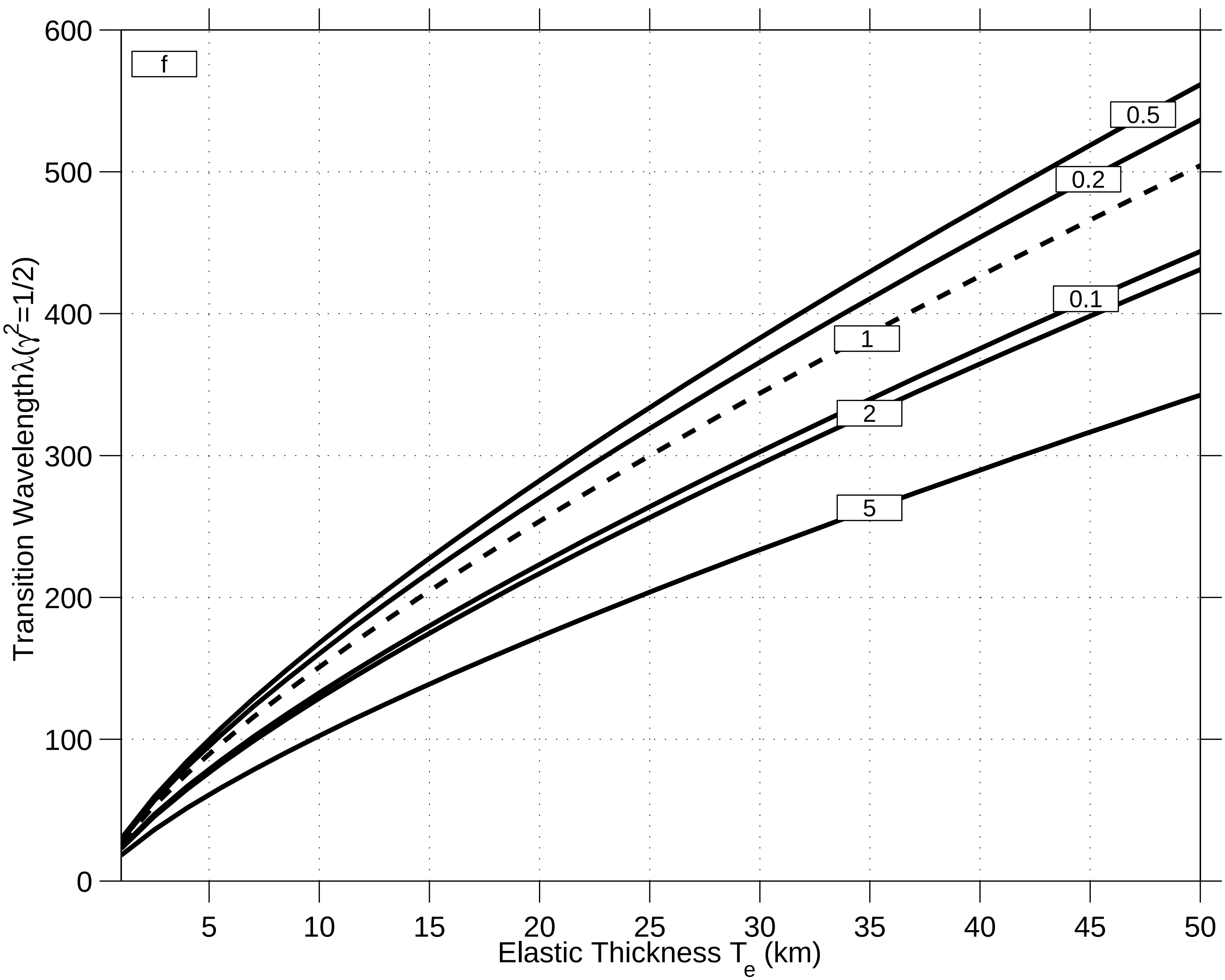
ρ = 20000

Coherence

Flexural rigidity D in a simple two-layer lithosphere.



The half-coherence wavelength



Simons & van der Hilst *EPSL* 2003

Spectral analysis: bias & variance

Measuring the coherence between two stochastic fields, gravity and topography, requires careful **data tapering** and **averaging** to **suppress** or **control**

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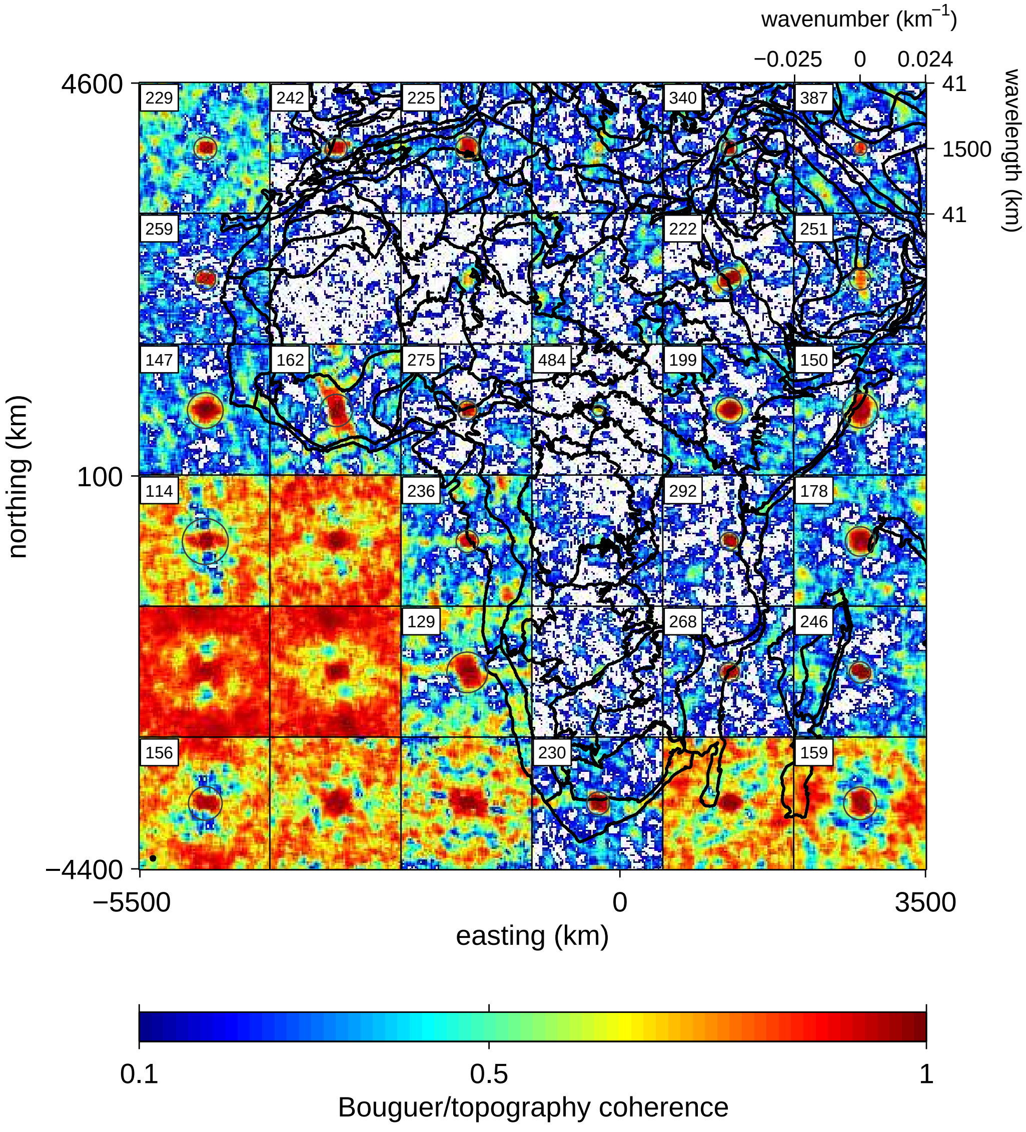
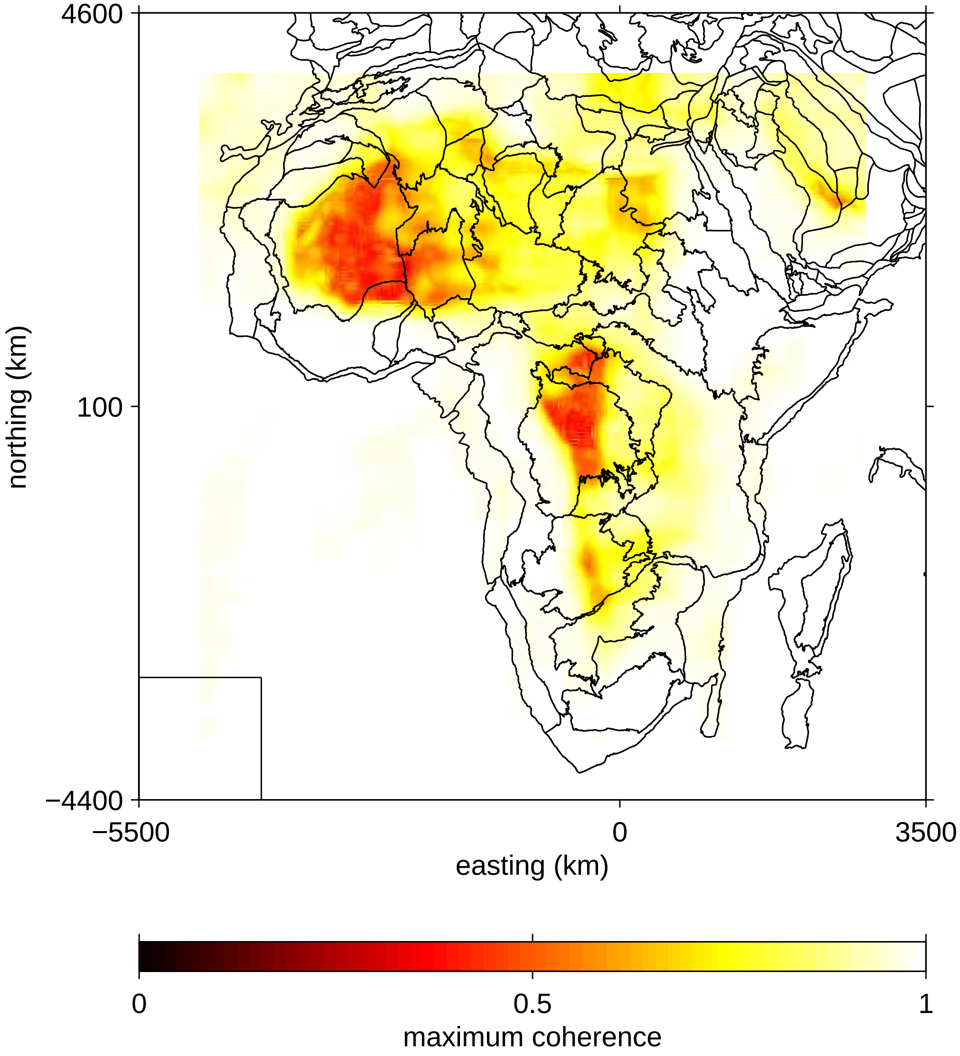
No matter how well we are able to measure coherence, the result is a non-Gaussian quantity whose least-squares inversion under the Forsyth model with two parameters has led to many different results. We have developed an alternative, but here we'll use coherence **within the limits of the standard model**.

