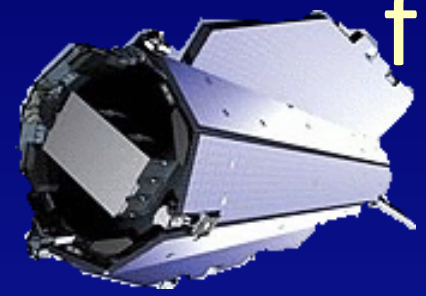
Multi-scale gravity field modeling from GOCE & surface data



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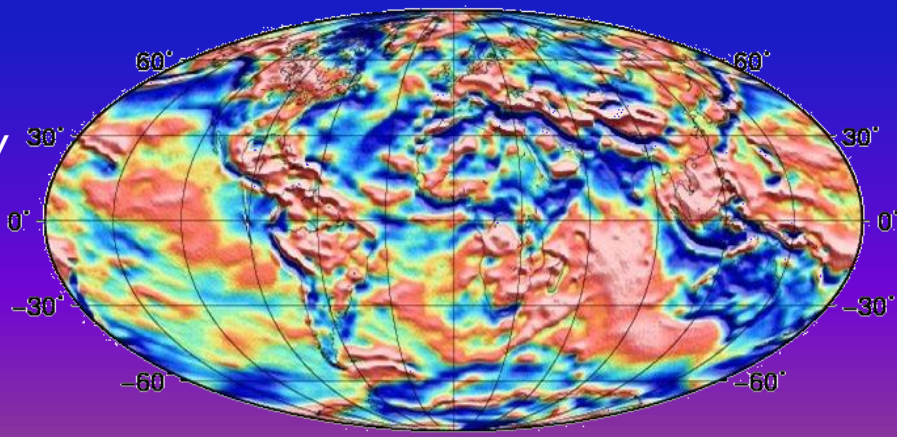
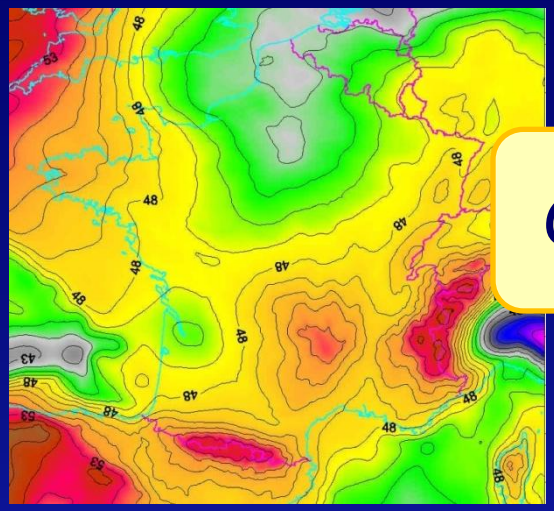
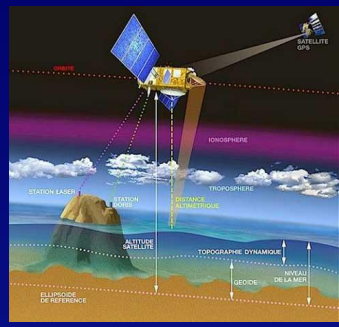


Motivations

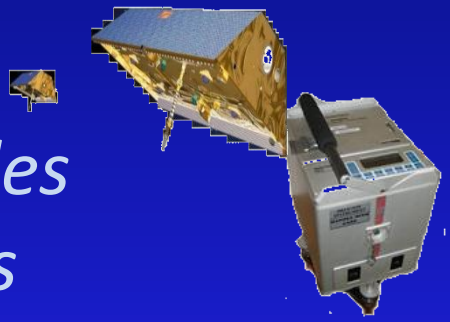


Geopotential modeling

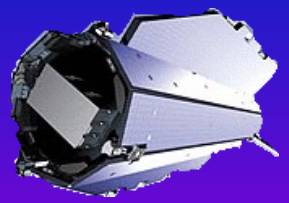
Geoid



- Local zoom
- *Best possible precision at all spatial scales from large, heterogeneous datasets*

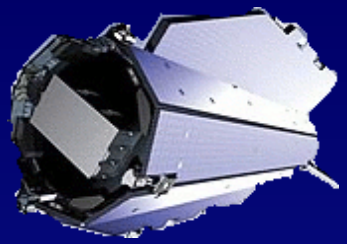


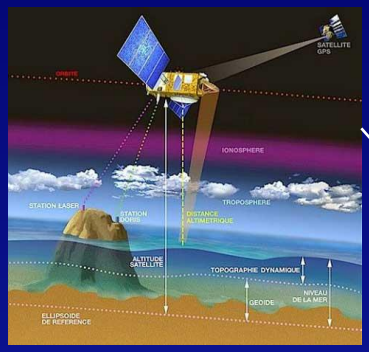
Use of the GOCE gradients

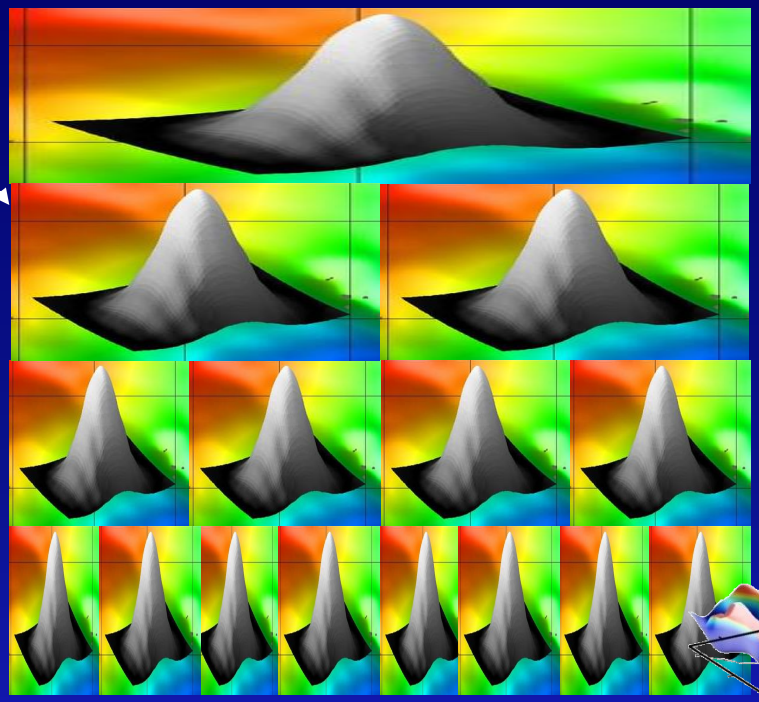


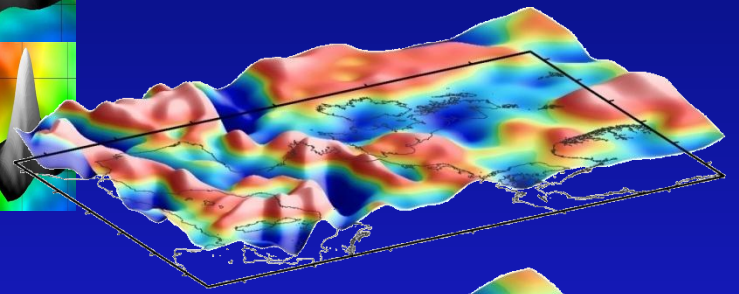
- Curvature of the equipotential surfaces
- Redundancy → local signal/noise optimization

