Space-borne gravimetry: progress, predictions and relevance for *Swarm*

Pieter Visser

First *Swarm* workshop, Nantes, France, 3-5 May, 2006

Department of Earth Observation and Space Systems
Astrodynamics and Satellite Systems

Delft University of Technology

Contents

- Space-borne gravimetry: missions & technology
- Global Earth gravity field modeling:
  - Recent progress
  - Challenges
- Role of LEO satellite formations
- Outlook

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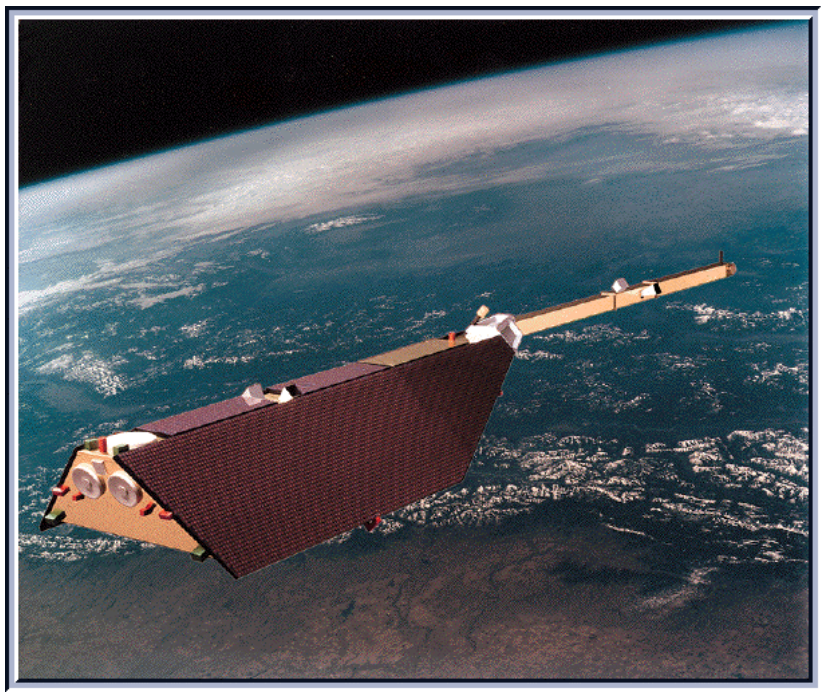
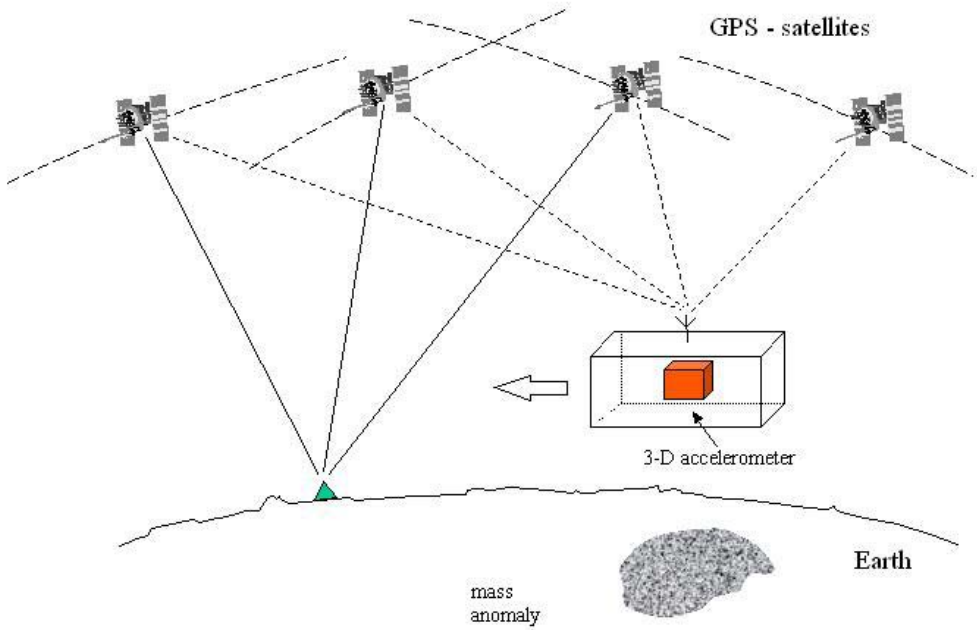
CHAMP:
- DLR
- Launch 15/7/2000

