

Plate tectonics



**Mantle convection
in practice**



Dream



Linking surface tectonics with deep mantle evolution

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Dietmar Müller

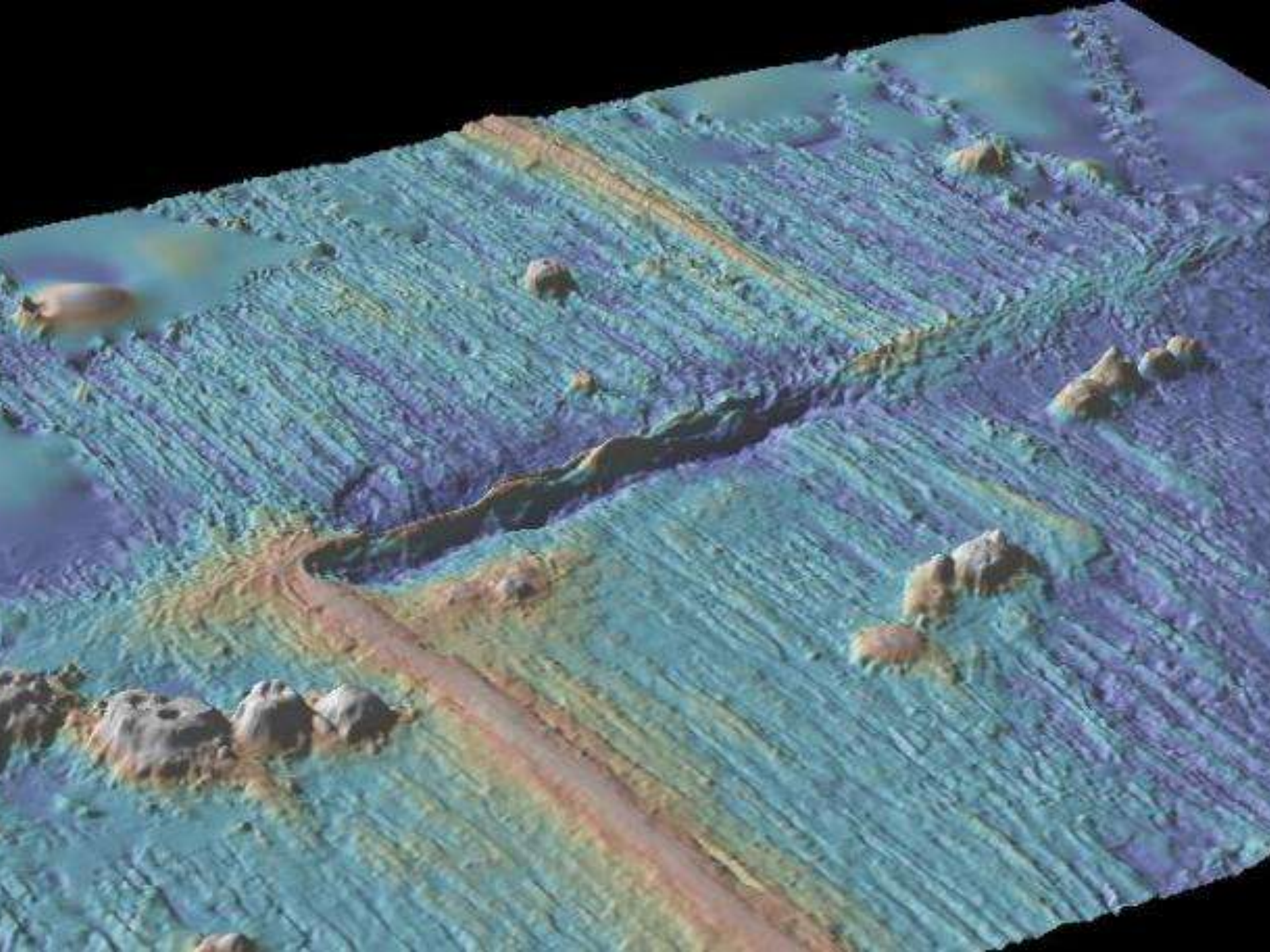


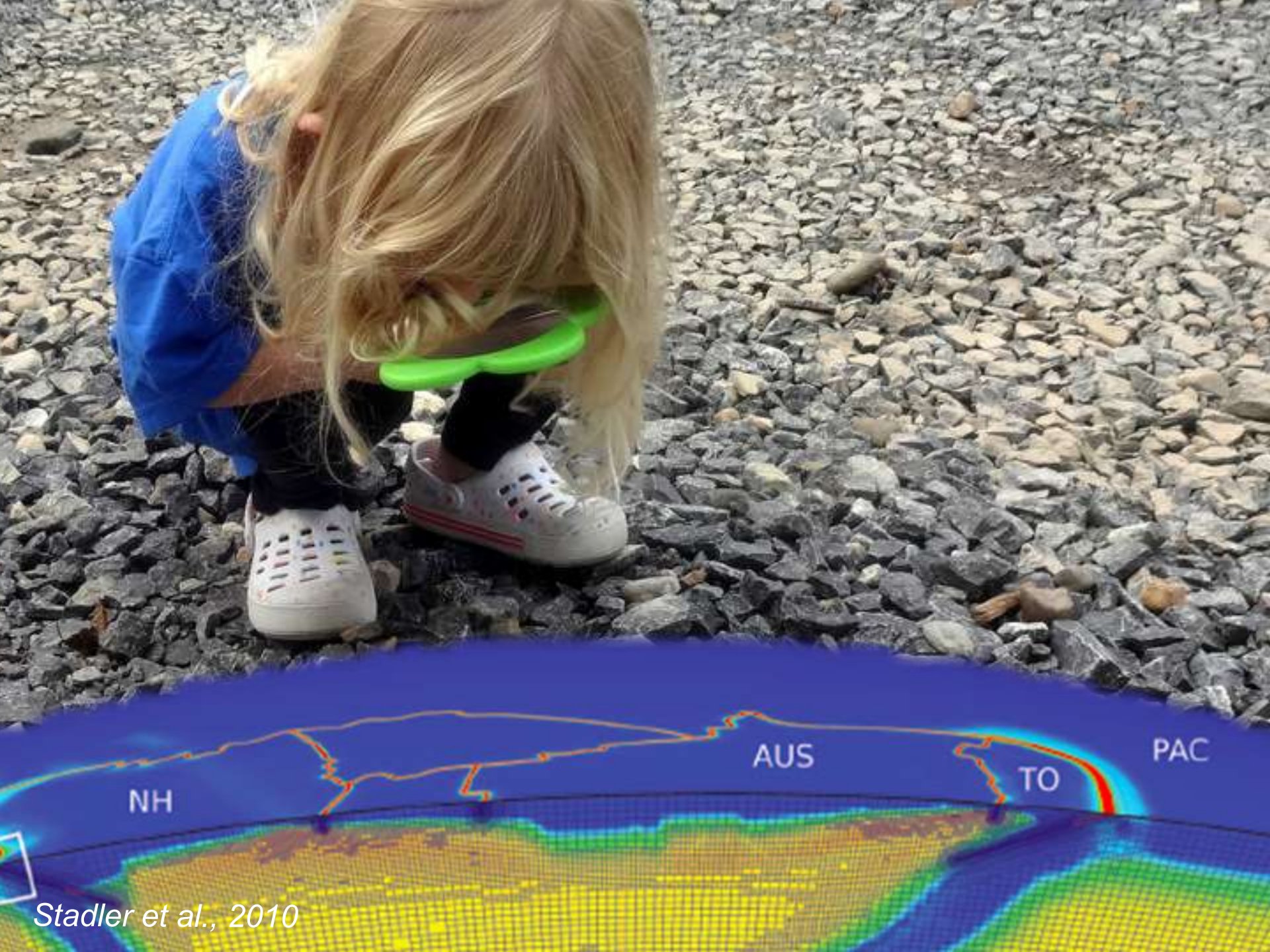
Alexandre Fournier

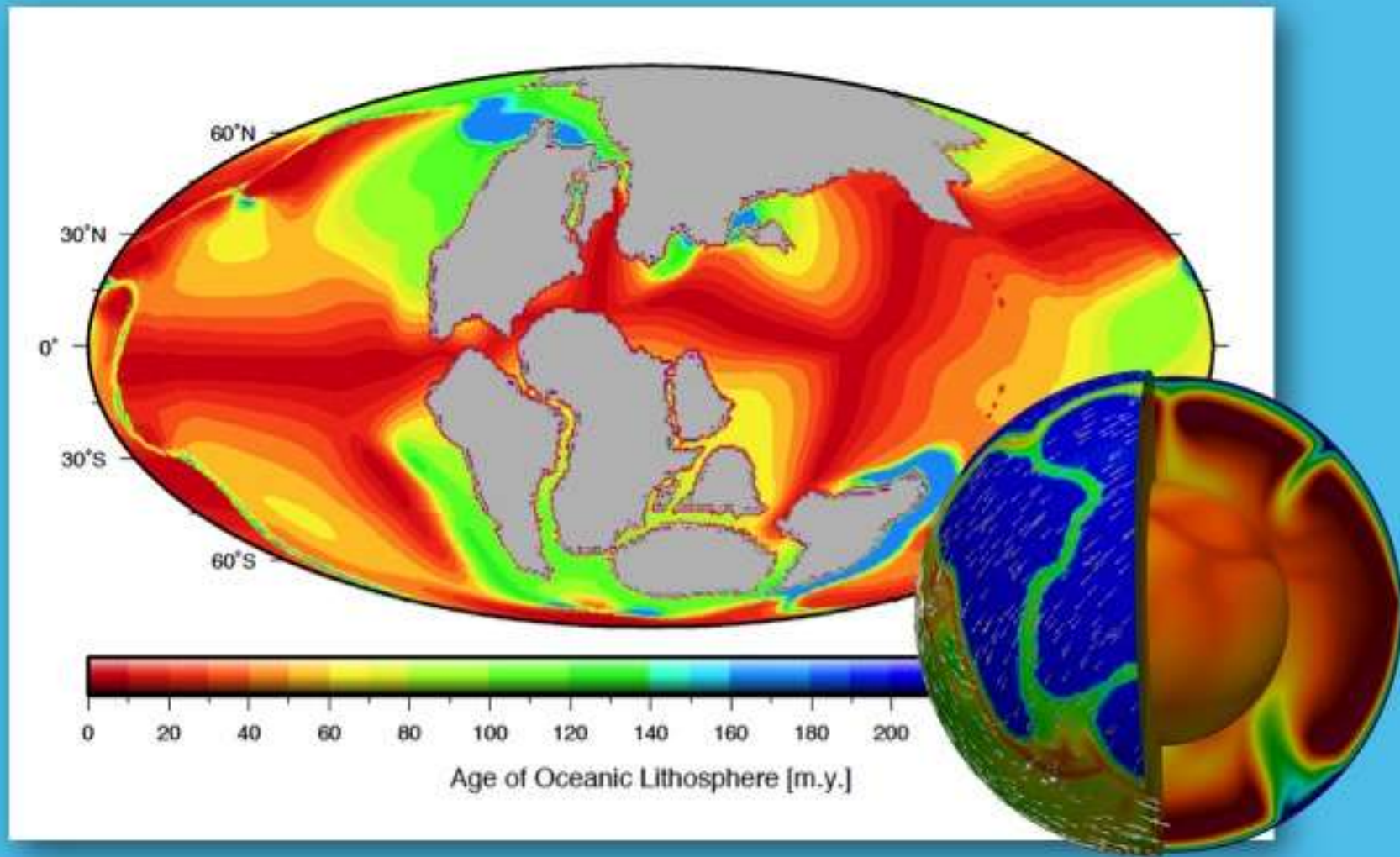








