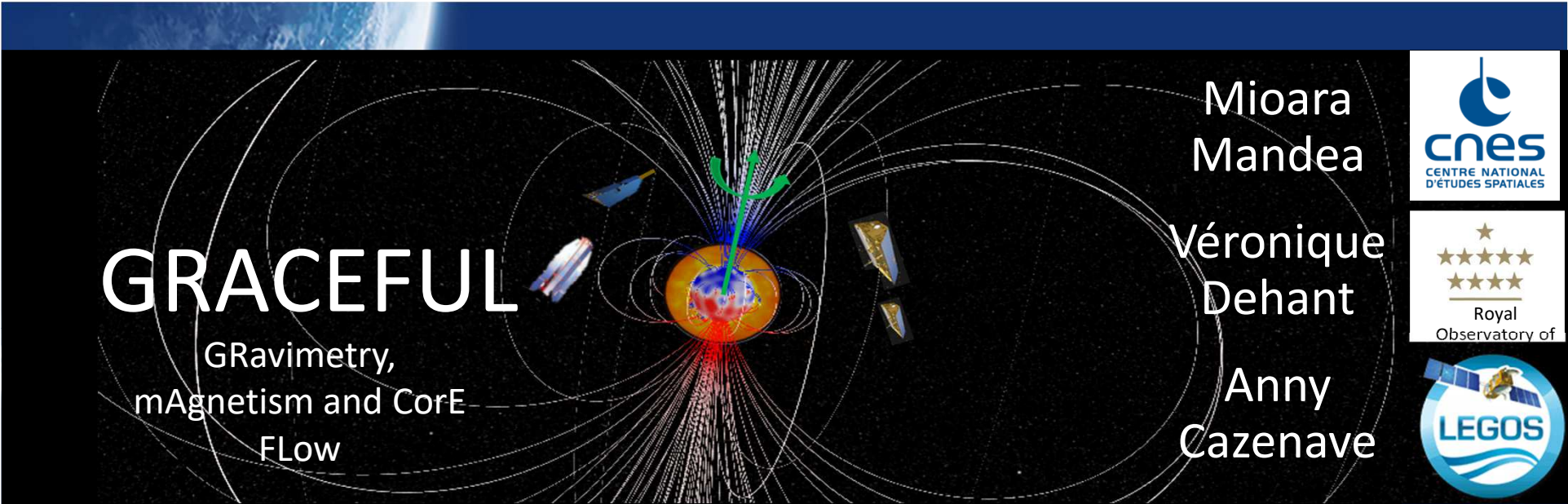




GRACEFUL

GRavimetry,
mAGnetism and CorE
Flow

Mioara
Mandea

Véronique
Dehant

Anny
Cazenave



PROBING THE DEEP EARTH INTERIOR BY SYNERGISTIC USE OF OBSERVATIONS OF THE MAGNETIC AND GRAVITY FIELDS, AND OF THE EARTH'S ROTATION