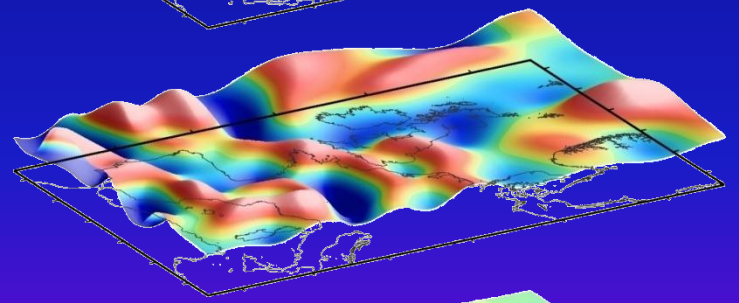
Regional multi-scale models

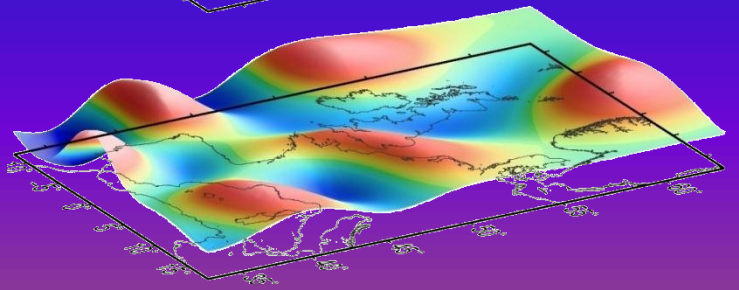








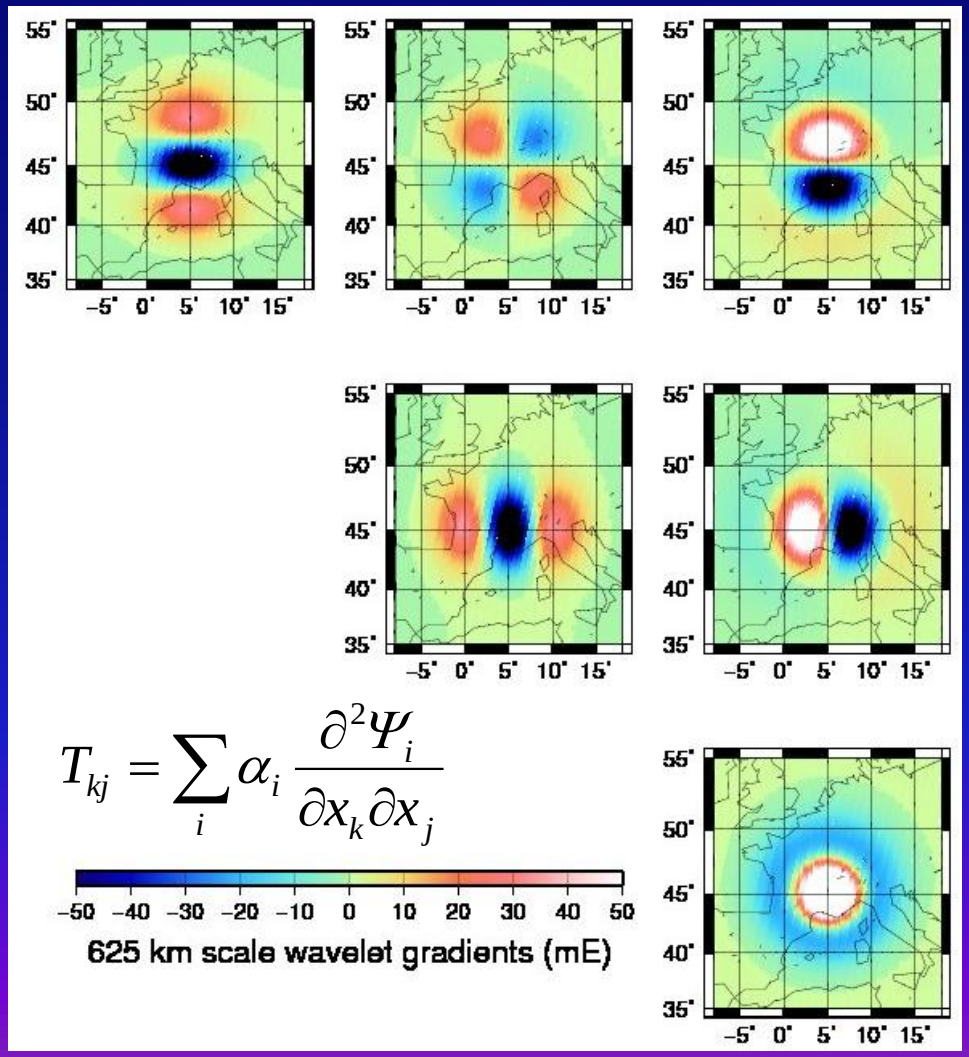




- *Local densification **embedded in regional** and global models ?*

- *How to build a model over a wide area **block by block** ? How to « patch » local densifications ?*

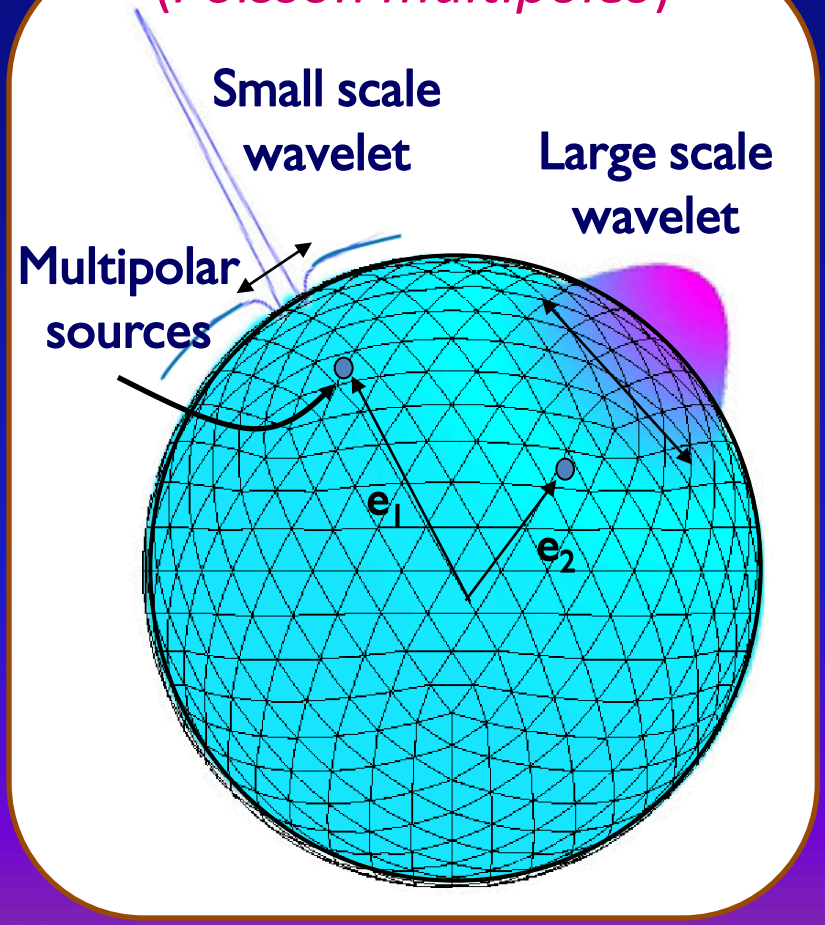
The wavelets and their gradients



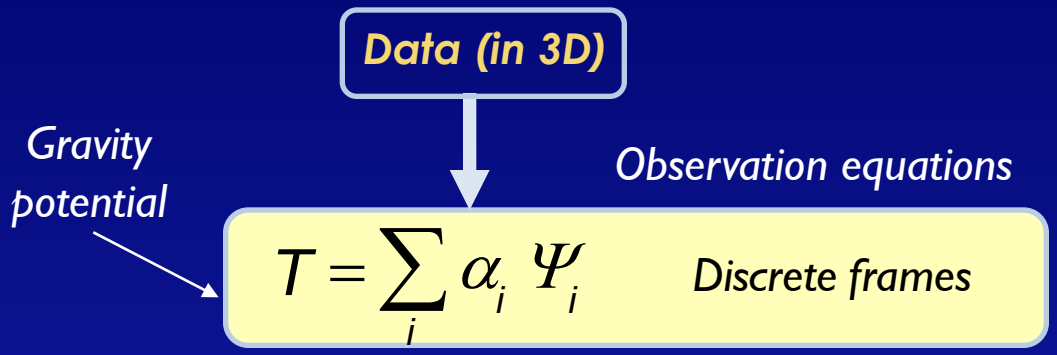
Analytical computation of the derivatives