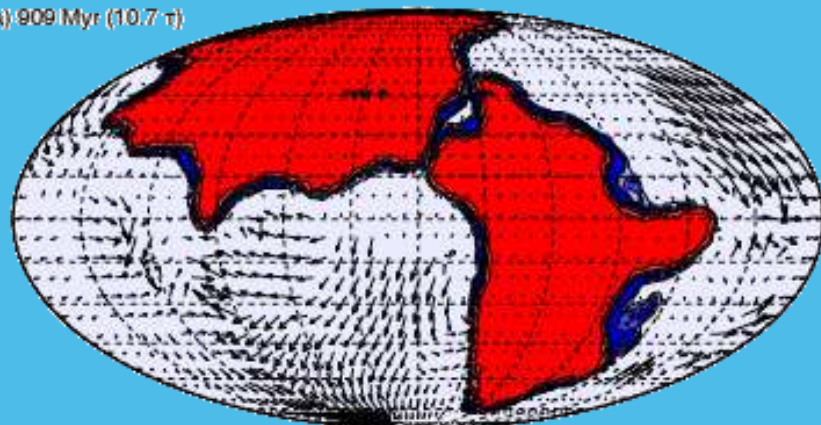




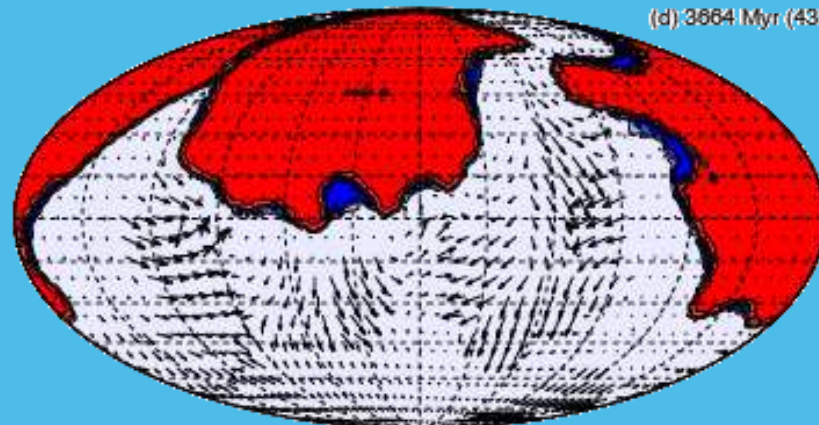
Toroidal motion: ~40% but no pure transform

see Coltice et al., Science 2012

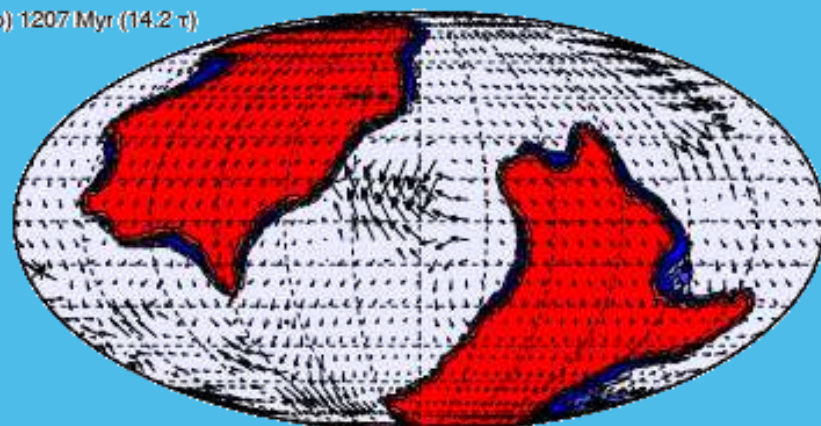
(a) 909 Myr (10.7 τ)



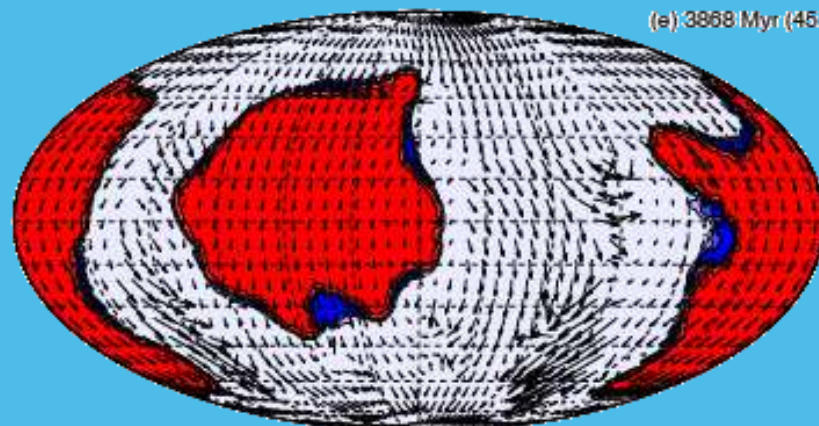
(d) 3664 Myr (43.1 τ)



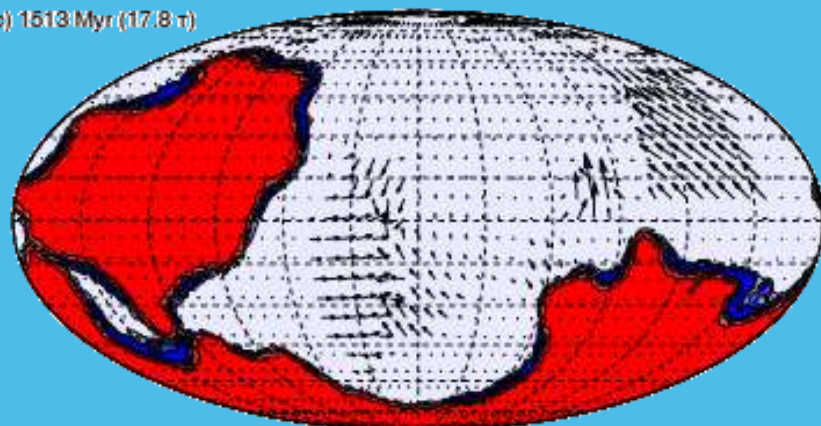
(b) 1207 Myr (14.2 τ)