EGU2020-13515

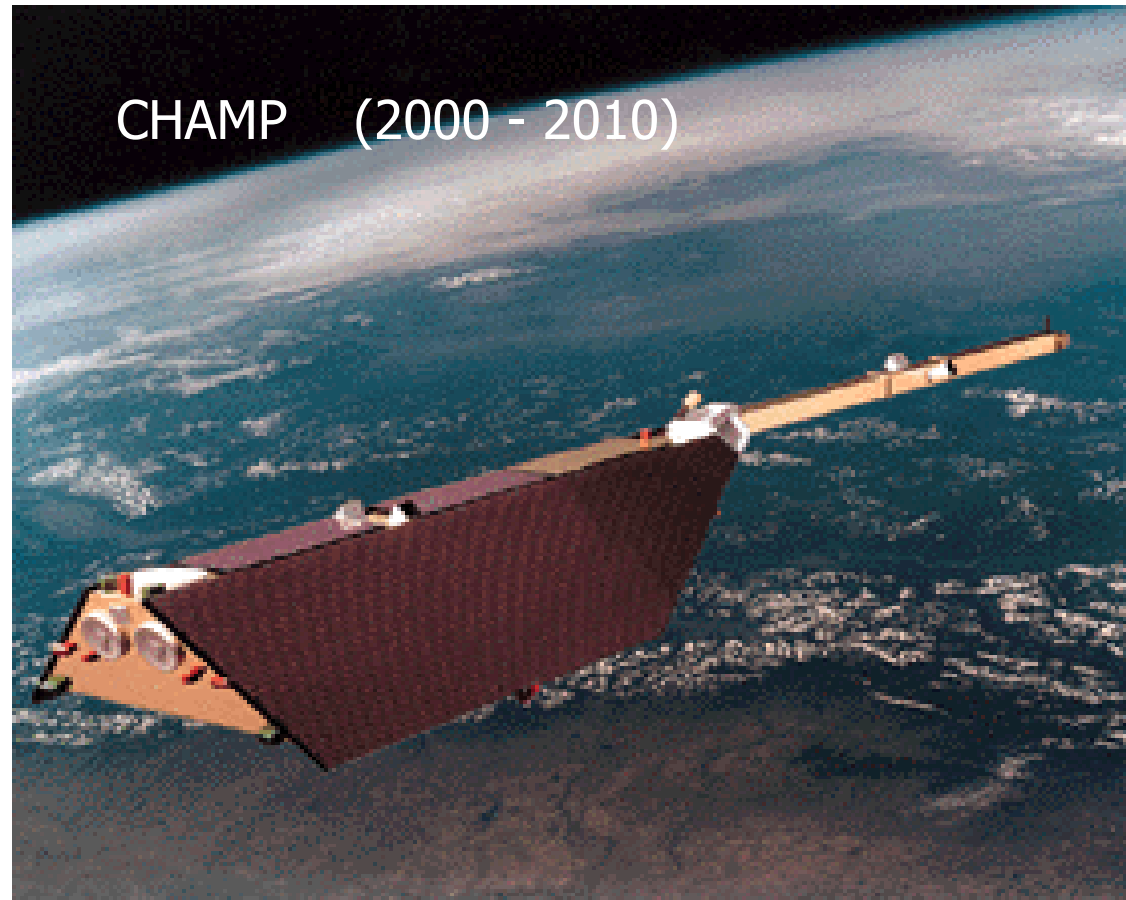


To improve our understanding of physical processes involved in the deep interior of the Earth. *In particular, we intend to study:*

- the dynamics of the Earth's fluid iron-rich outer core and its impact on the Core Mantle Boundary (CMB)
- the core global rotational and inertial modes
- the interaction between the core and the mantle
- the geomagnetic jerks related to the magnetic field and rapid flows in the core
- the impact of the core flow on the rotational properties of the Earth

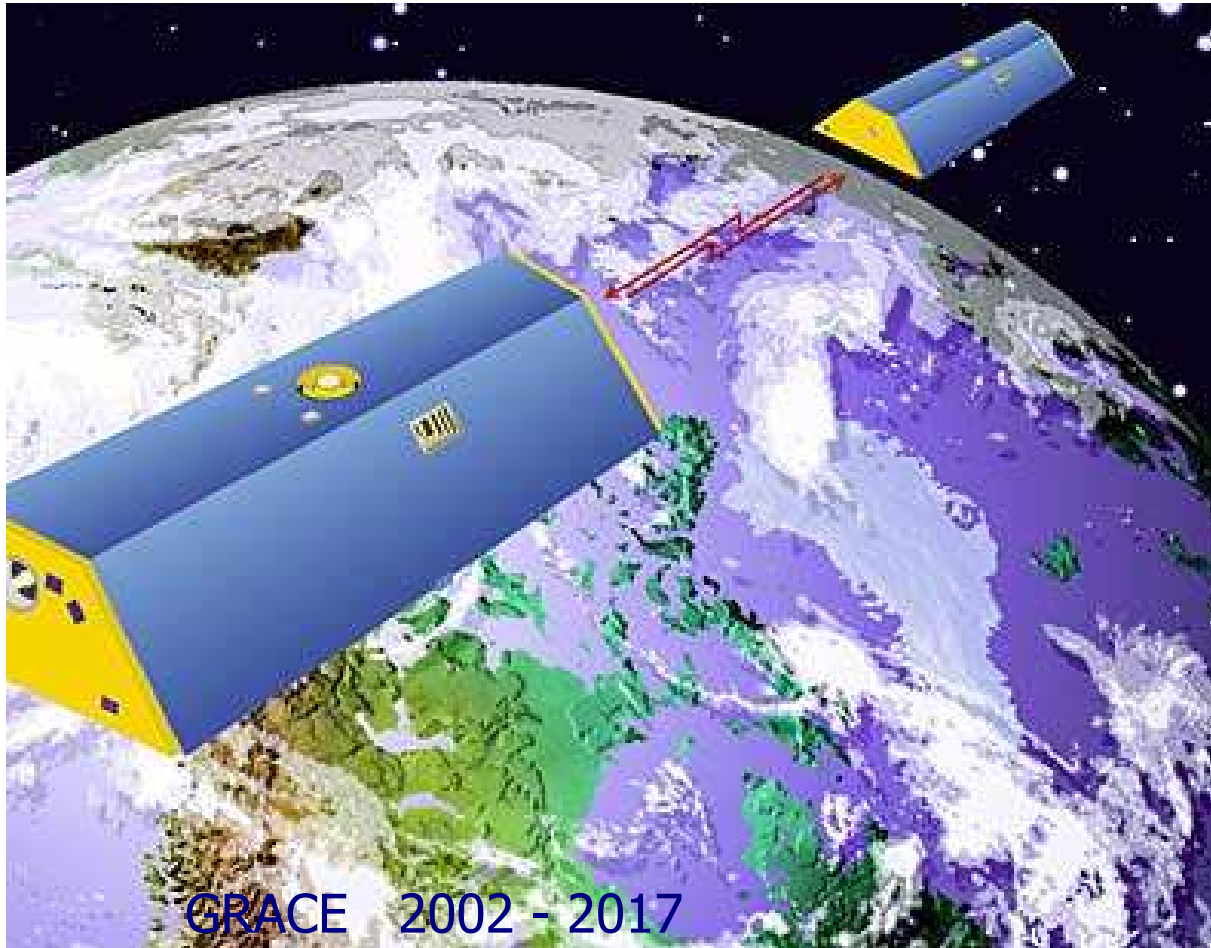
Using in synergy observations of the magnetic and gravity fields of the Earth and of the Earth's rotation (length of day)