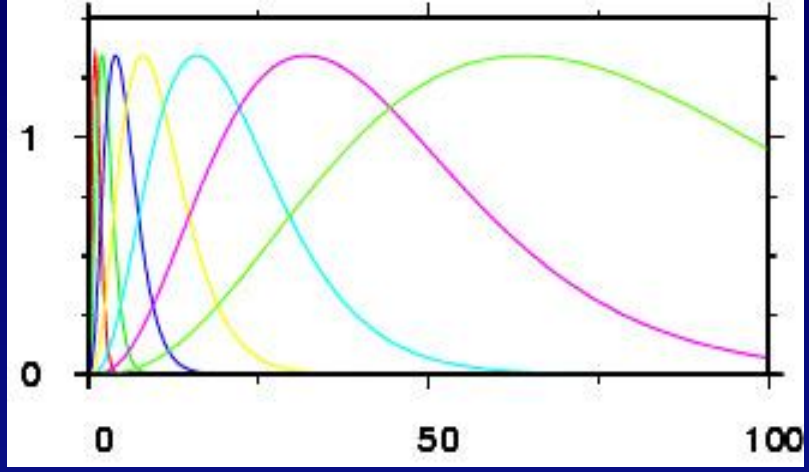
Equivalent sources

(*Poisson multipoles*)

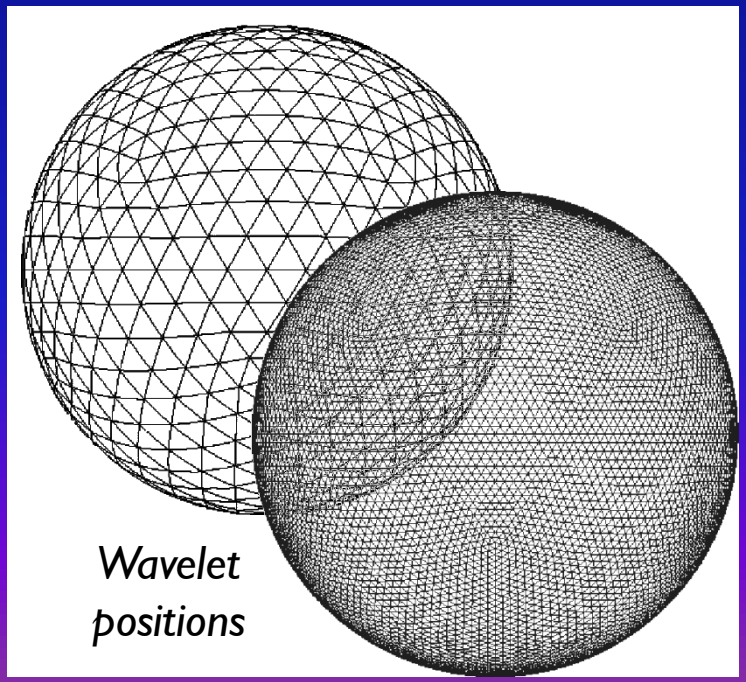


Building the model





Wavelet spectra as a function of S.H. degree, for different scales.

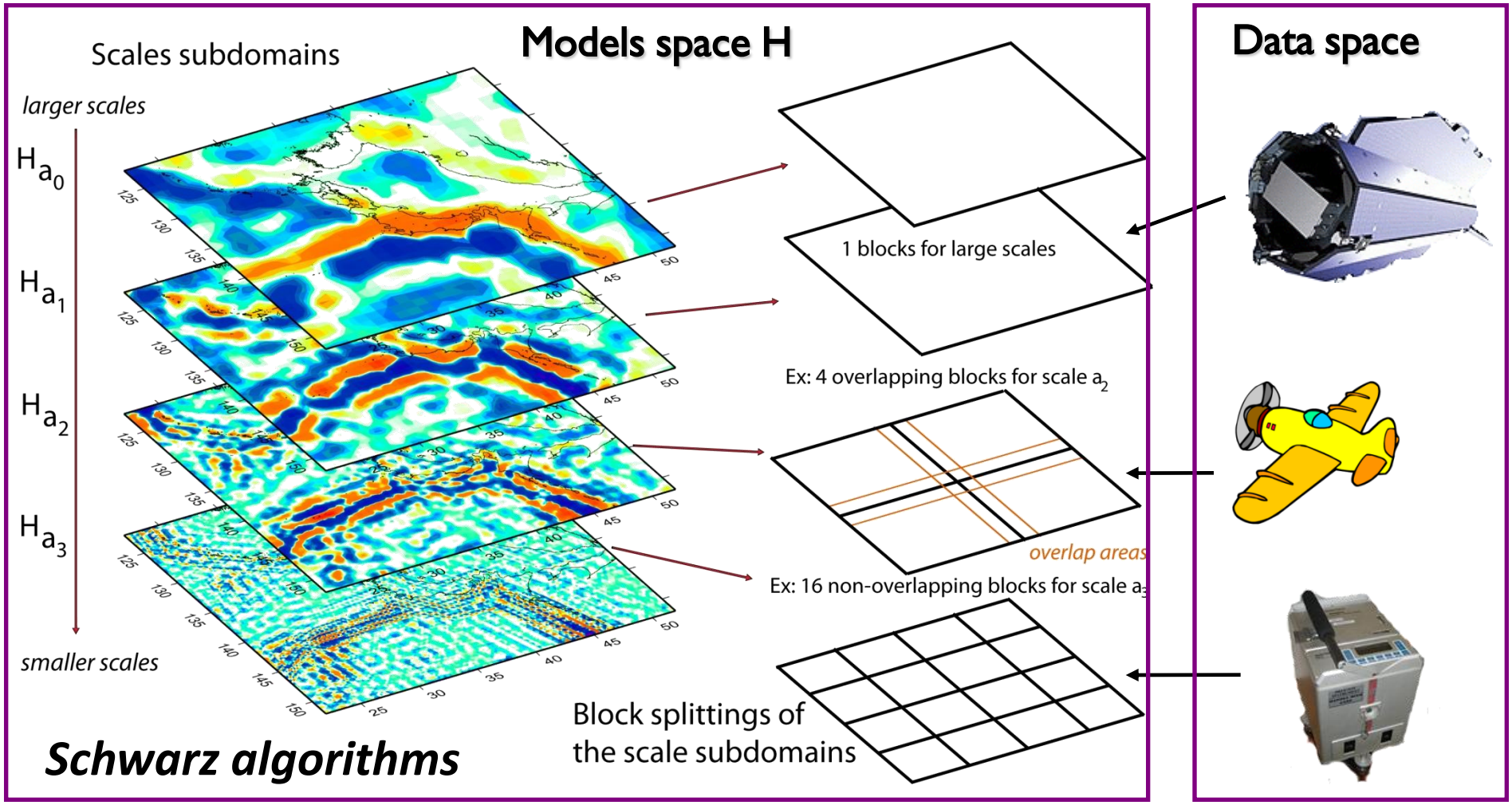


- A discrete wavelet frame representation of T is built by an appropriate discretisation of a continuous wavelet transform (CWT) in scale and space.