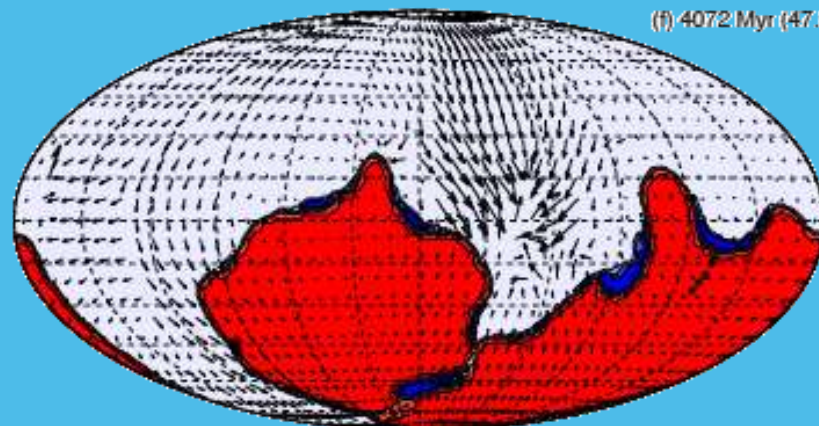
(e) 3868 Myr (45.5 τ)



(c) 1513 Myr (17.8 τ)



(f) 4072 Myr (47.9 τ)