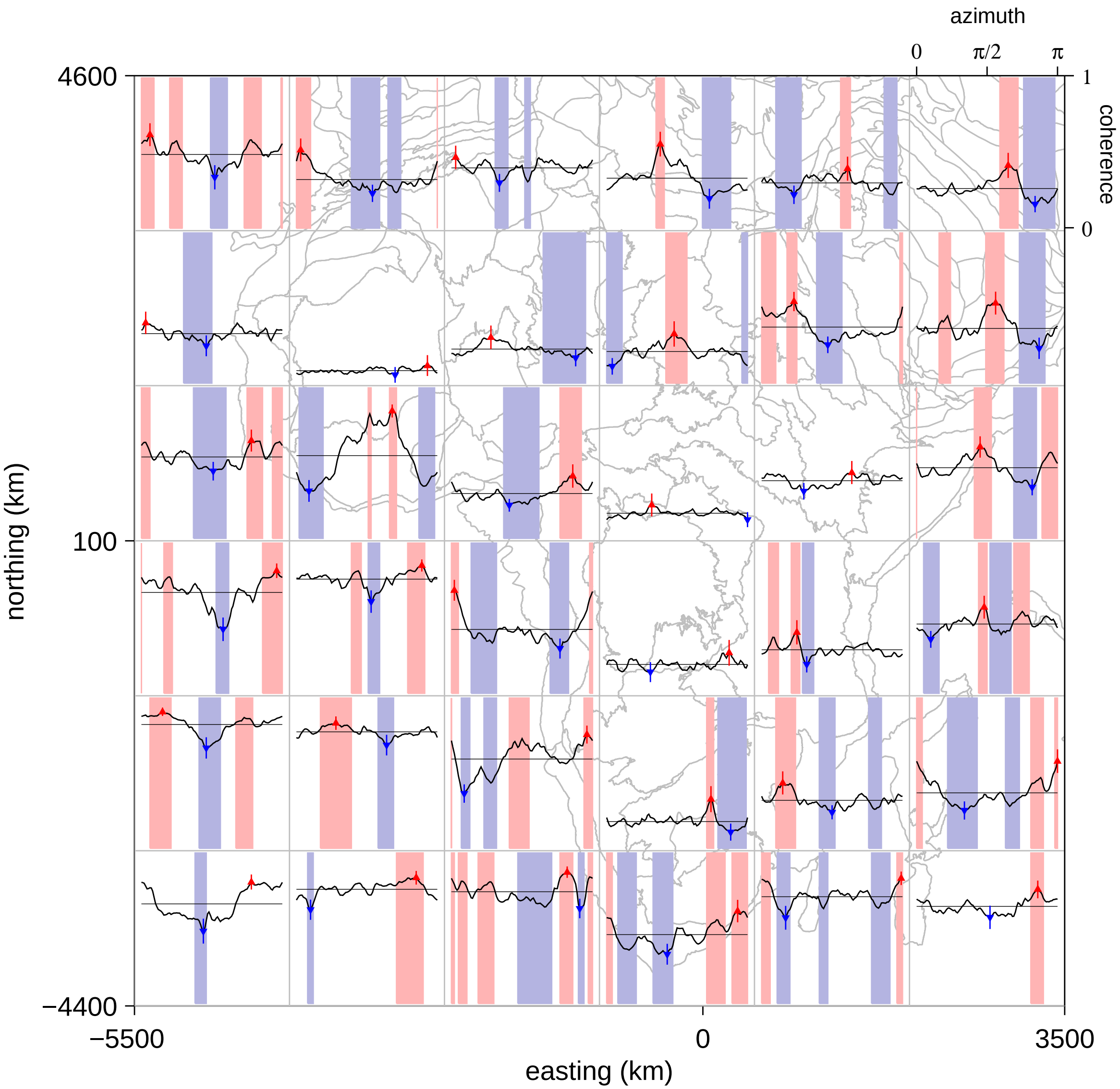
2D Coherence (1400 km)



Maximum coherence (1400 km)



Azimuthal dependence — first pass (1400 km)