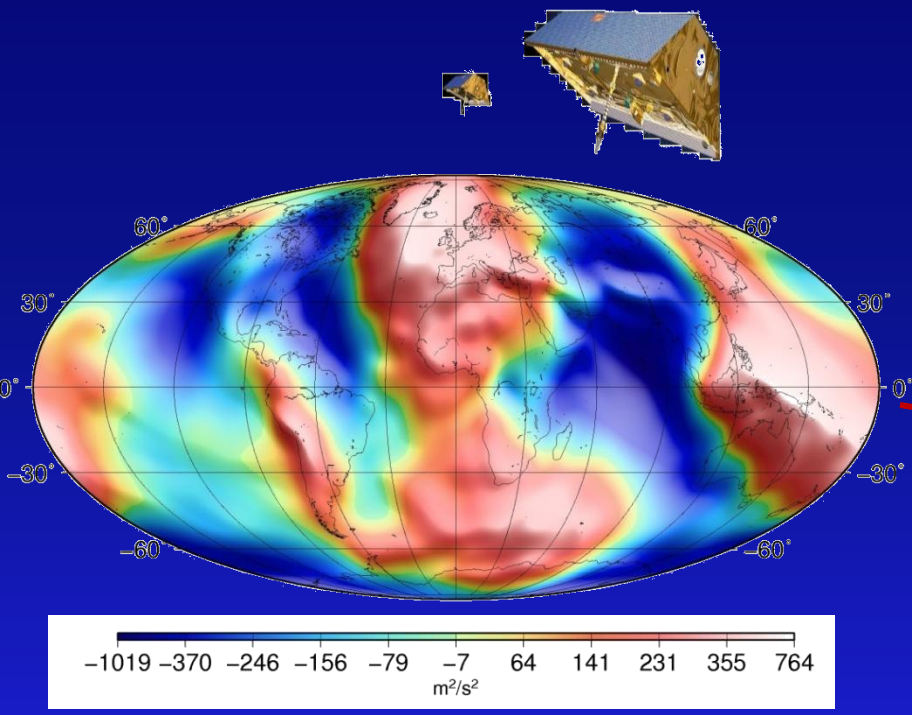
- The least-squares adjustment of the data allows to get the wavelet coefficients α.

Domain decomposition method

- *Sequential scale iterations & for a given scale: parallel block iterations.*
- *Larger number of blocks at smaller scales.*

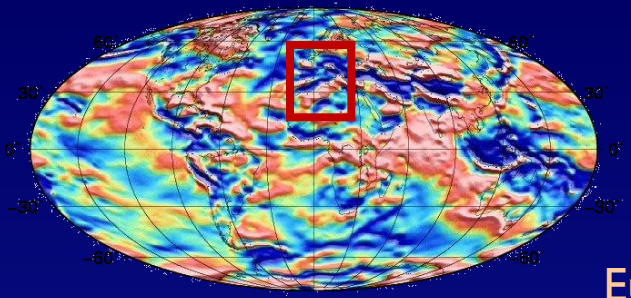


Data & models



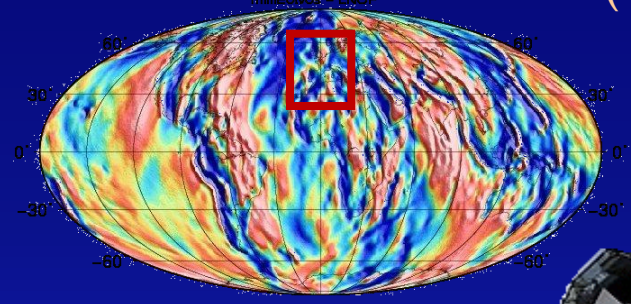
Global scale (down to 1250 km) - *GRACE model* (SH)

Medium scale (625 – 80 km) - *GOCE LNOF/GRF gradients* (wavelets)

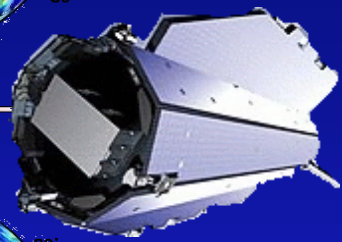


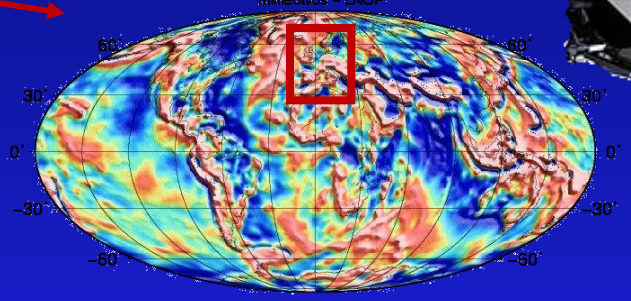
V_{xx}

Europe (30°x30°)