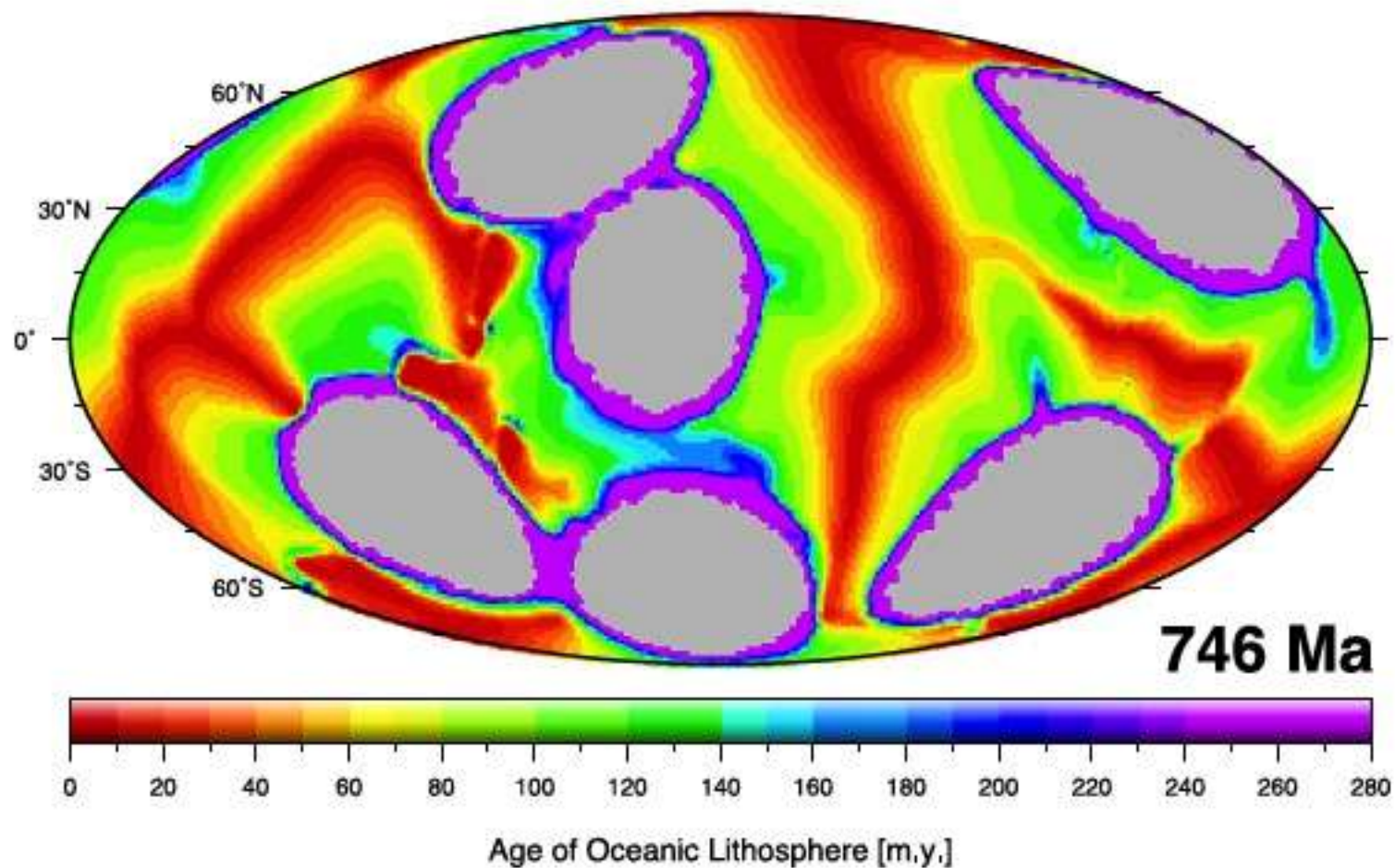


Craton

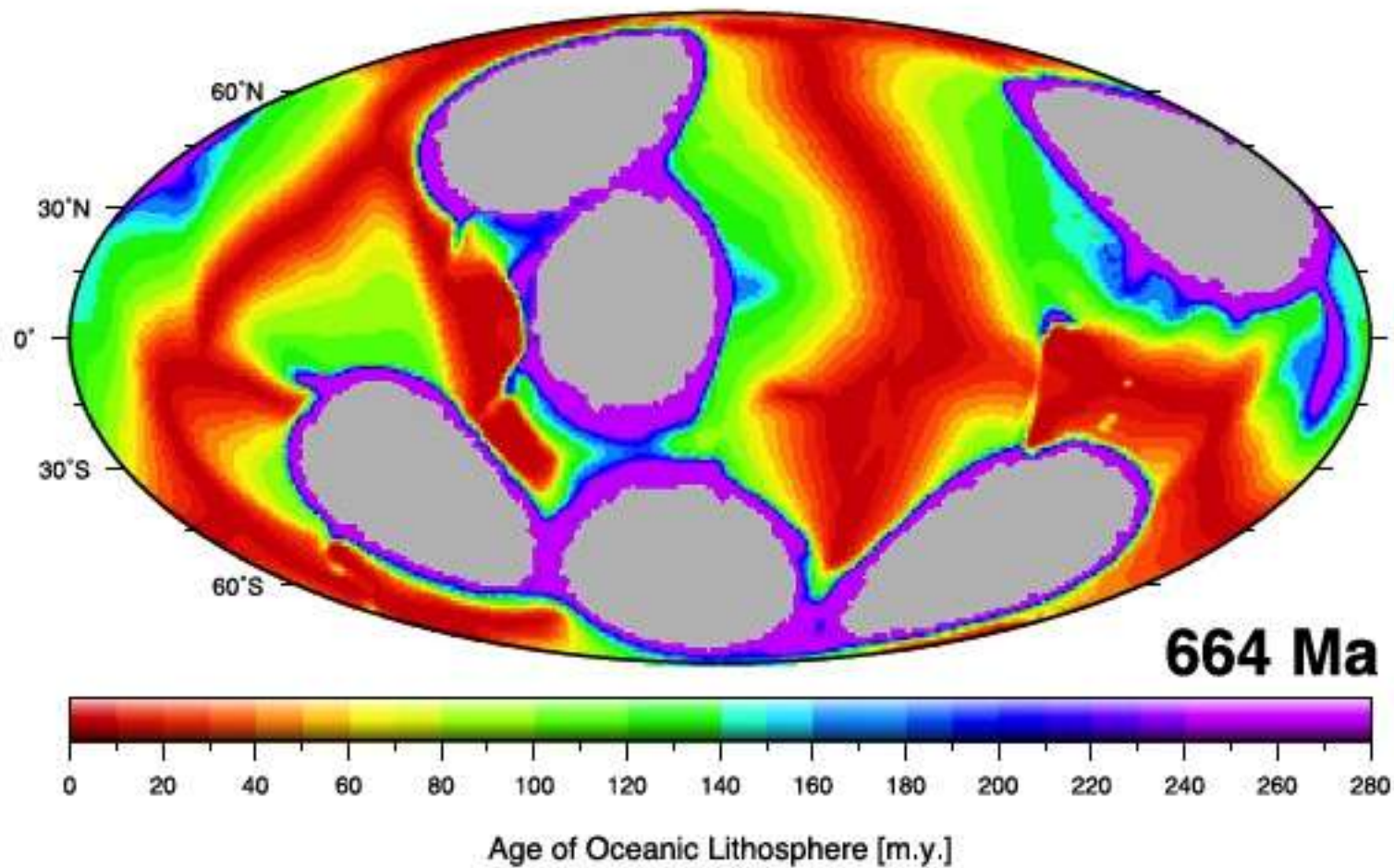
Normal

Weak

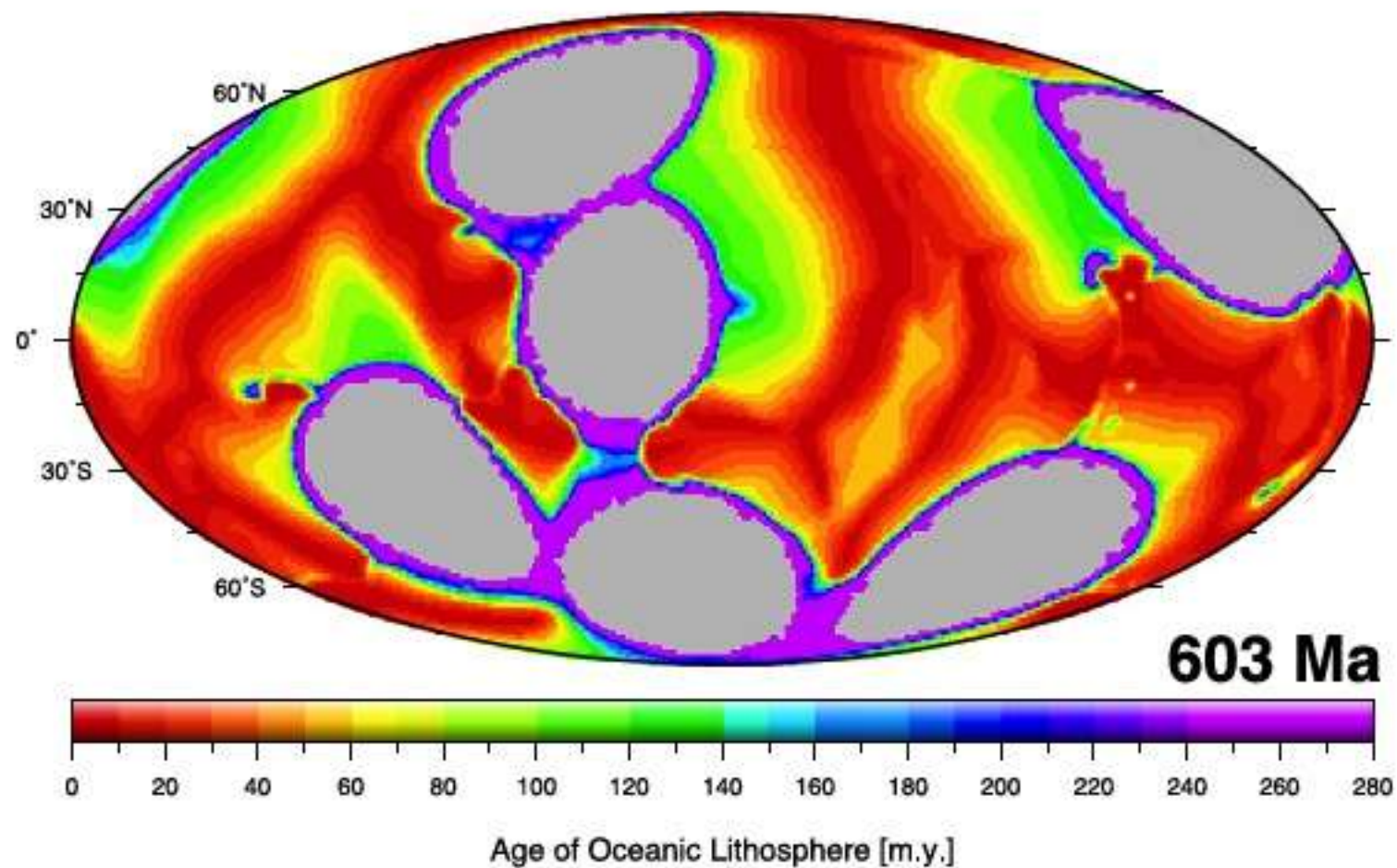
$$C_0 = 3.3 \text{ km}^2 \text{ y}^{-1}$$



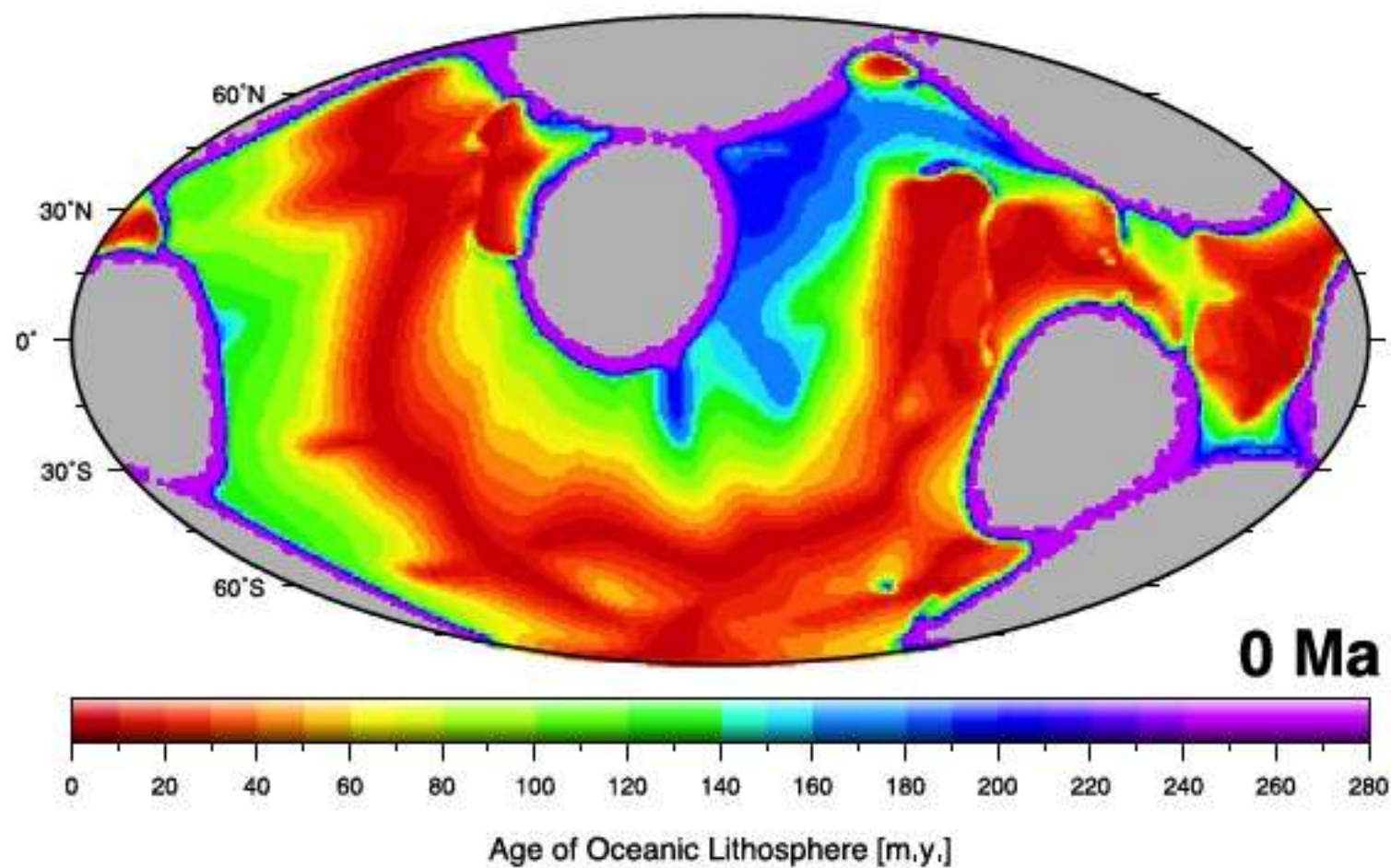
$$C_0 = 4.7 \text{ km}^2 \text{ y}^{-1}$$