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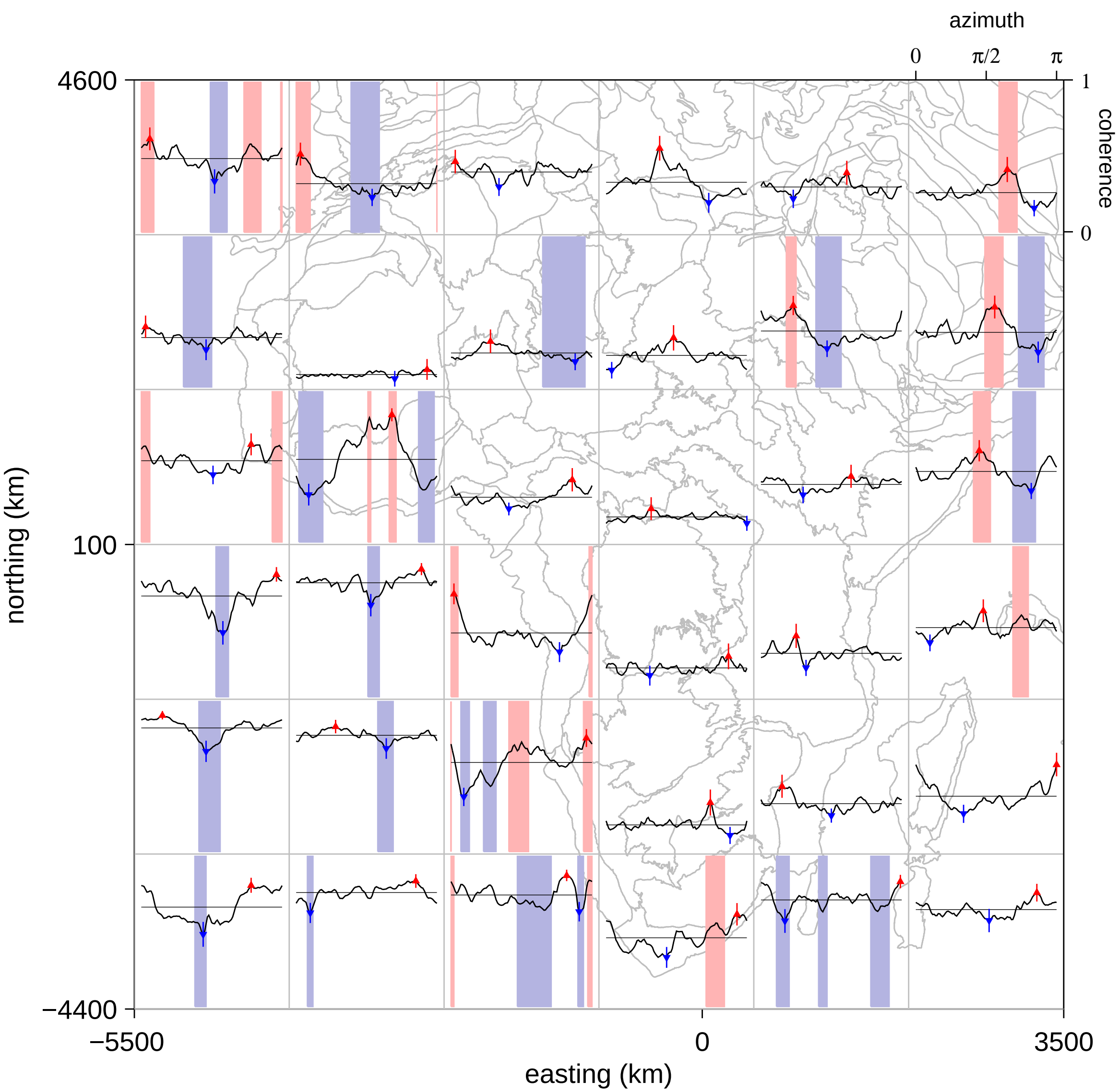
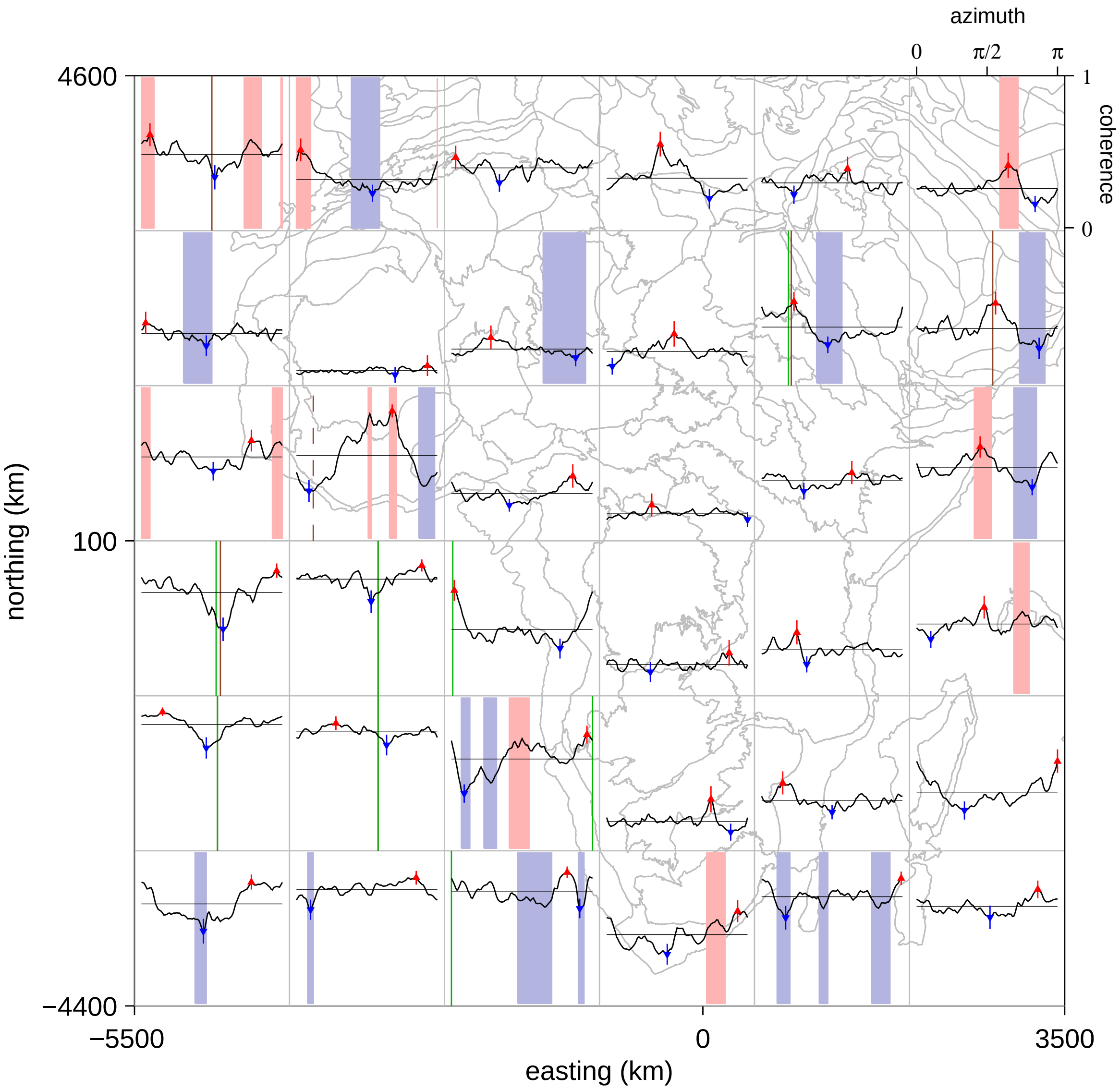


Azimuthal dependence — third pass (1400 km)