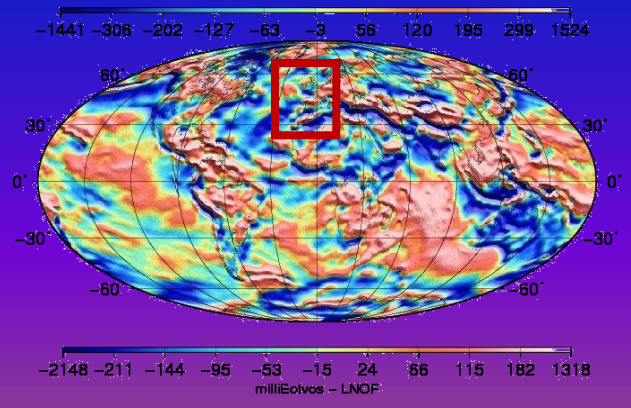


V_{yy}



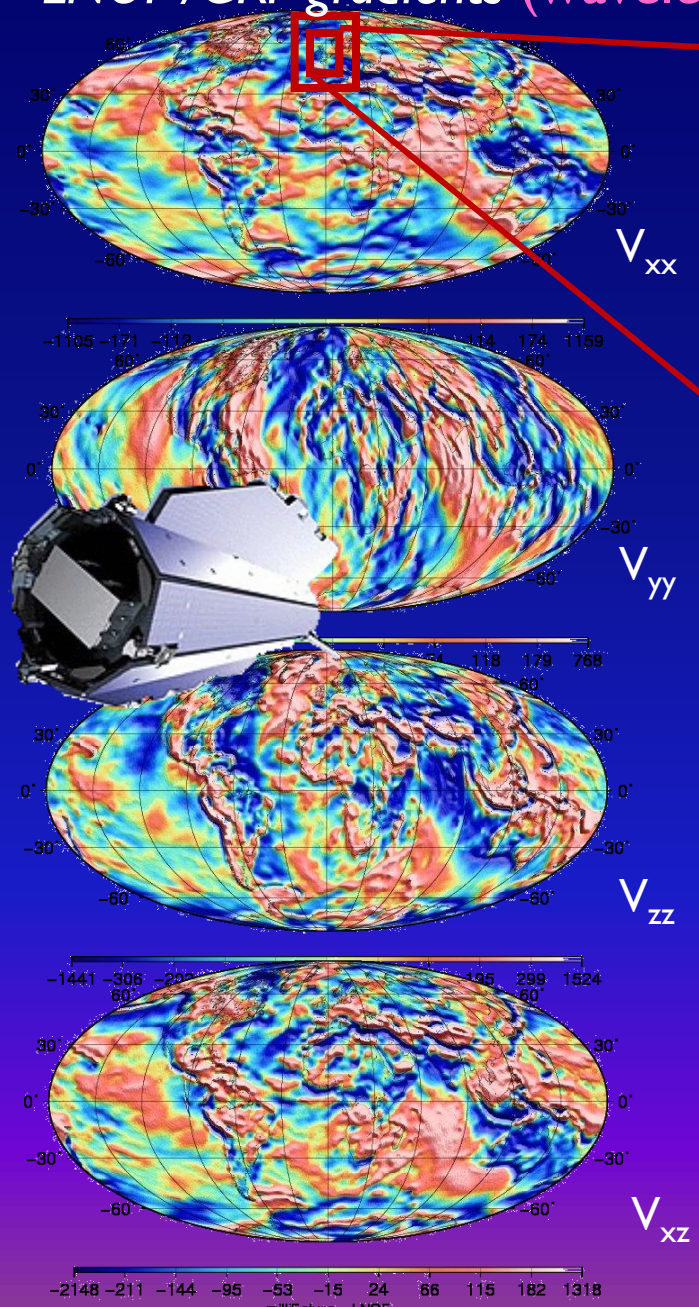


V_{zz}

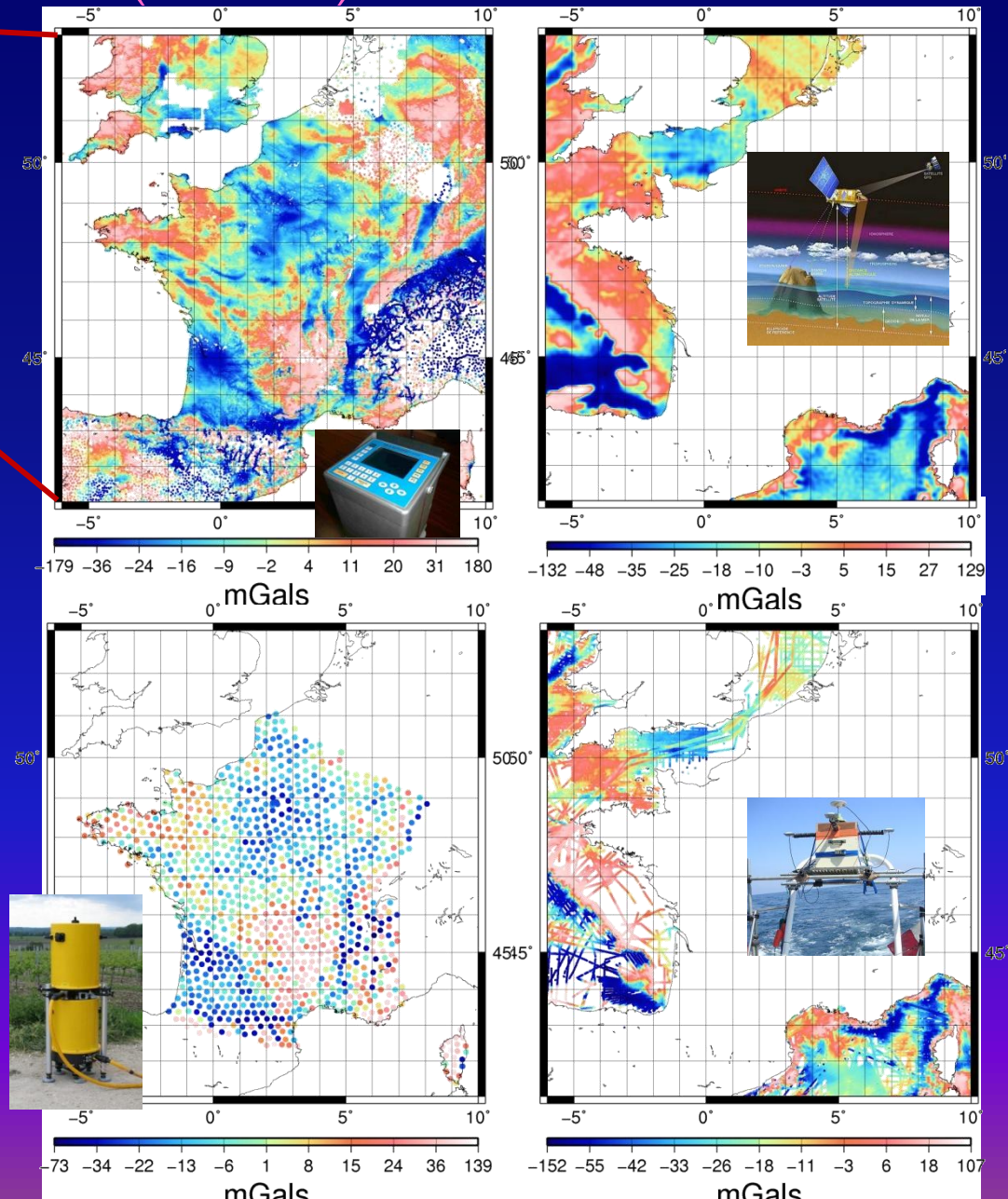


V_{xz}

Medium scale (625 – 80 km) - *GOCE LNOF /GRF gradients* (wavelets)



Small scales (200 – 20 km) – *Surface data* (wavelets)