$$C_0 = 5.9 \text{ km}^2 \text{ y}^{-1}$$



$$C_0 = 4.1 \text{ km}^2 \text{ y}^{-1}$$



Data assimilation





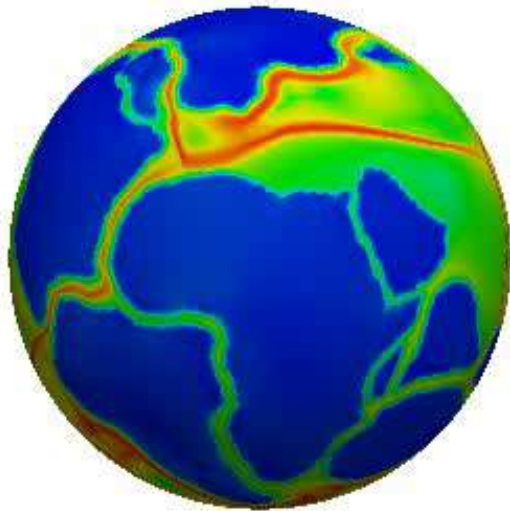
Léa Bello



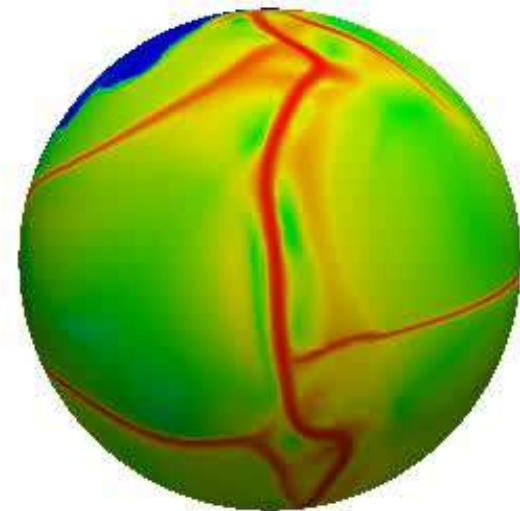
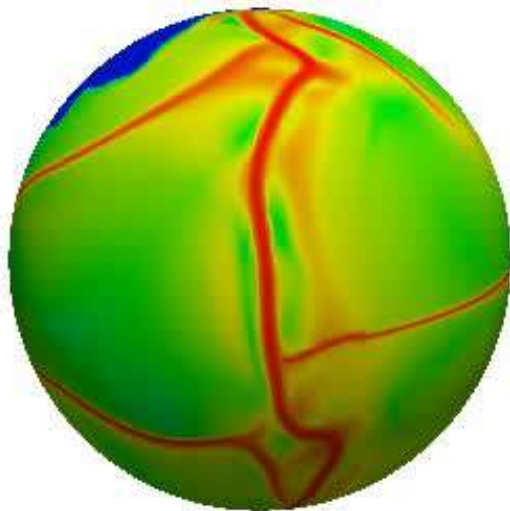
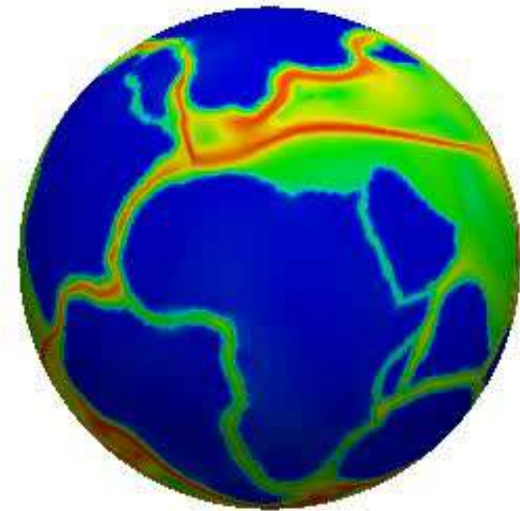
$$E(t) \sim E(0)e^{\lambda t} [1 + O(e^{-(\lambda-\lambda_2)t})]$$