Which magnetic field measurements?



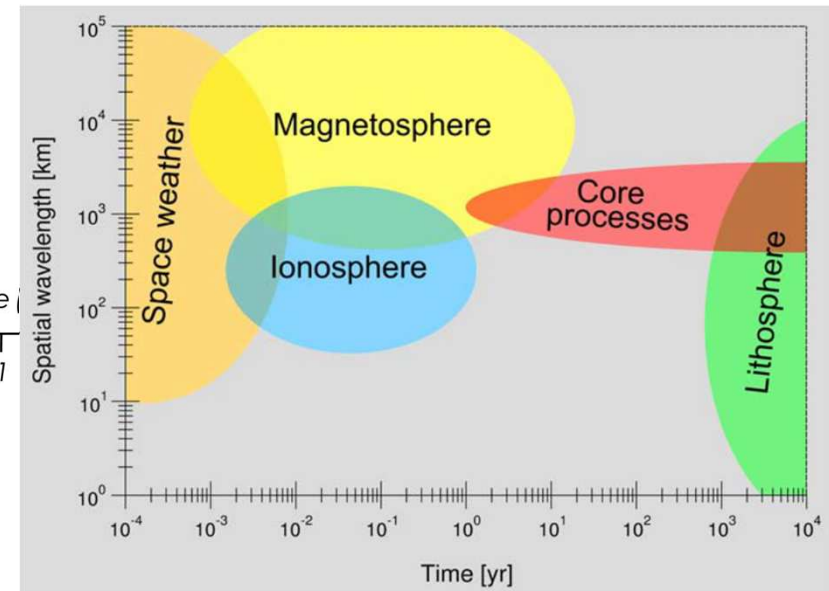
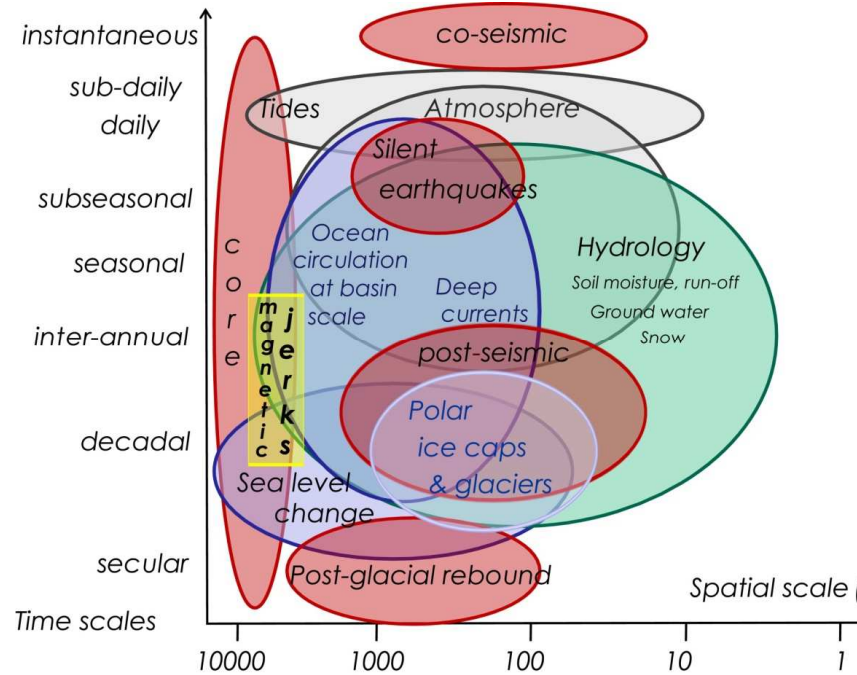
- CHAMP satellite
- Magnetic observatories

Which gravity field measurements?