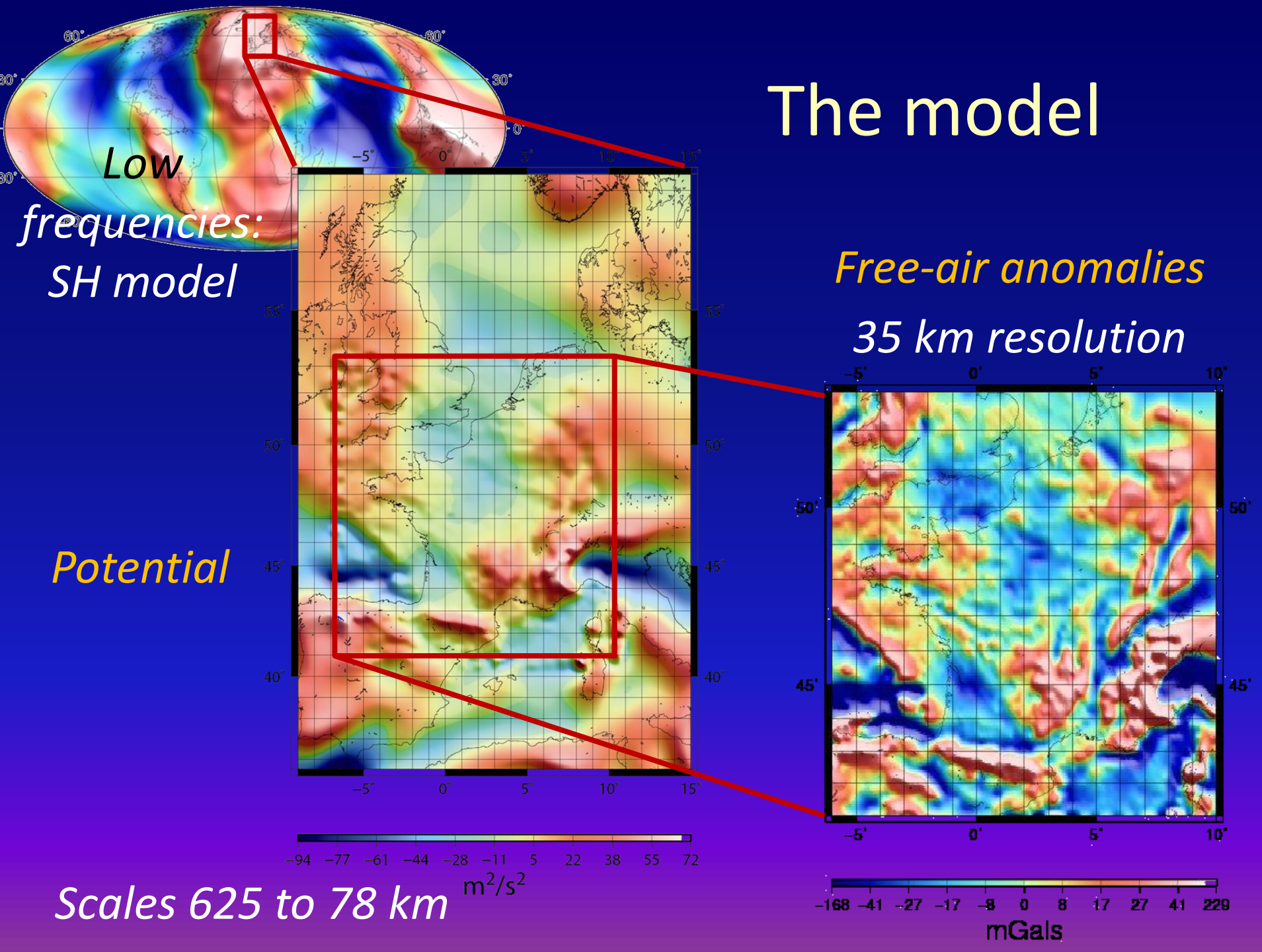
The model

Low frequencies: SH model

Potential

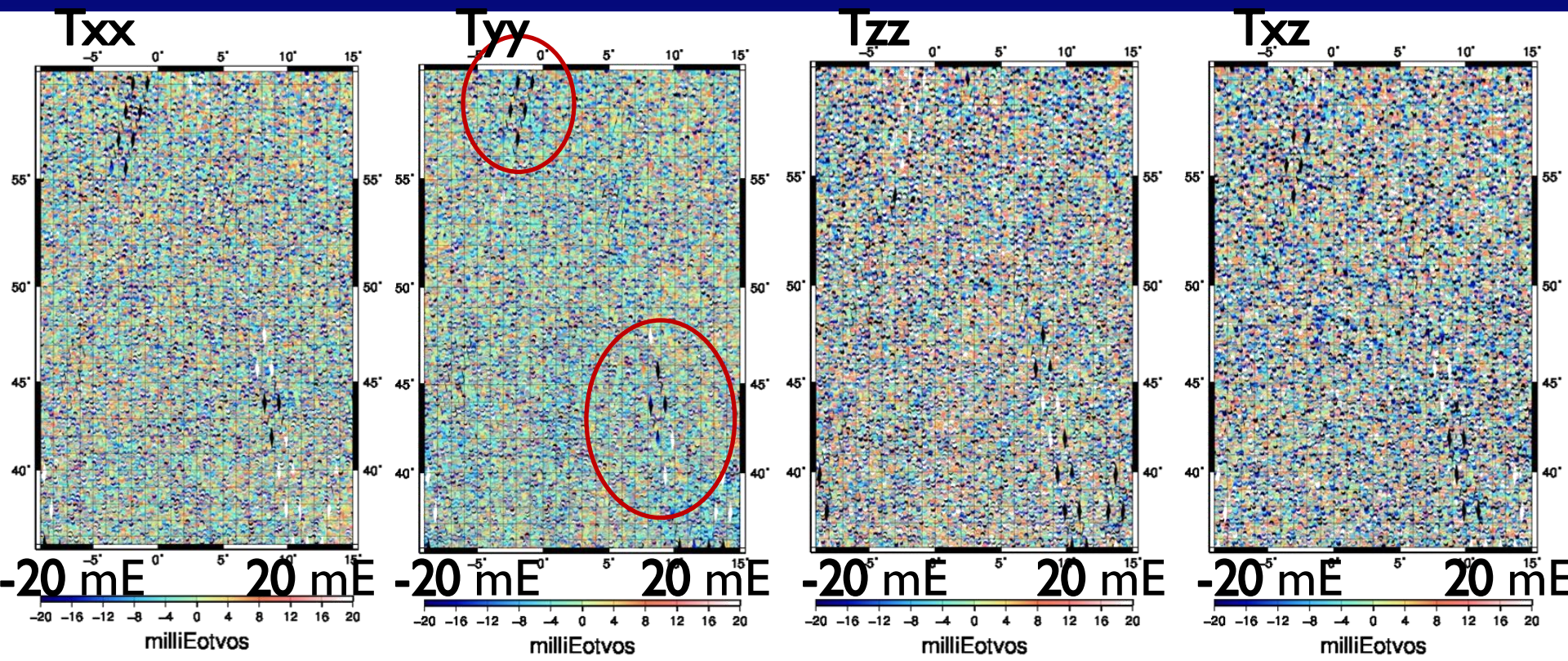
Free-air anomalies

35 km resolution



Scales 625 to 78 km

Residuals to the LNOF gradients

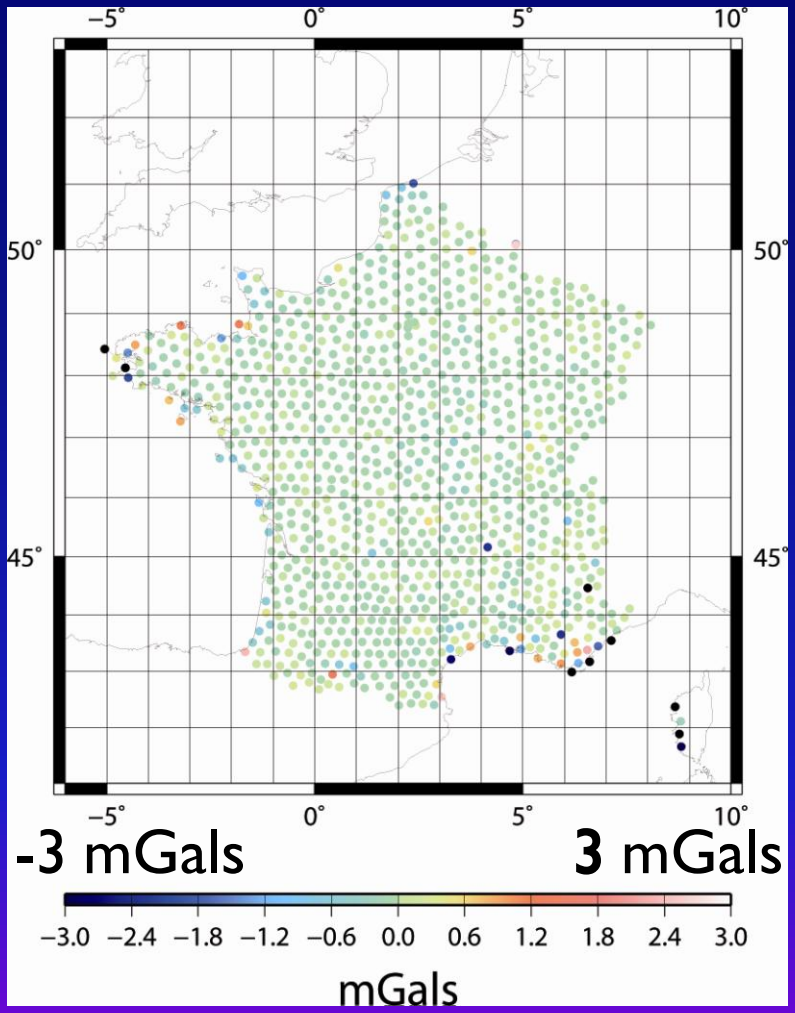


rms: 11.6 mE 12,2 mE 15.2 mE 13.9 mE

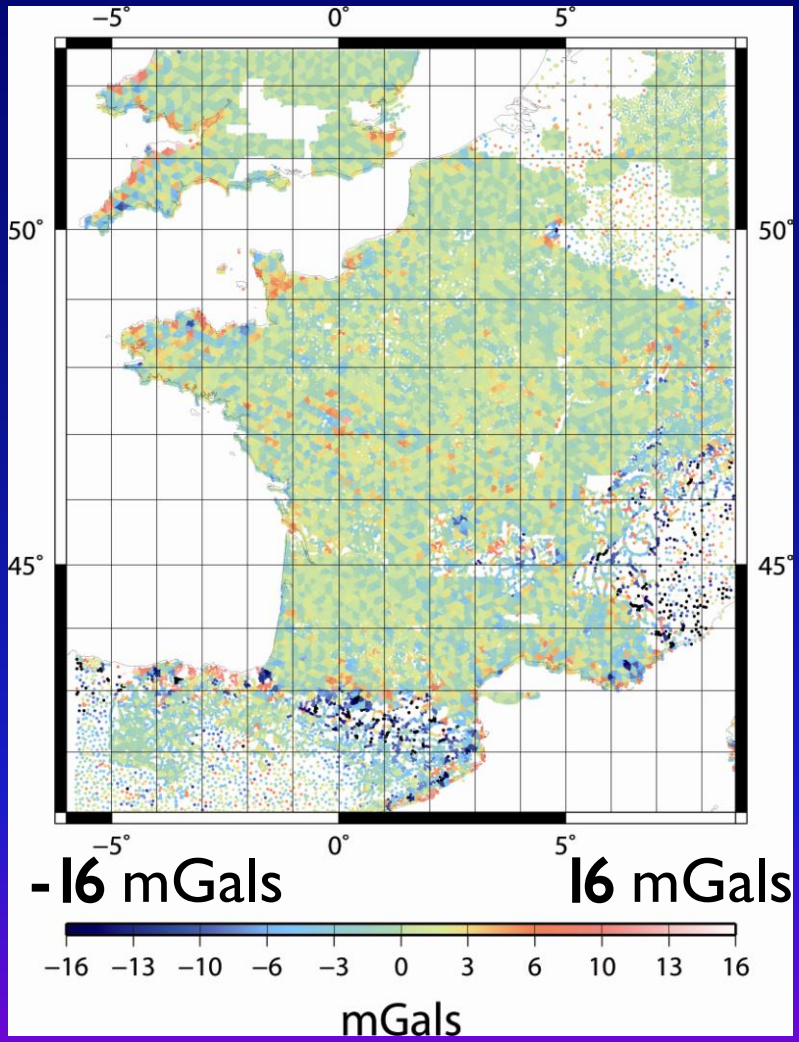
LNOF gradients from November 2009 to December 2010