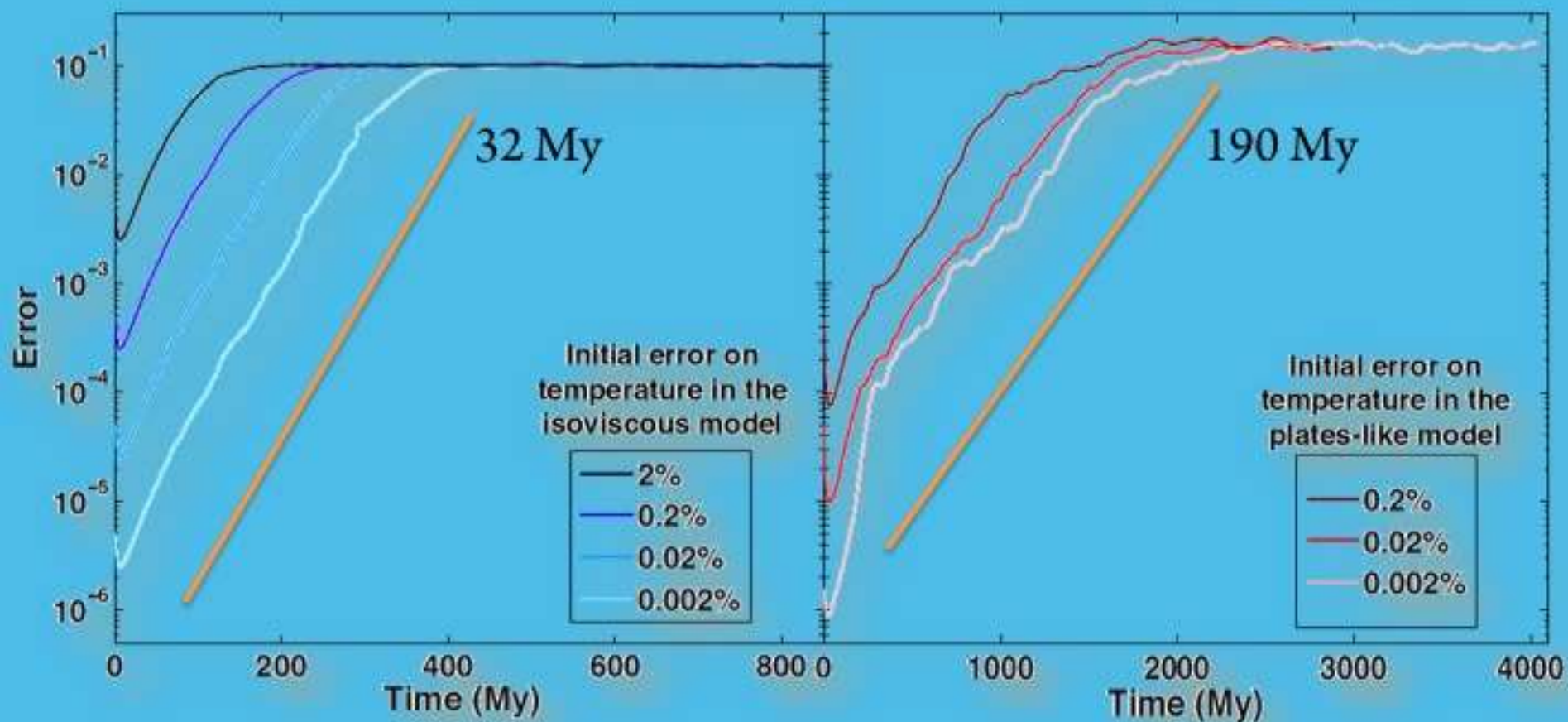
Reference

Reference+error



Viscosity
7094111.5
1000000
10000
100
1
0.26620048





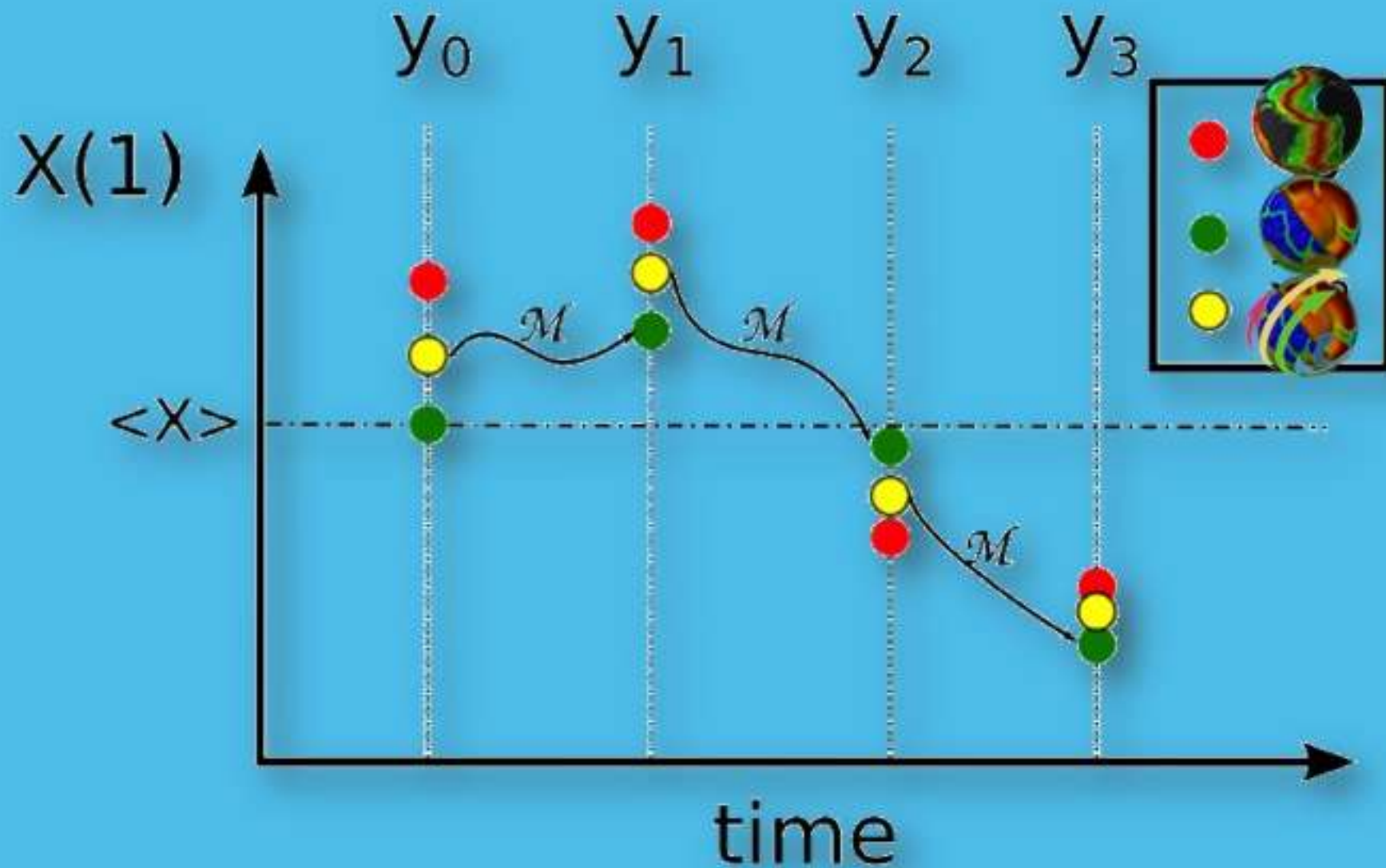


Marie Bocher



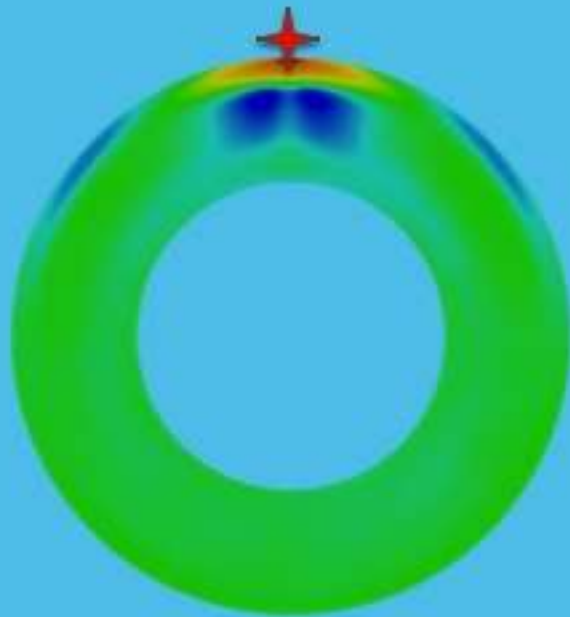
Sequential data assimilation:

Predict mantle structure & tectonics



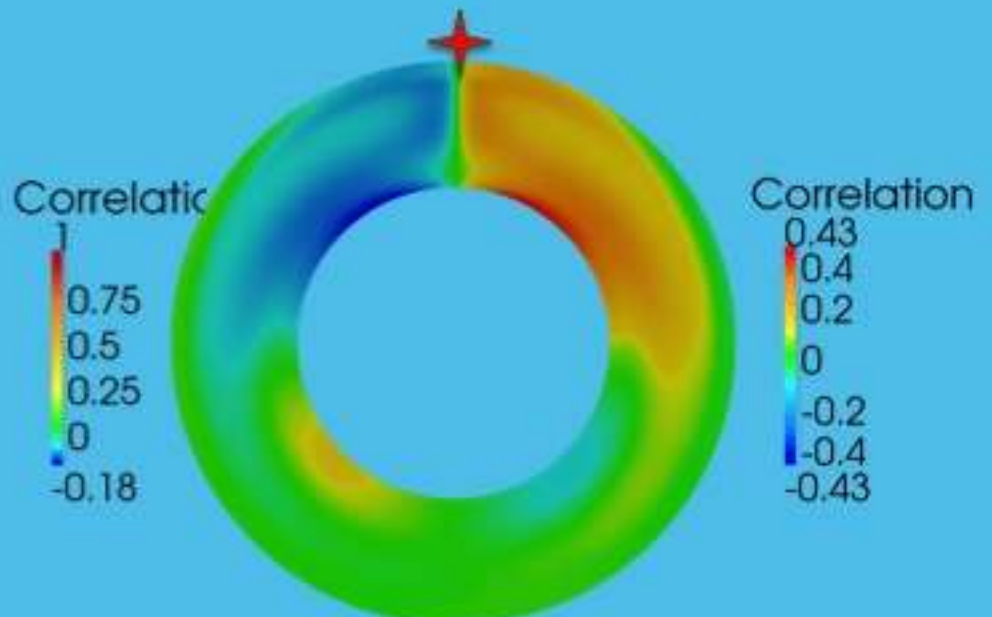
Kalman filter: Correcting using model statistics