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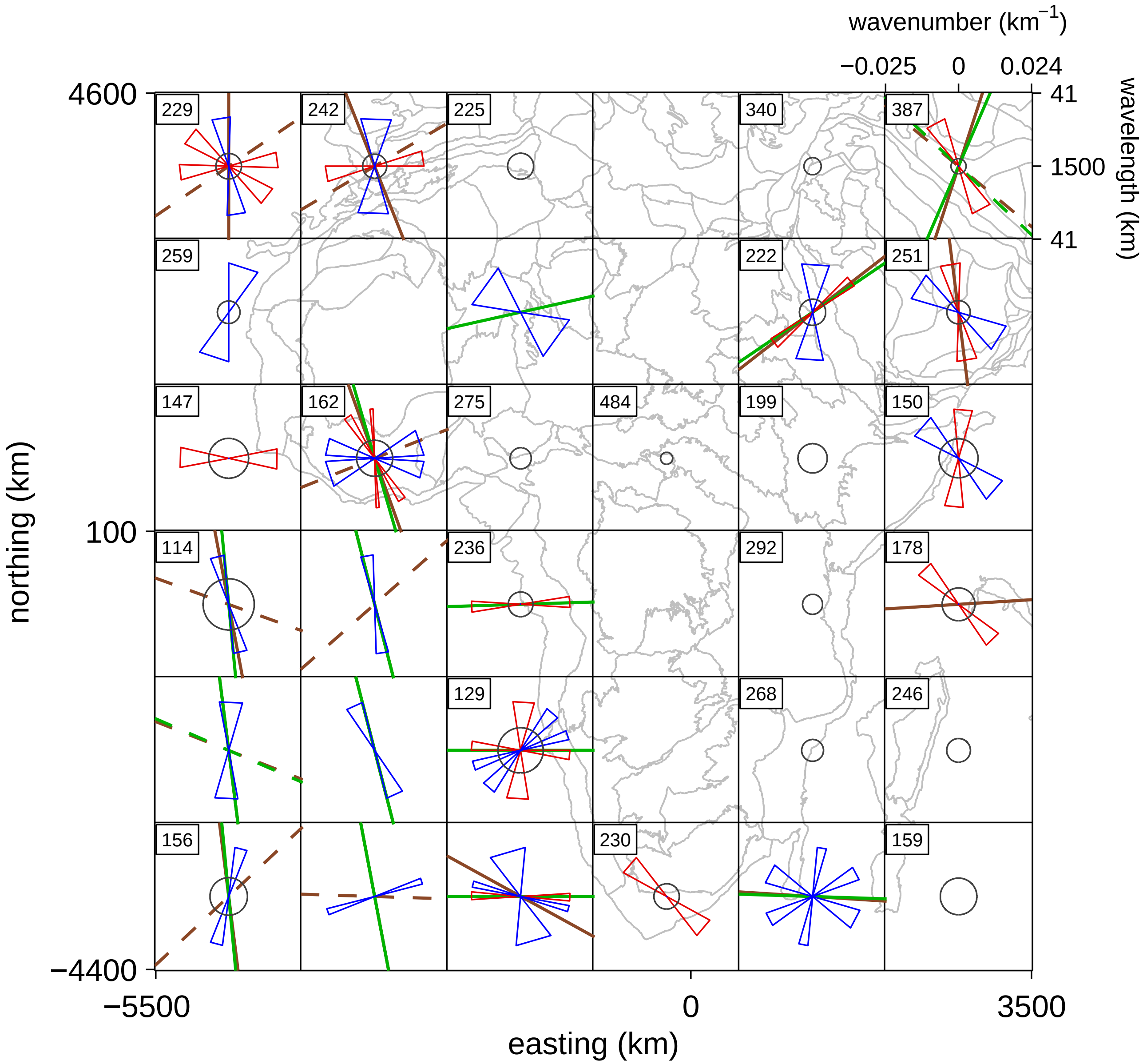
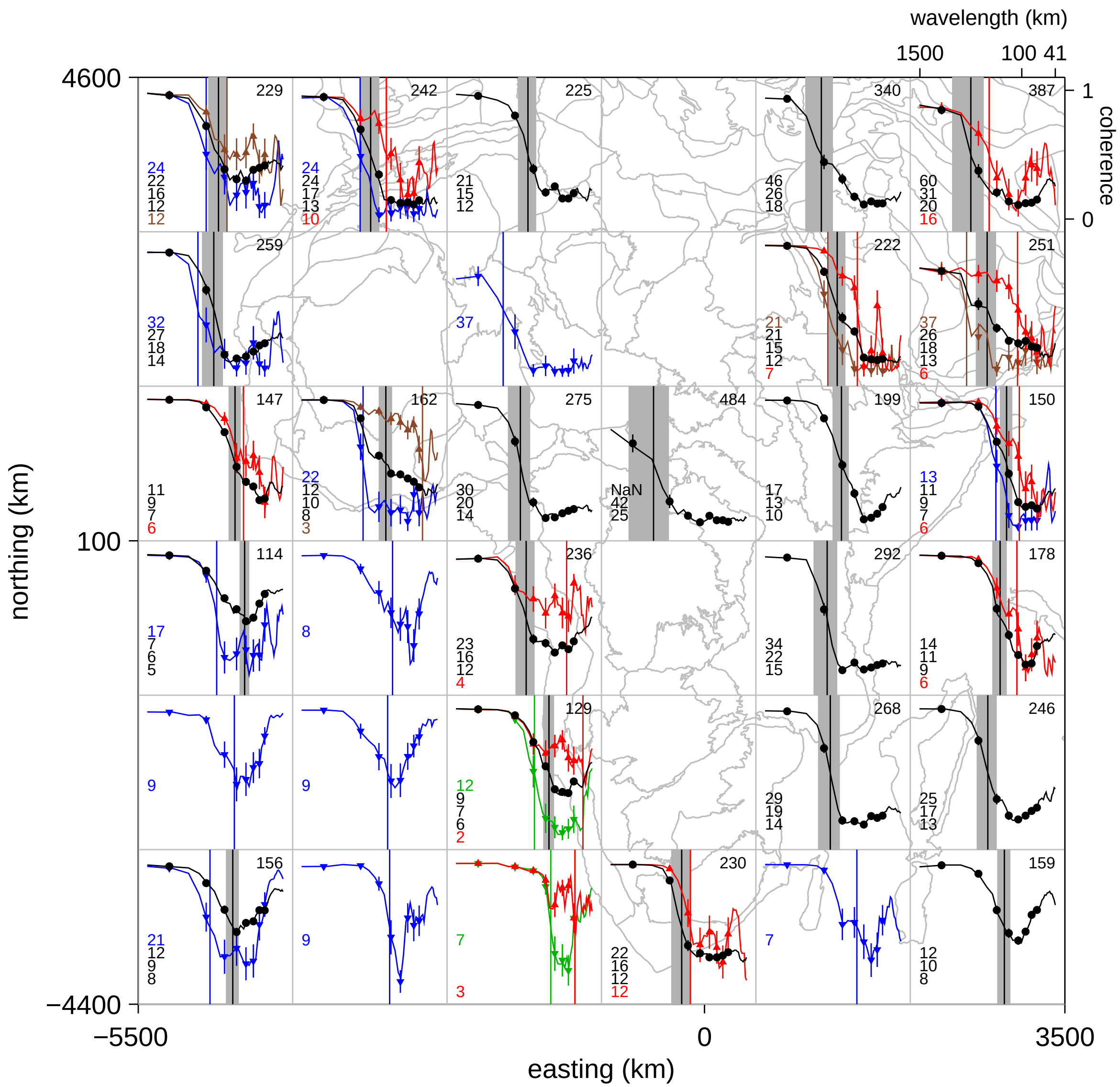
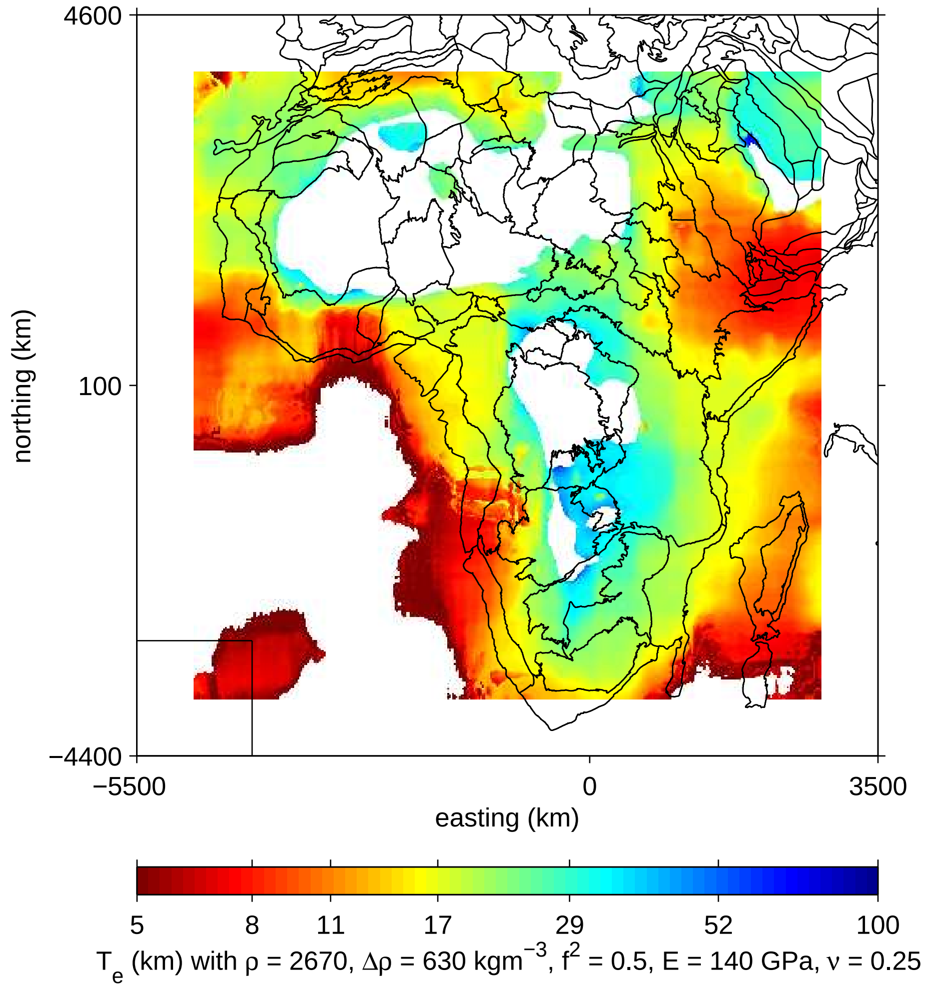