Residuals to terrestrial gravity

35 km resolution



rms: 0.8 mGal

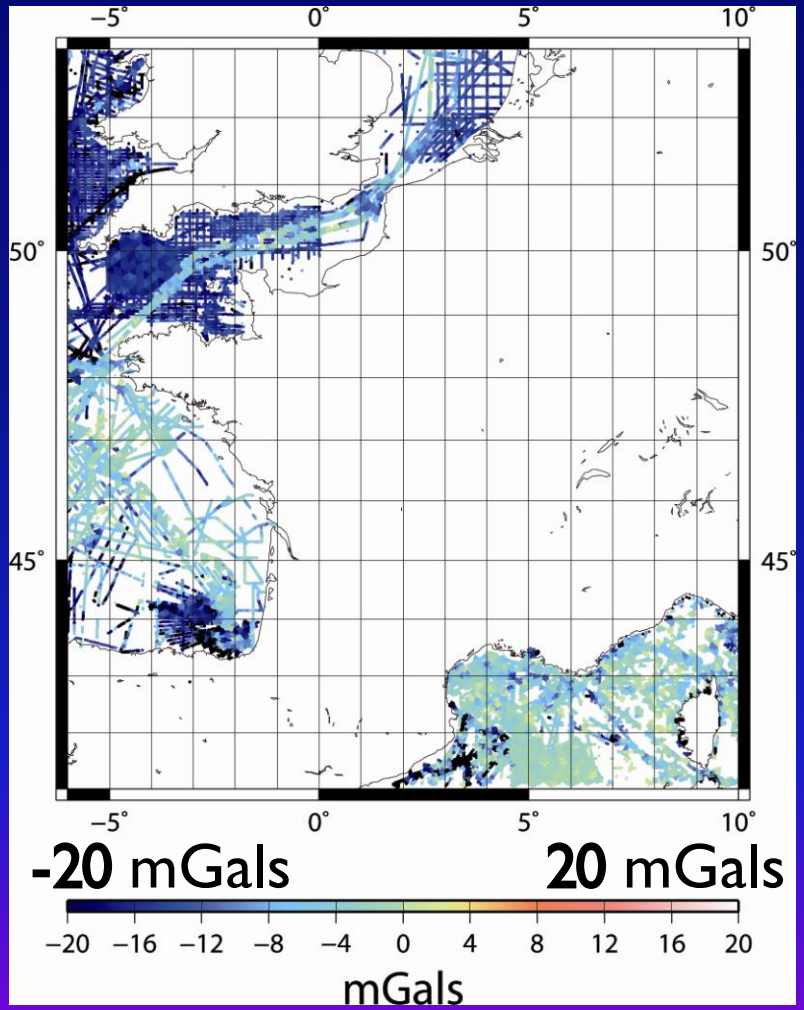


rms: 2,4 mGal

Residual terrain corrections applied for scales < 35 km.