Surface heat flux vs Temperature field

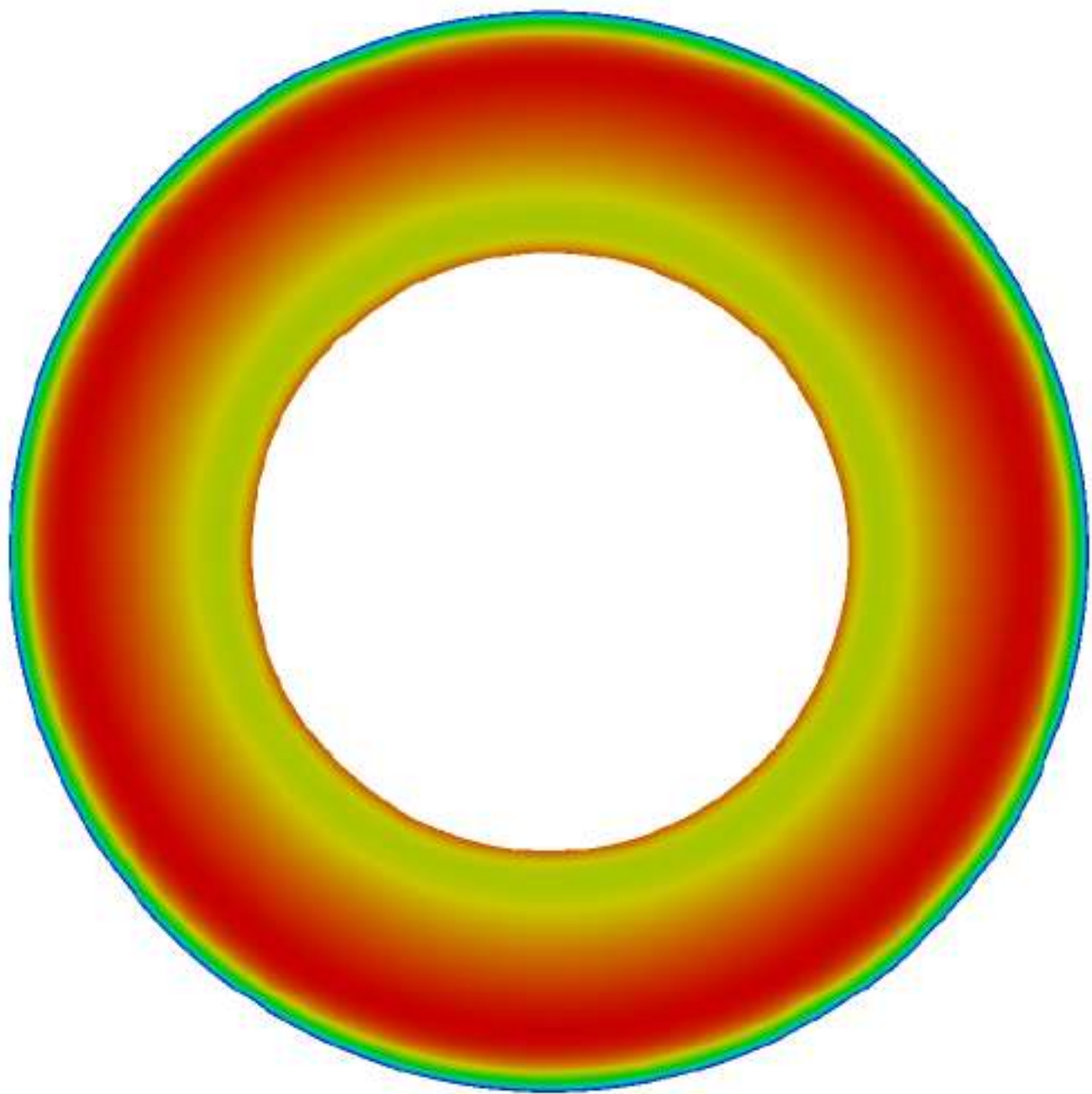


Boundary layer probe

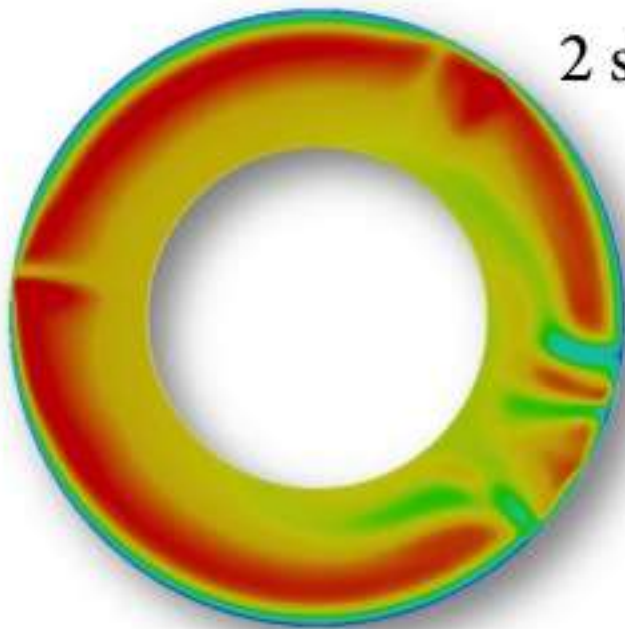
Surface velocity vs Temperature field



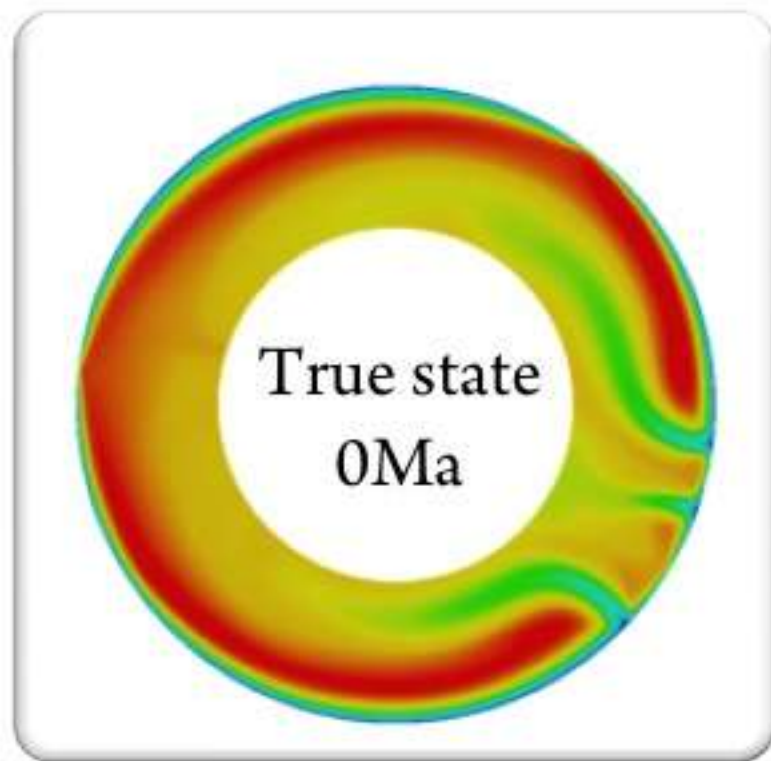
Interior probe



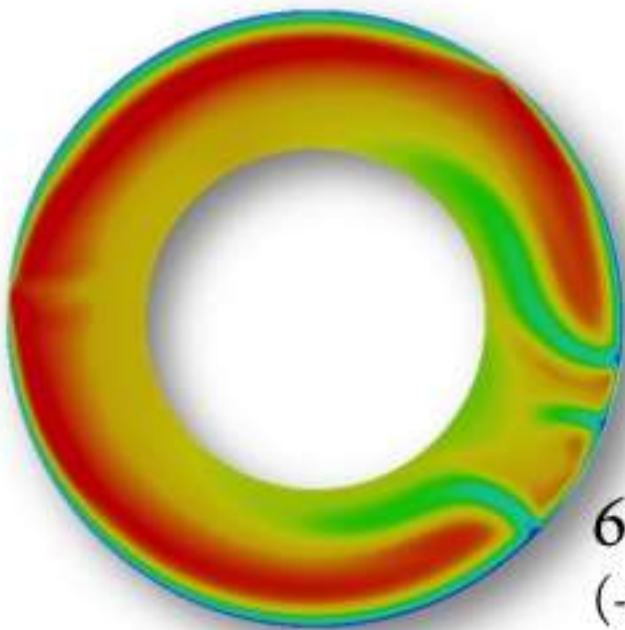
2 steps of assimilation
(-100Ma & 0Ma)



True state
0Ma



6 steps of assimilation
(-100Ma, -80Ma, -60Ma, -40Ma, -20Ma, 0Ma)