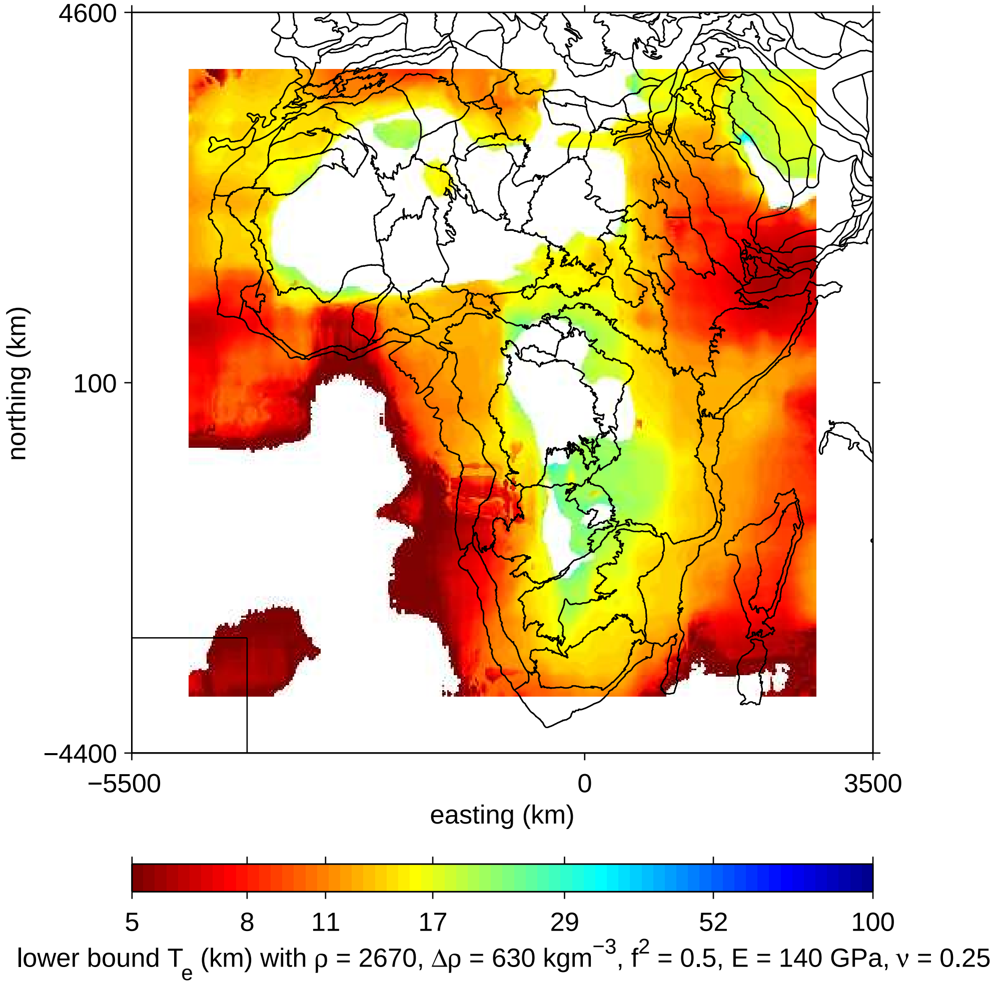
Wavenumber dependence (1400 km)



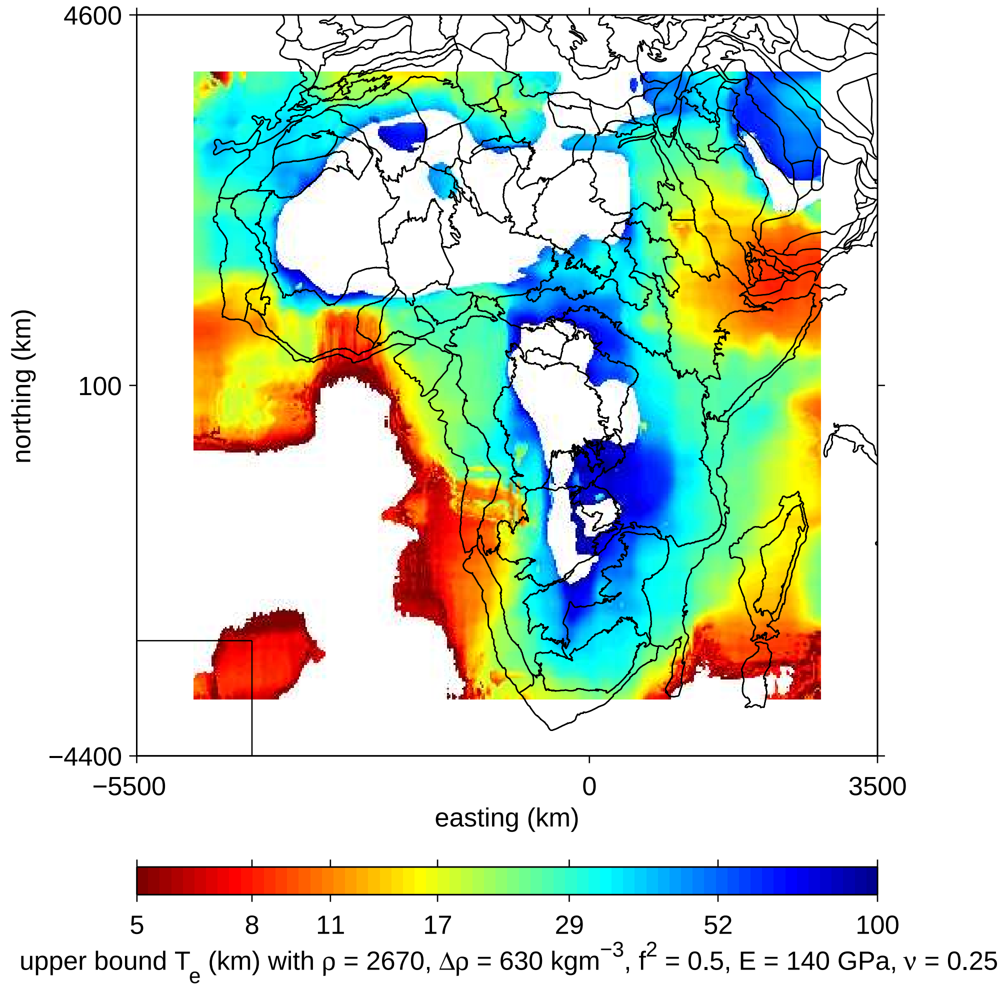
Elastic thickness, best estimate (1400 km)



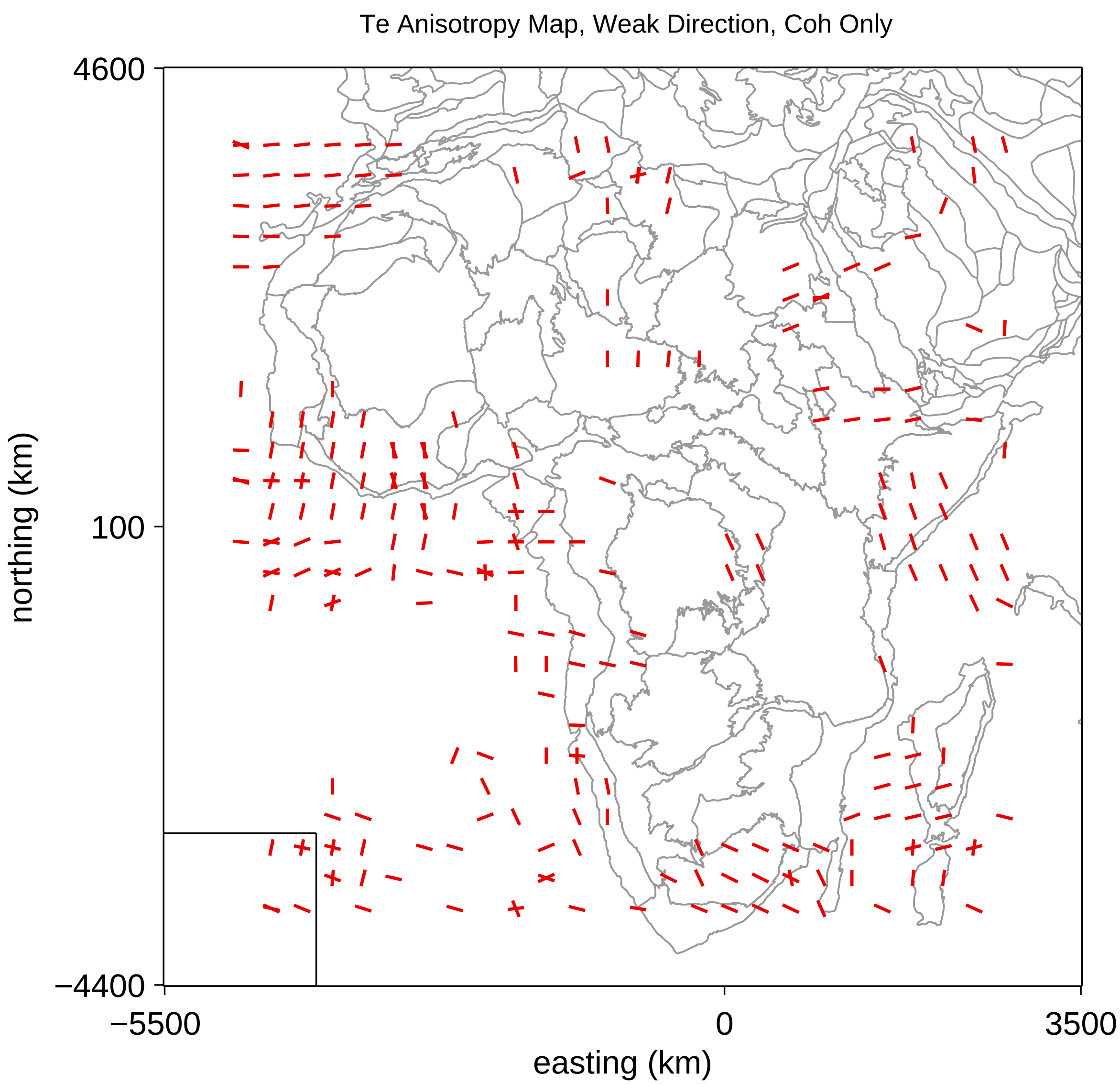
Elastic thickness, lower bound (1400 km)