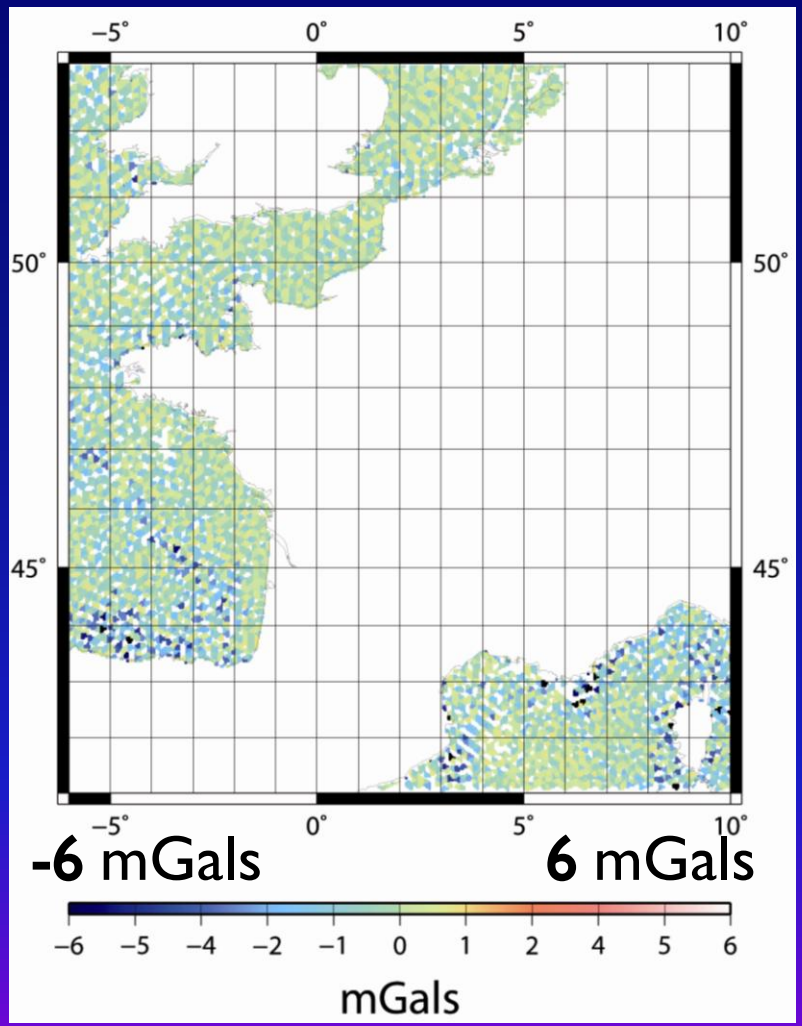
Residuals to ship & altimetry data

35 km resolution



rms: 6 mGal

bias: -2,4 mGal



rms : 1,5 mGal

Comparison with GPS/levelling height anomalies

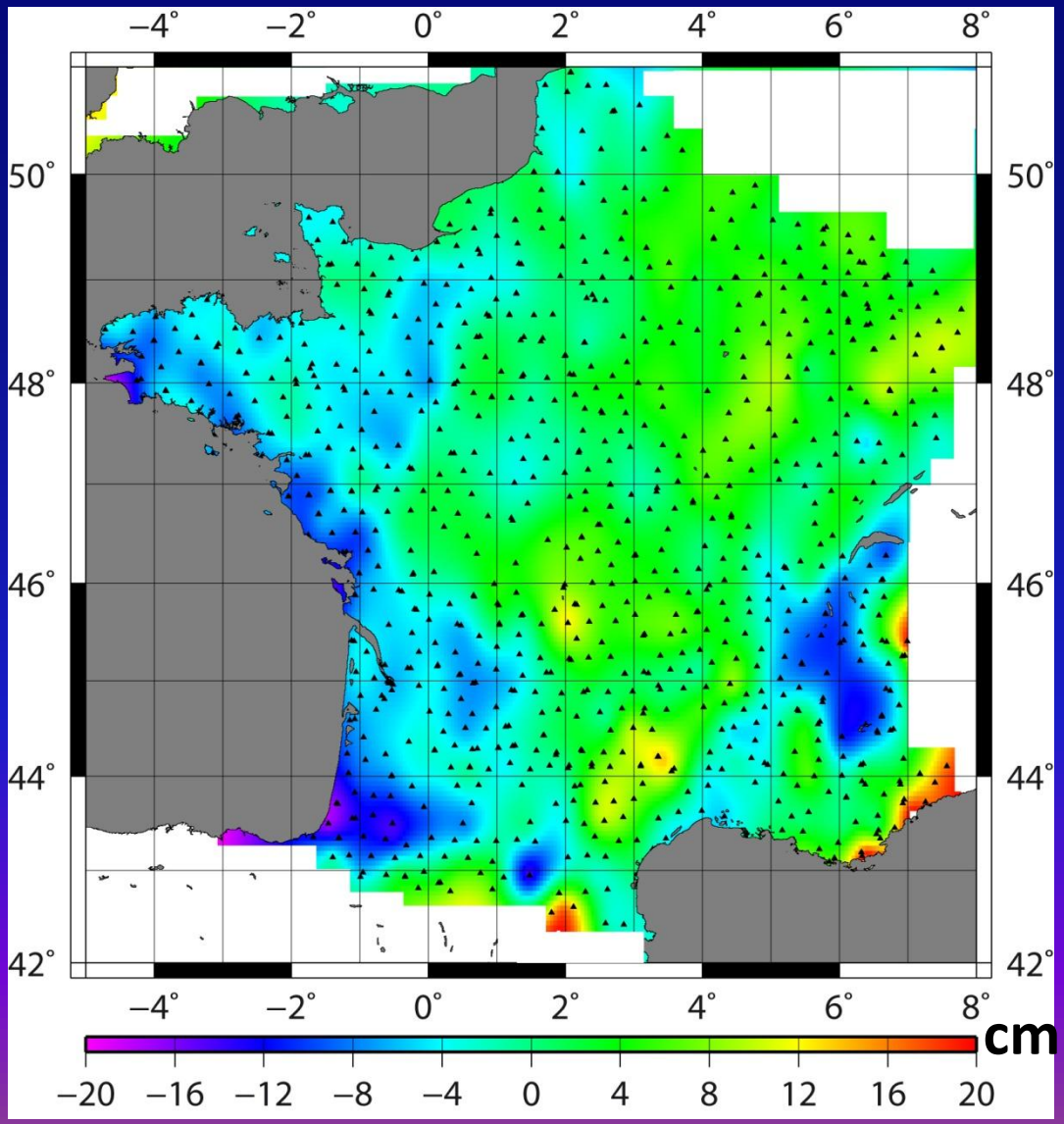
Differences on height anomalies:

- From the wavelet / SH model,

- From GPS & levelling.

Omission error reduced in the 35-9 km scale band using EGM2008.

rms = 7.3 cm



Comparison with GPS/levelling height anomalies

Case of the previous quasi-geoid model computed over France, **QGF98** (Duquenne, 1998):

rms = 10.9 cm

→ Improvement of the available gravity data

→ Validation of the results

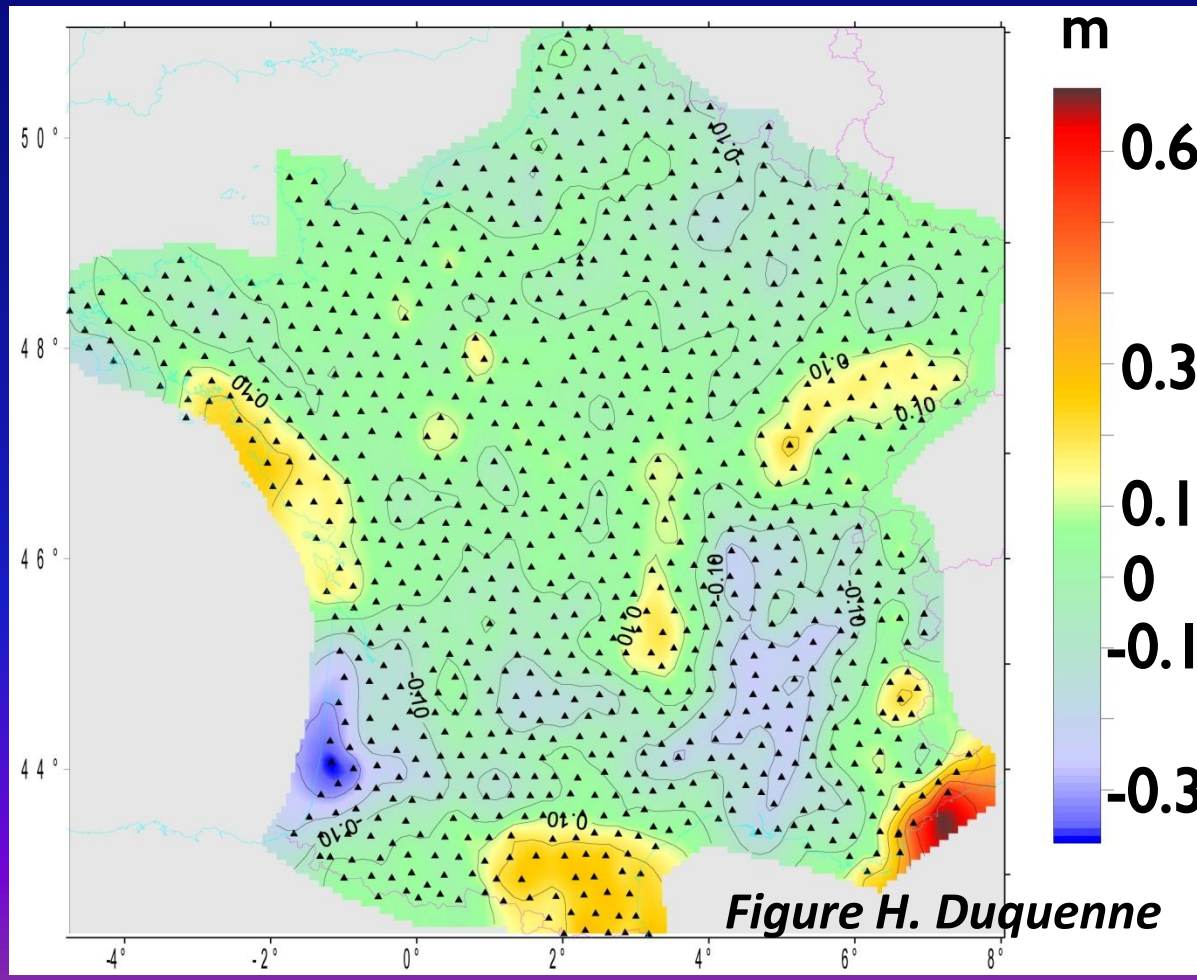
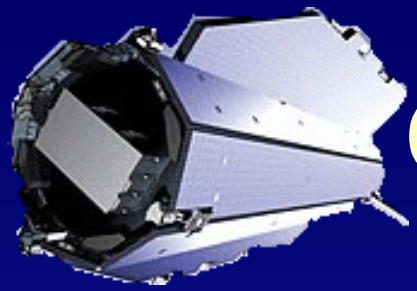
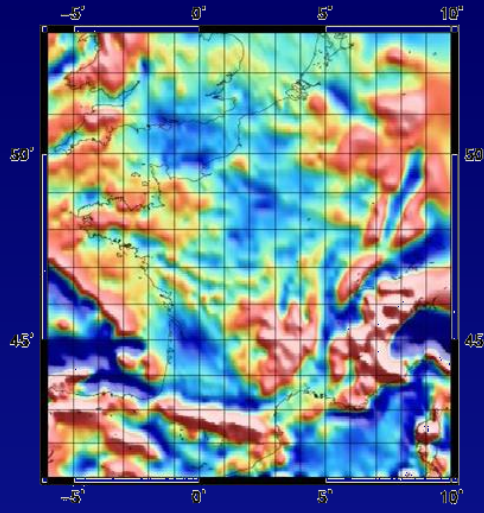


Figure H. Duquenne



Conclusion & outlook



→ A flexible method to combine the GOCE gradients with surface data.

Local models embedded in regional ones

→ The domain decomposition approach allows to handle wide areas by blocks. The block size is related to the scale.

→ We obtain a 35 km resolution model around France.

→ *Understand discrepancies to GPS/levelling on the Atlantic coast*

→ *Increase spatial resolution*