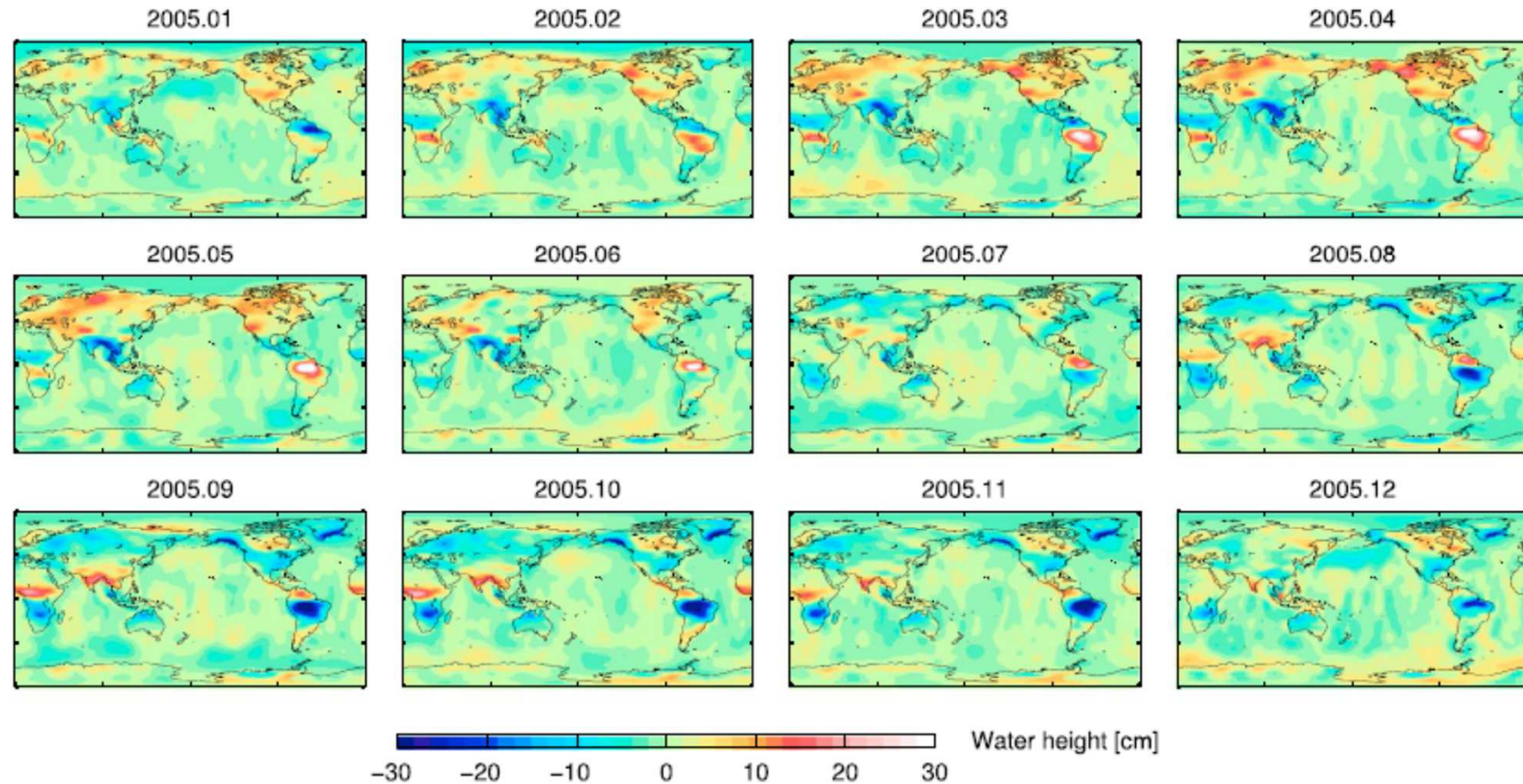


- GRACE space gravimetry
- Removal of the climate-related surface contributions and GIA (Glacial Isostatic Adjustment)

Which gravity and magnetic field contributions?