Elastic thickness, upper bound (1400 km)



Anisotropy, grid-based (1400 km)



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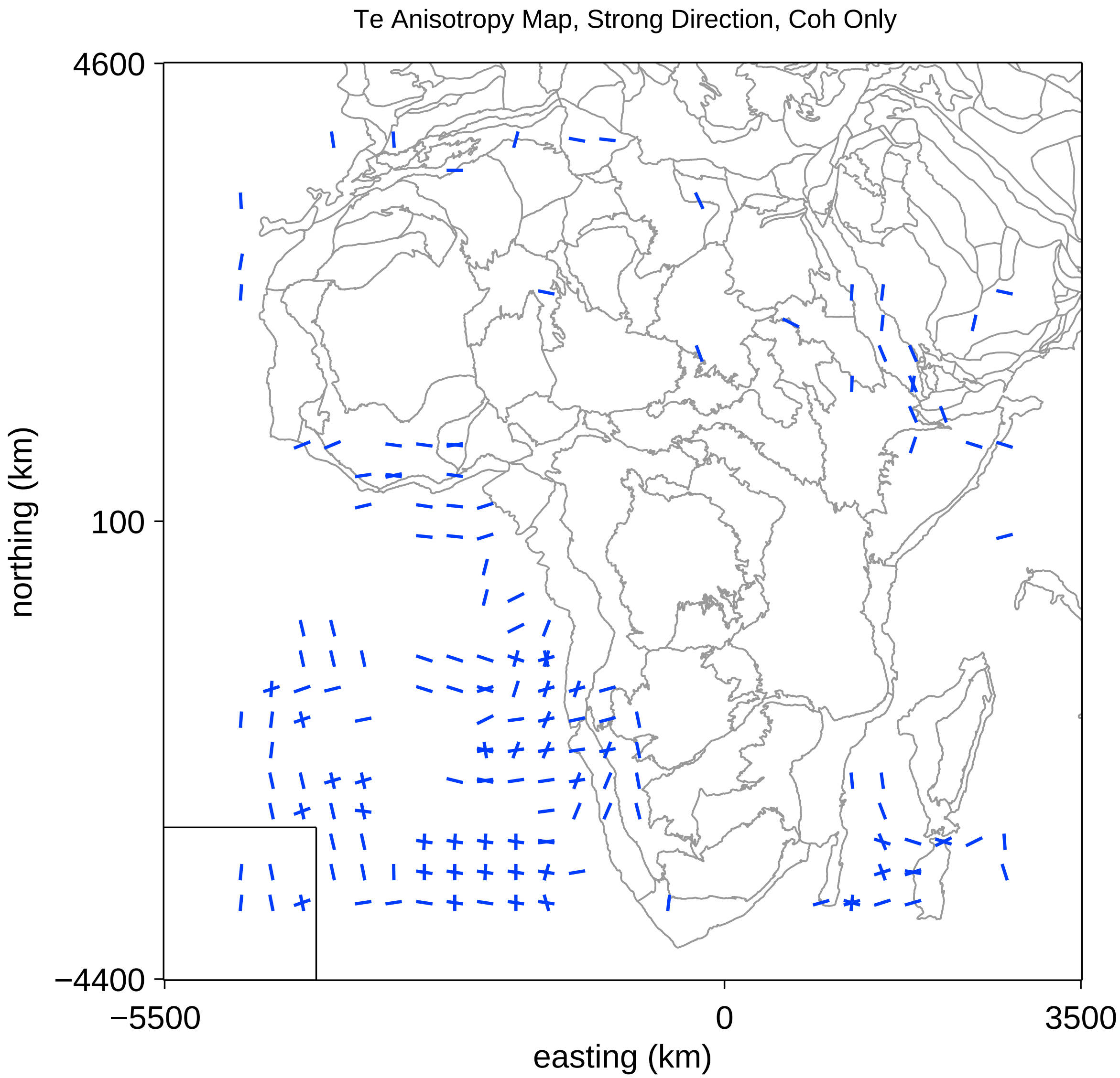
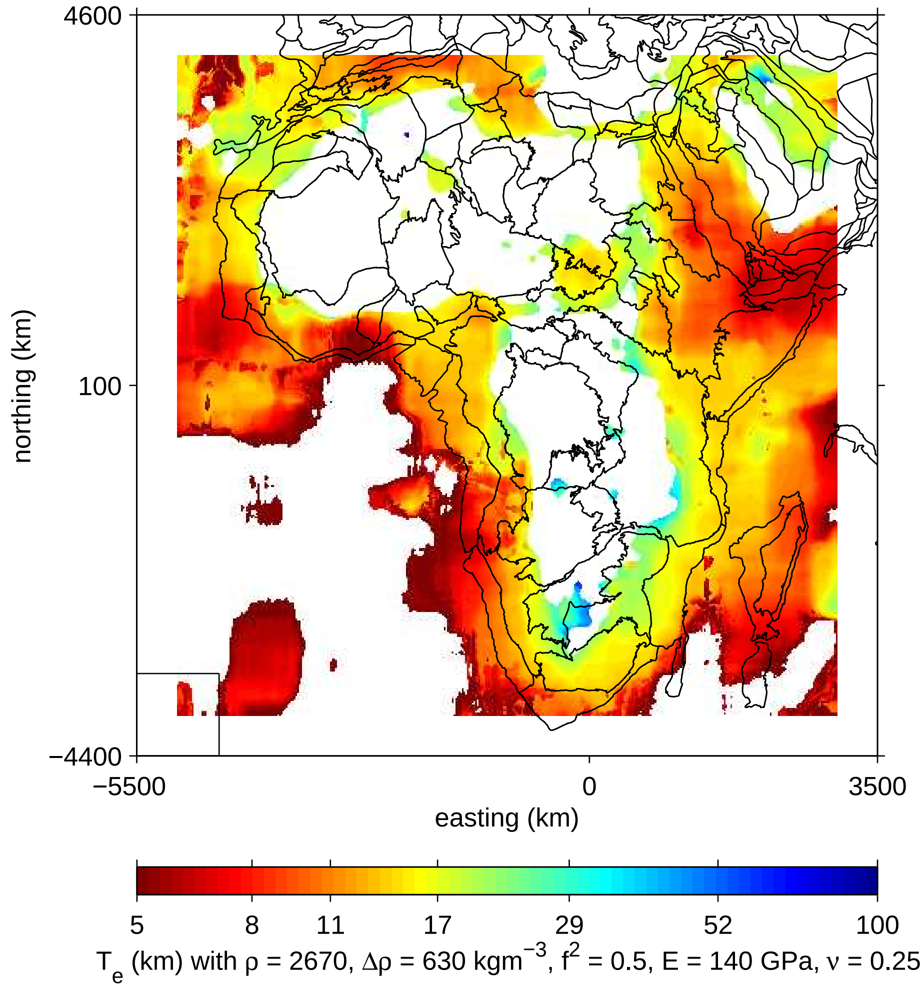
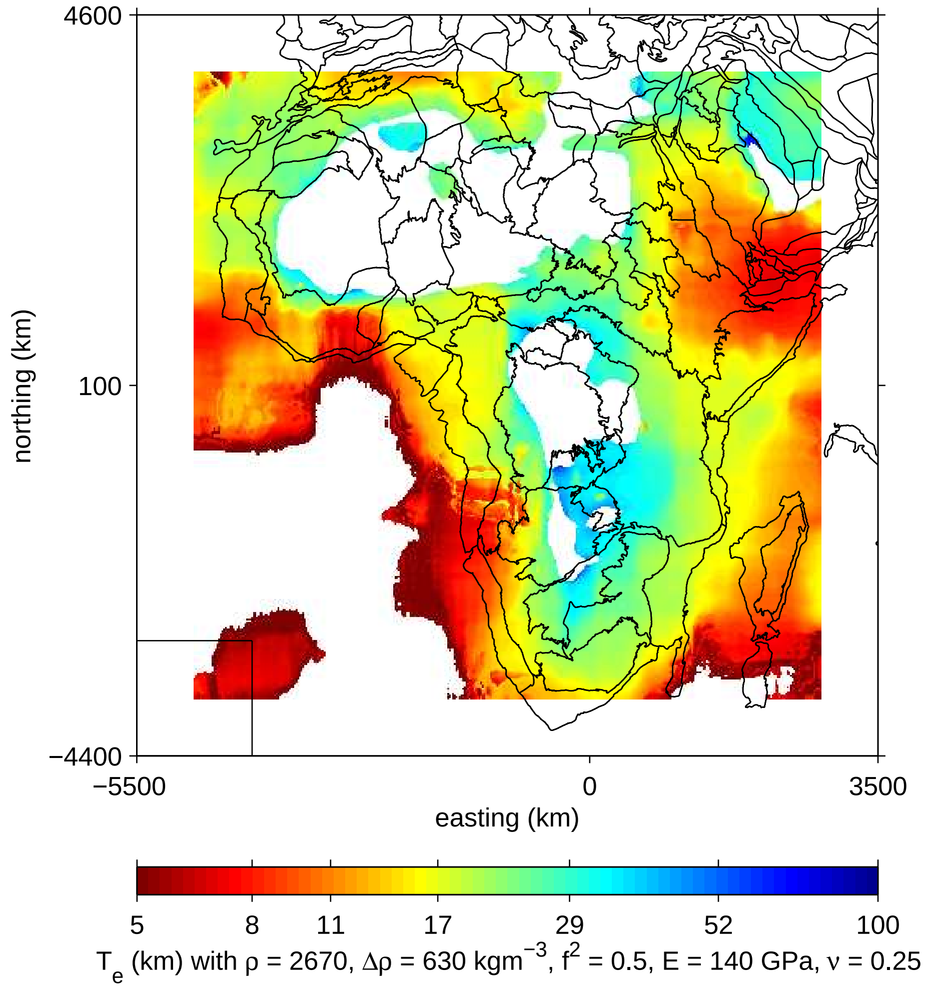