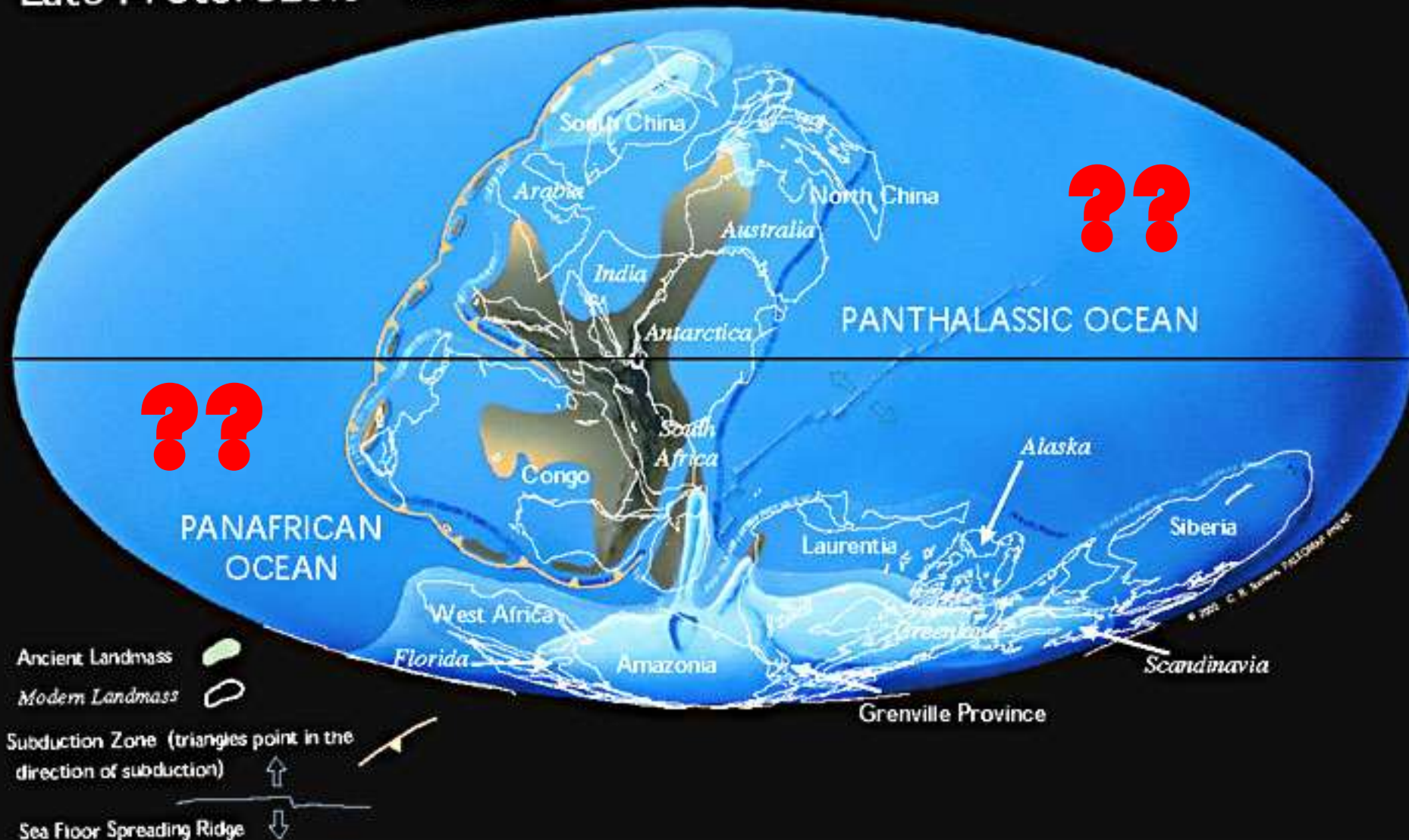


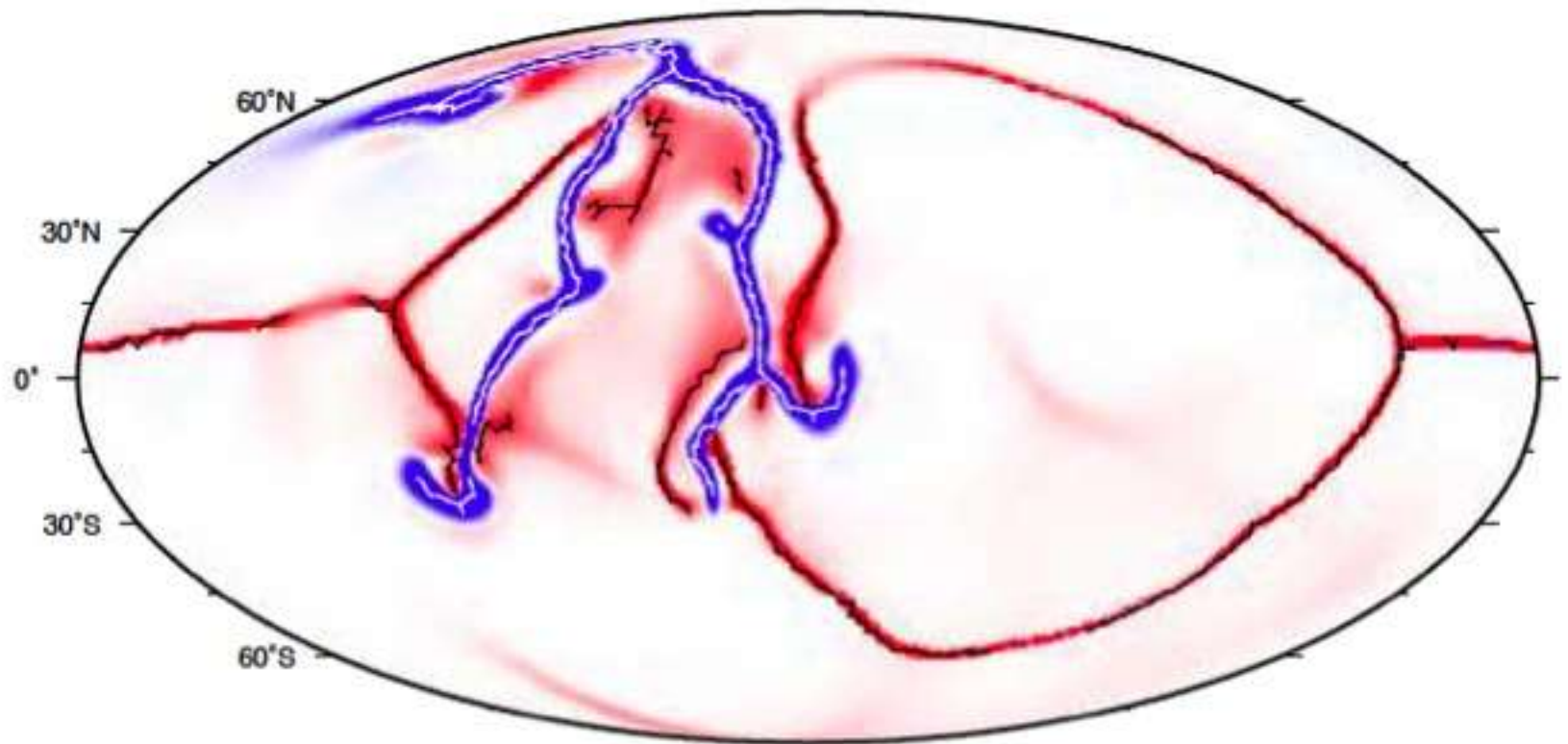
European Research Council



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Late Proterozoic 650 Ma



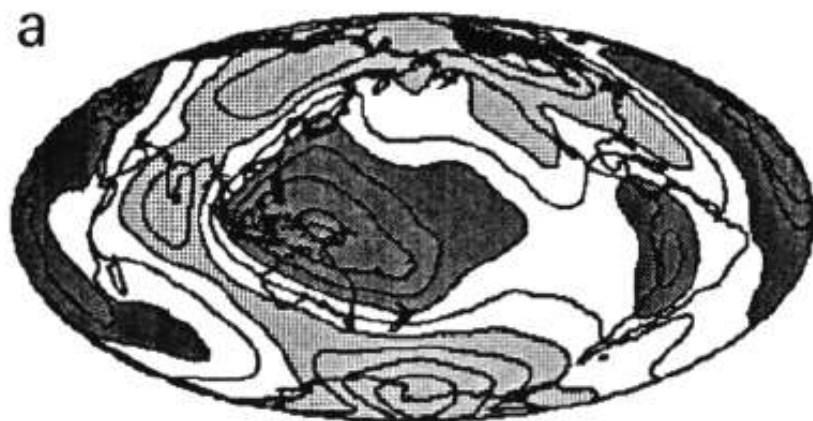


Horizontal divergence: “**RIDGES**”
& “**SUBDUCTIONS**”

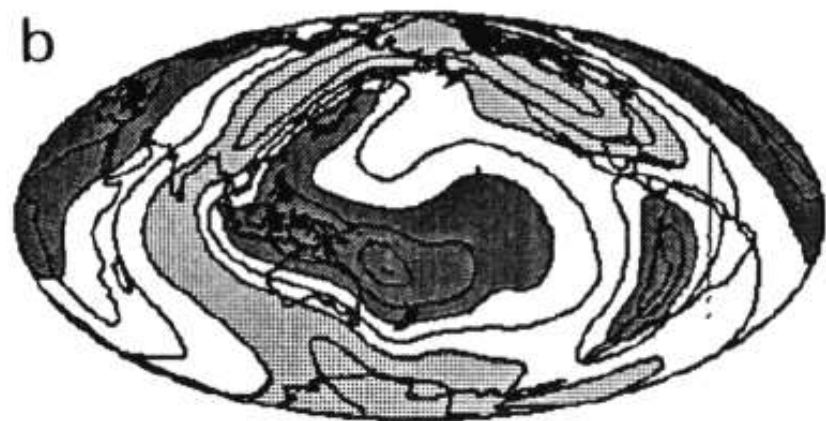
Toroidal motion: ~40% but no pure transform

RICARD ET AL.: GEODYNAMIC MODEL OF MANTLE HETEROGENEITIES

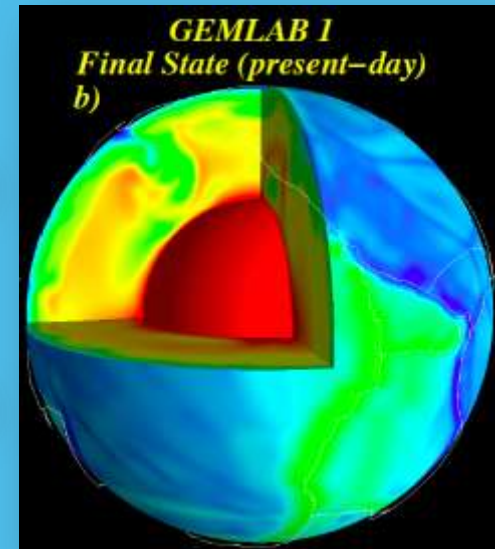
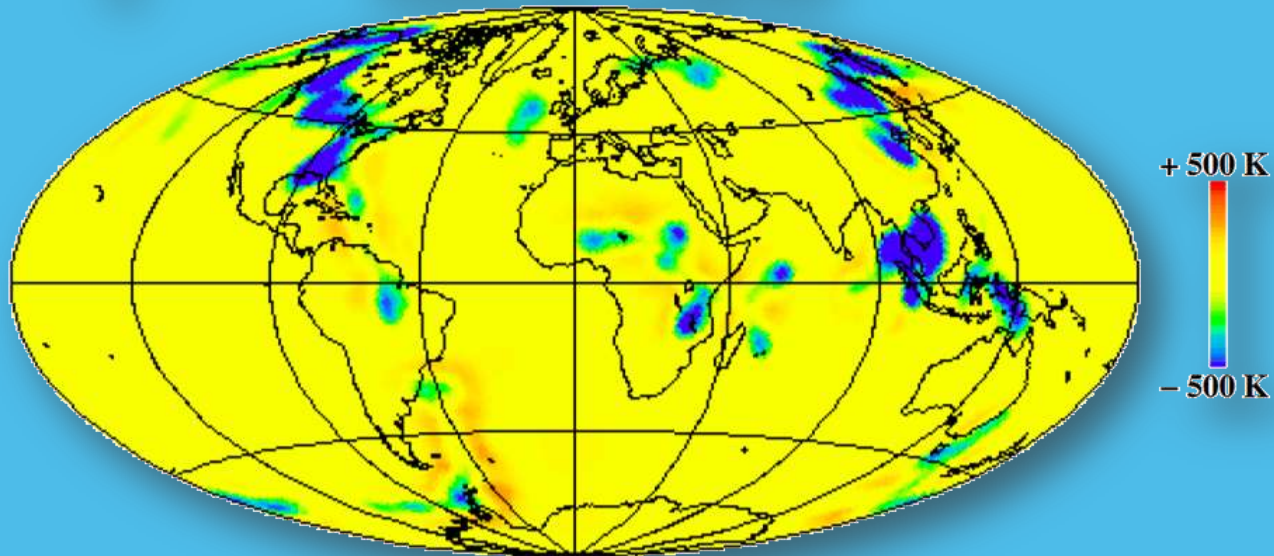
OBSERVED GEOID



COMPUTED GEOID WITH C21 S21



a) **GEMLAB 1 (1100 km)**



b) **GRAND 1997 (1000 km to 1150 km)**