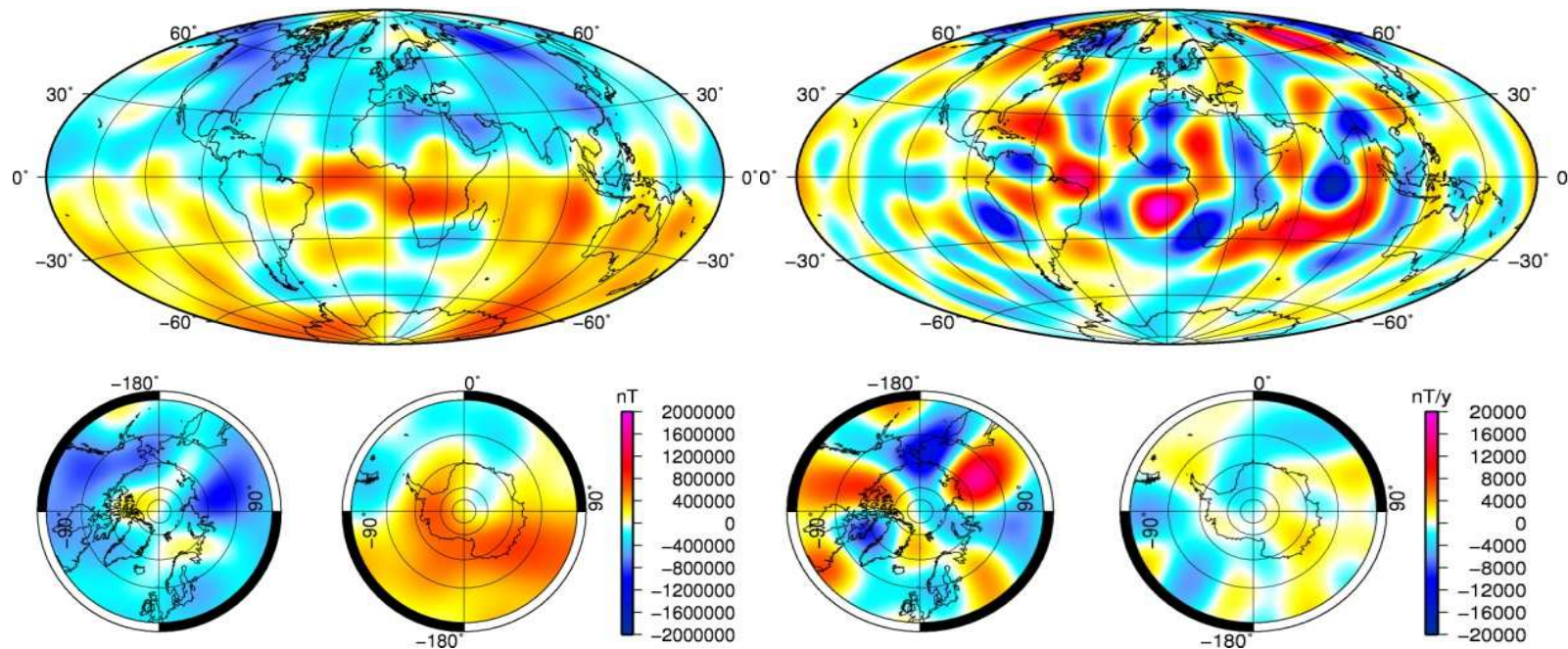


Gravity change from GRACE



Example of monthly mass anomalies for 2005 from GRACE (source: Wang et al., JGR, 2016)