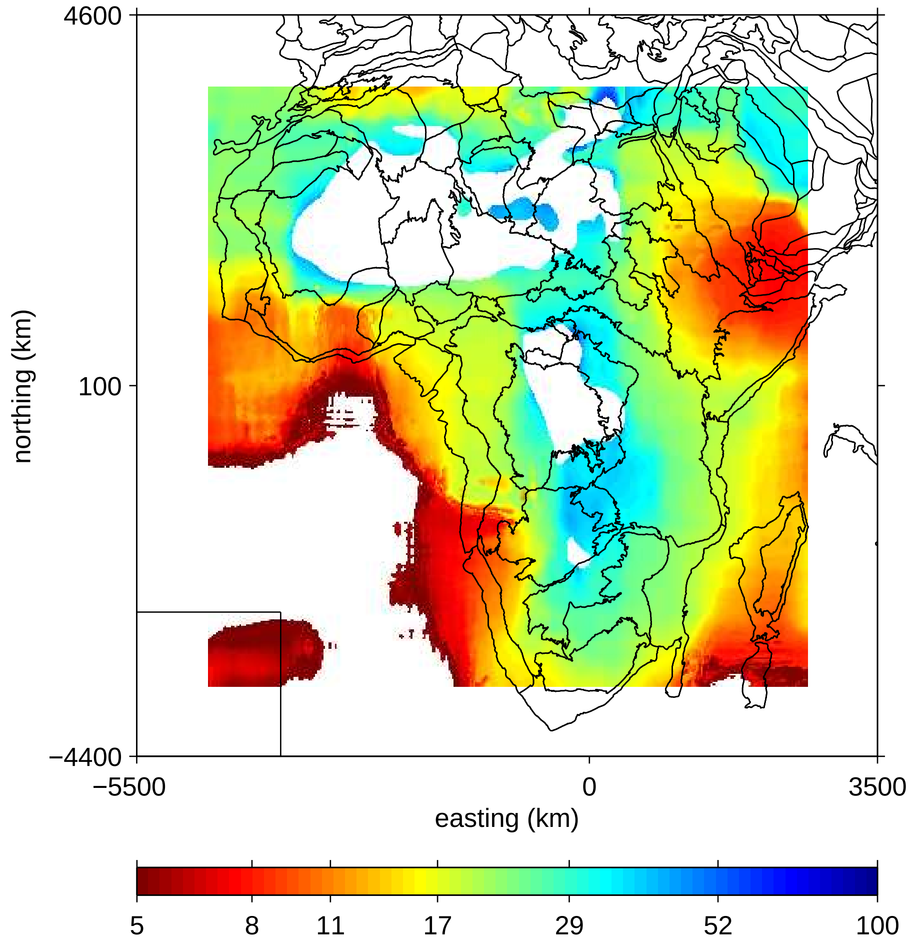
Elastic thickness, best estimate (1000 km)



Elastic thickness, best estimate (1400 km)

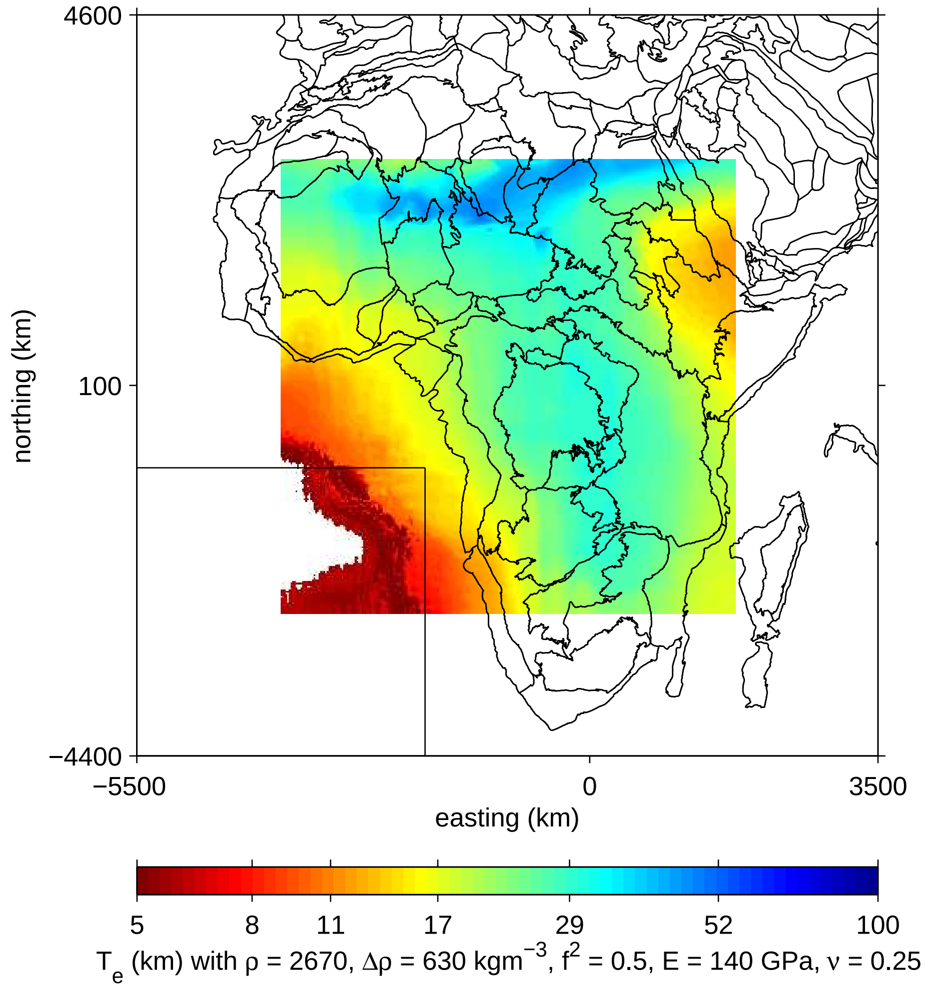


Elastic thickness, best estimate (1750 km)