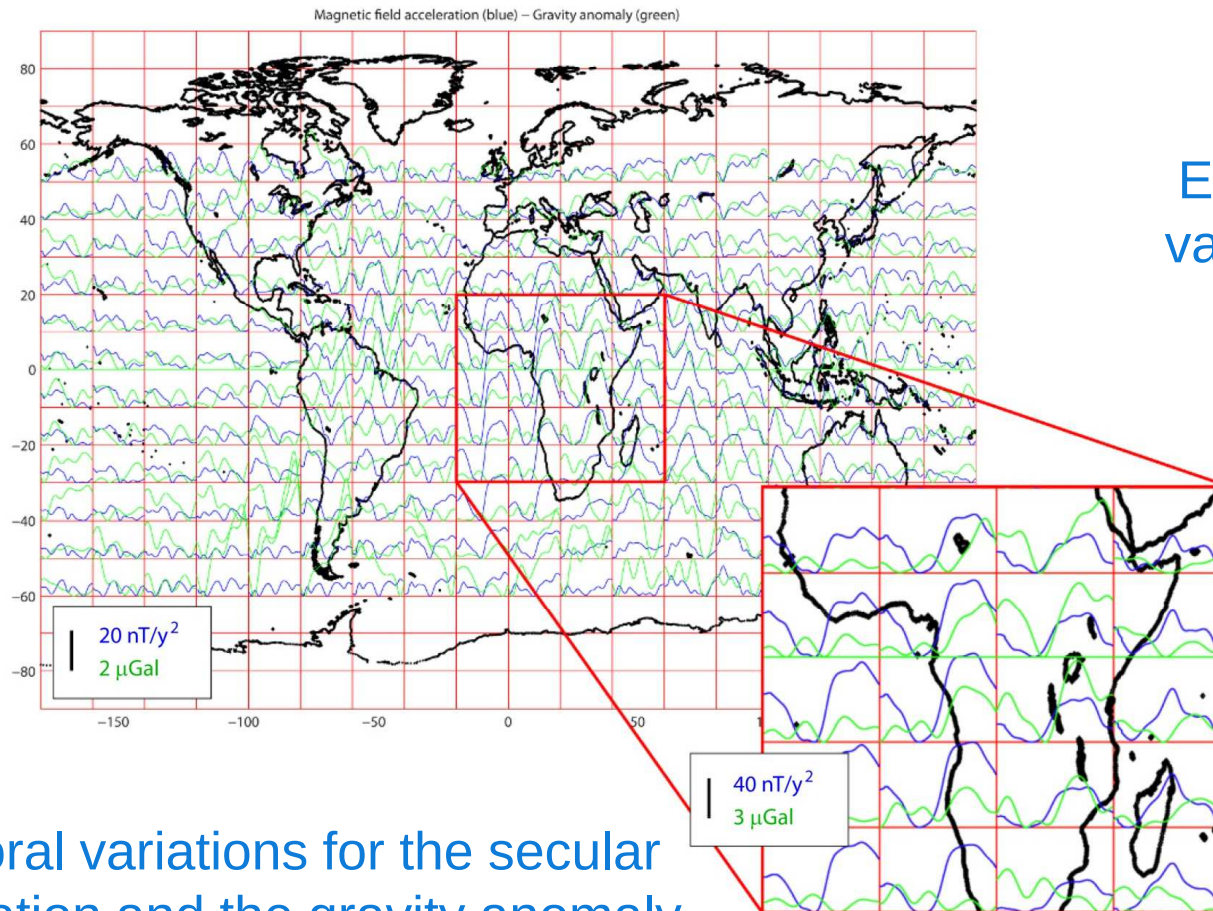
Magnetic models



CHAMP (2000 - 2010)

Radial component of the core magnetic field and its secular variation as estimated at the CMB from the GRIMM-3 model truncated at SH degree/order 13.

Virtual magnetic and gravity observatories

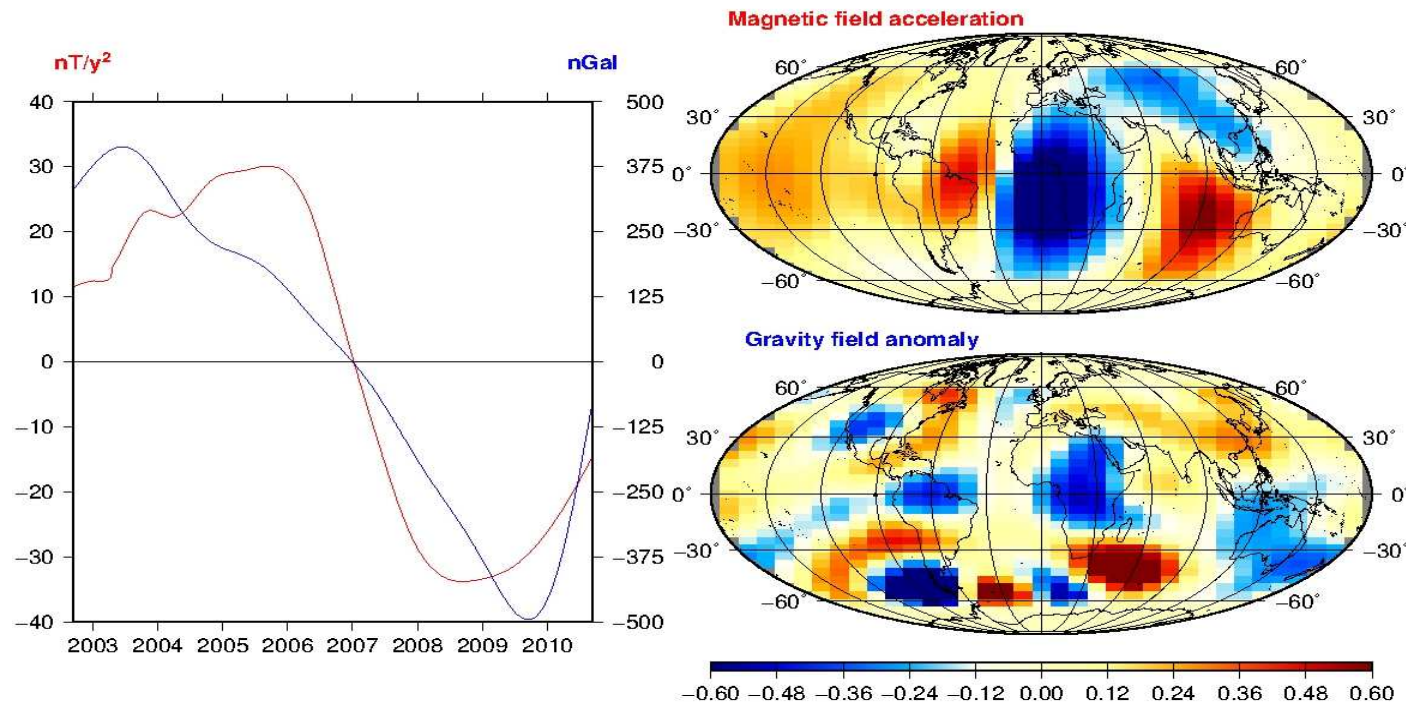


Each series 281
values: Aug 2002
- Aug 2010

Temporal variations for the secular
acceleration and the gravity anomaly,
at each VMGO position.

Mandea et al. (2012)

Statistical analysis



Results of the SVD for magnetic and gravity time-series:
Left panel - temporal pattern (60nT/yr² and 900 nGal - P2P)
Right panels - the spatial pattern for the magnetic (upper)
and gravity (bottom) data

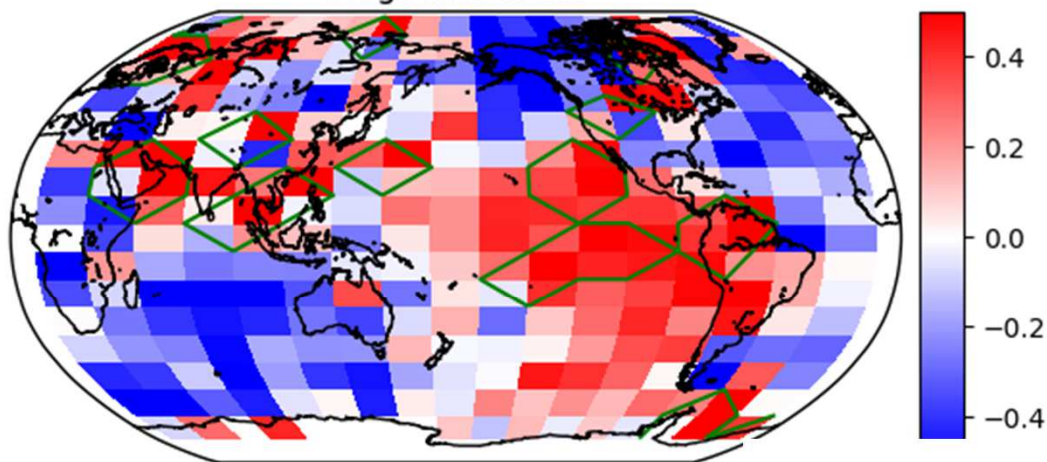
Mandea et al. (2012)

NEW MODELS FOR GRAVITY FIELD AND MAGNETIC FIELD

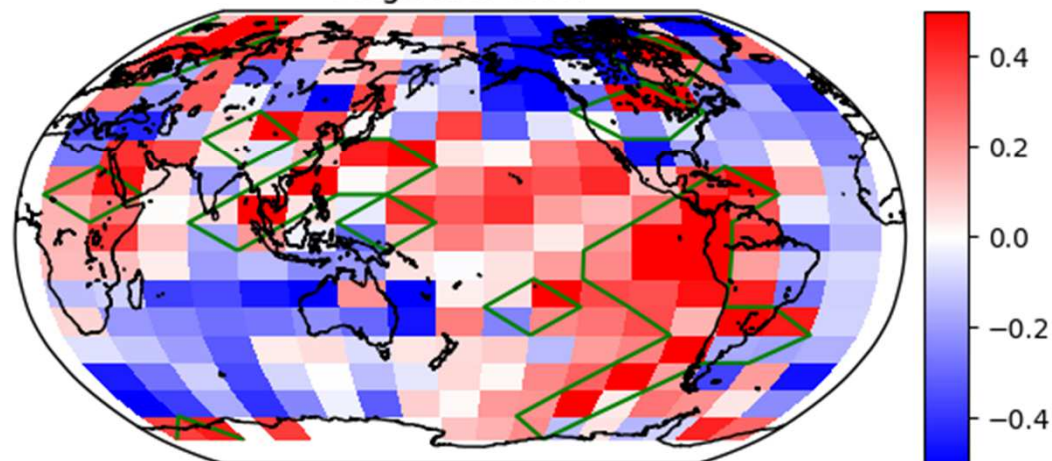
- Jan 2003- Dec 2015 with some missing ones (monthly models) - previous Aug 2002 to Aug 2010
 - 2 magnetic models
 - Mean of 5 GRACE solutions for the variable gravity field (Blazquez et al., 2018)
- to create VMGOs - we consider wide scales (so SH up to degree / order 8)
- A grid of 10 degrees in geographic latitude and 20 degrees in longitude
- Each observatory in the center of the cell
- Magnetic / gravity series correlations