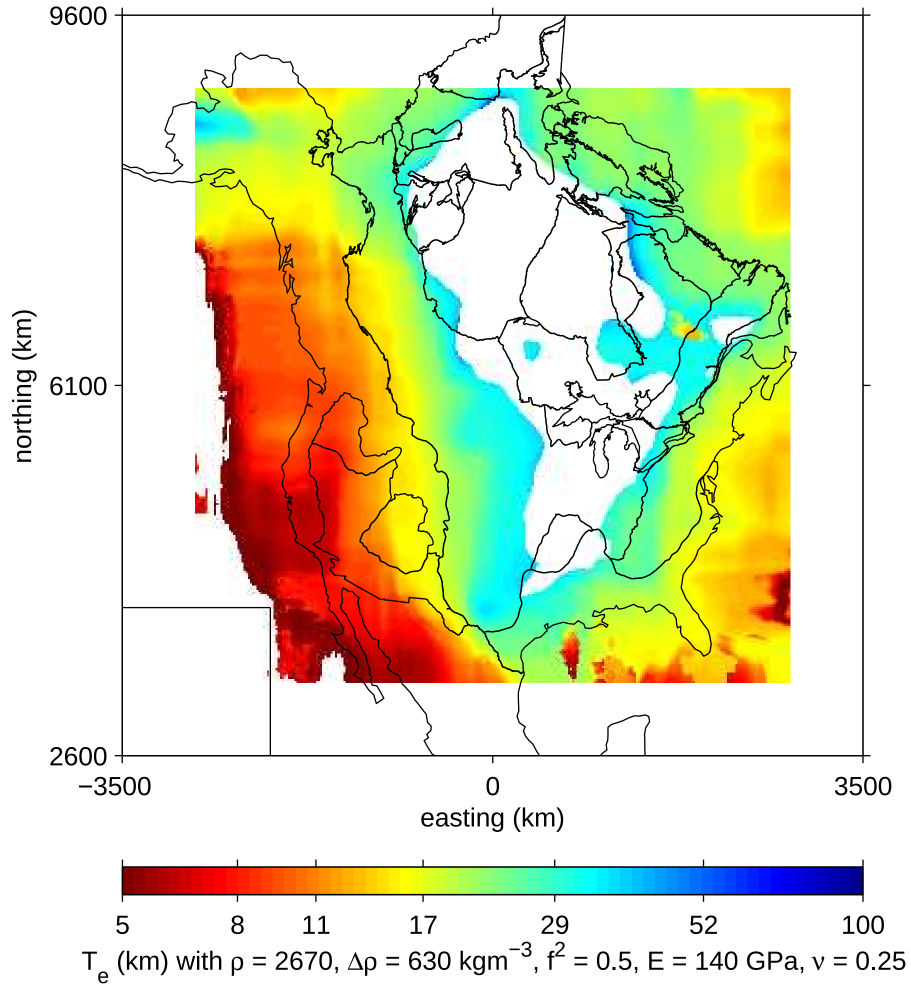


T_e (km) with ρ = 2670, $\Delta\rho$ = 630 kgm^{-3}, f^2 = 0.5, E = 140 GPa, ν = 0.25

Elastic thickness, best estimate (3500 km)



Elastic thickness, best estimate (1400 km)



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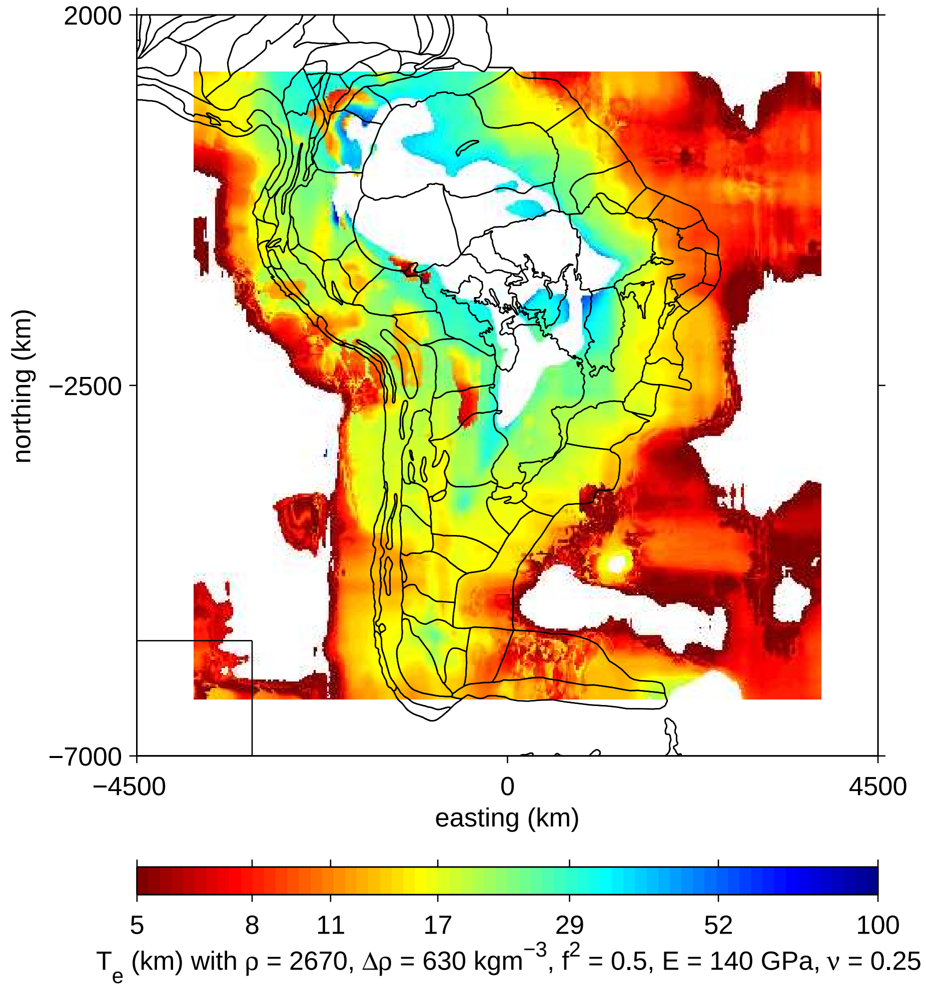

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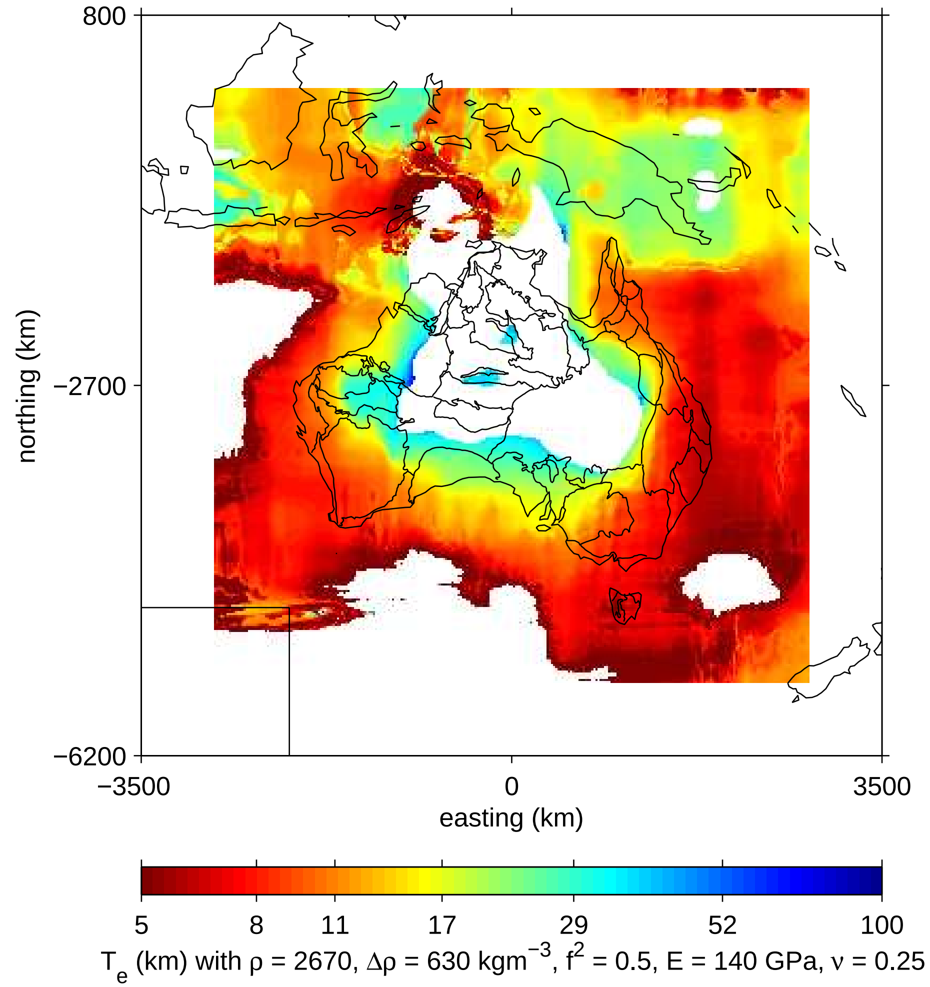

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Anisotropy is real but complex

- Though the obtained directions receive an imprint from the topography and gravity themselves; without a clear indication how to isolate the *lithospheric* anisotropy from coherence analysis

Conclusions – III

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Coherence is dead

- There is just too much variability in the coherence to be able to tell the elastic thickness to anything better than a factor of two, and sometimes not even that
- The case for anisotropy is tenuous and its relation to surface geology is not as straightforward as it may seem from less conservative analyses
- We are finalizing a non-coherence **maximum-likelihood estimation** method that outperforms all others and has been validated so far **on synthetic data**... more to come