New study

Mag1 and Gravi

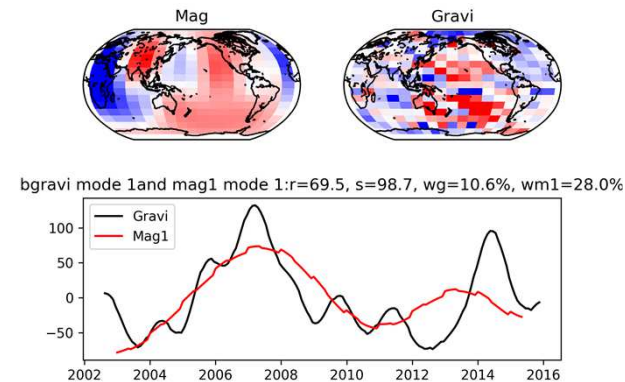


Mag2 and Gravi

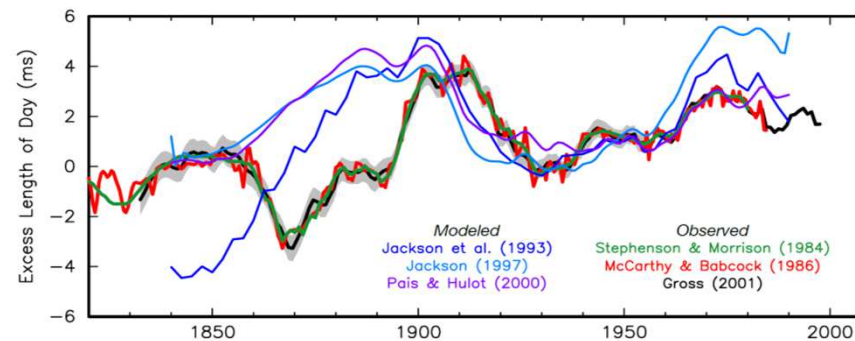


How magnetic, gravity, LOD series are correlated?

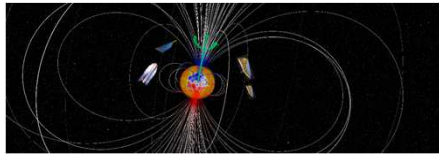
1. Spatio-temporal correlation detected for the first time between the magnetic and gravity fields at interannual time scale (Mandea et al. 2015)



2. Decadal oscillations of the LOD are attributed to variations of the core angular momentum deduced from observations of the magnetic field



GRACEFUL - ERC



Magnetic field

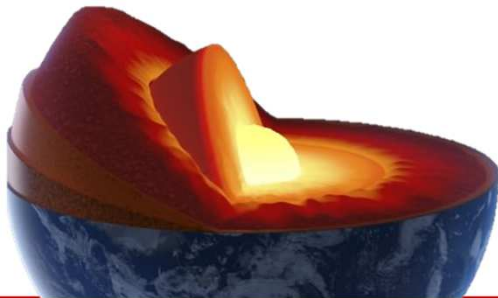
Magnetic field
Core flow at core-mantle boundary
⇒ Core flow

Gravity field

Mass anomalies in hydrosphere and mantle
⇒ Core flow
⇒ Mass anomalies at core-mantle boundary

LOD variations

Core flow at core-mantle boundary
⇒ Core flow
⇒ Core angular momentum



- Better understanding of core flow processes
- Core flows in a rotating bumpy ellipsoid, immersed in a magnetic field, having core rotational and inertial modes, and interacting with the mantle

Conclusions



Magnetism space data: Decadal models for the core magnetic field and its variations (secular and acceleration) & flow at the CMB

Gravity space data: Decadal changes in the gravity field, possibly of deep Earth origin

Geopotential fields: an analysis on global scale

Core signature: changes in magnetic and gravity satellite data; the pressure role in these changes.

Insights for future missions: Swarm & *GRACE-FO*