- Lifespan > 6 years
- Inclination 87.3°
- Altitude 416-476 km





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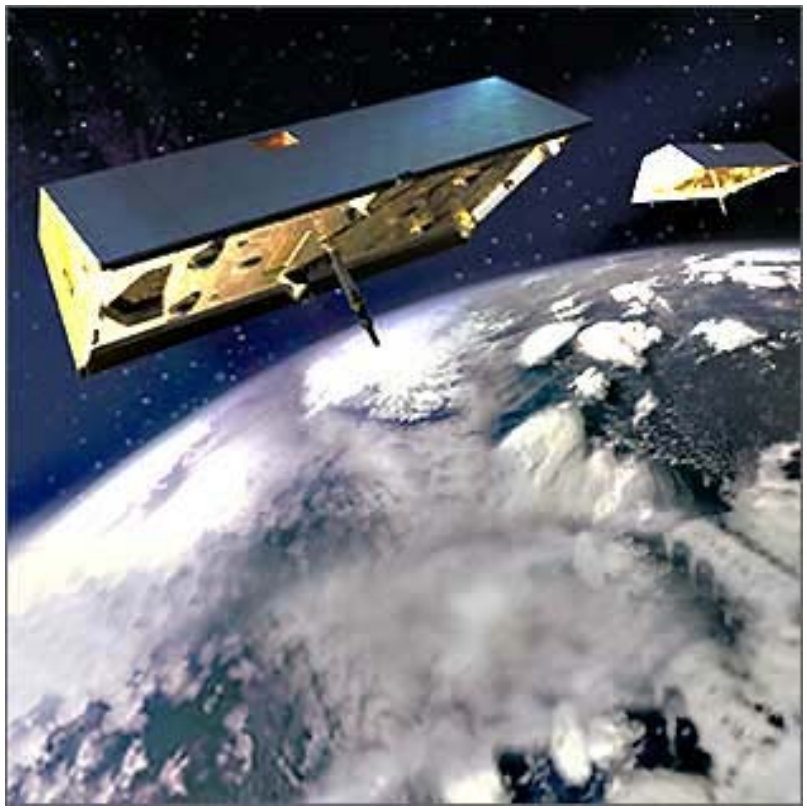
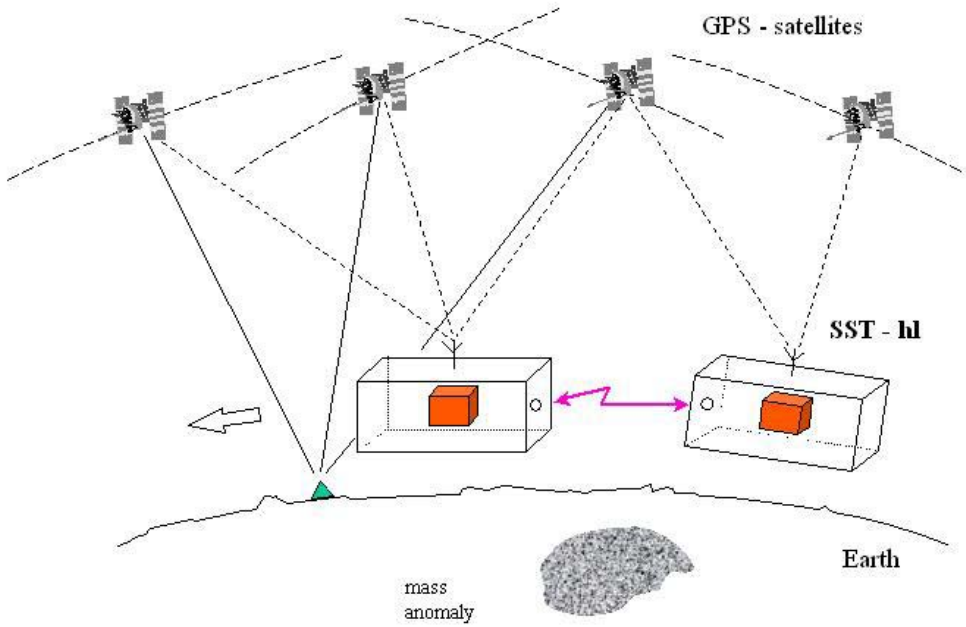
GRACE:
- NASA/DLR
- Launch 17/3/2002

- Lifespan > 5 years
- Inclination 89^{o}
- Altitude 400-500 km





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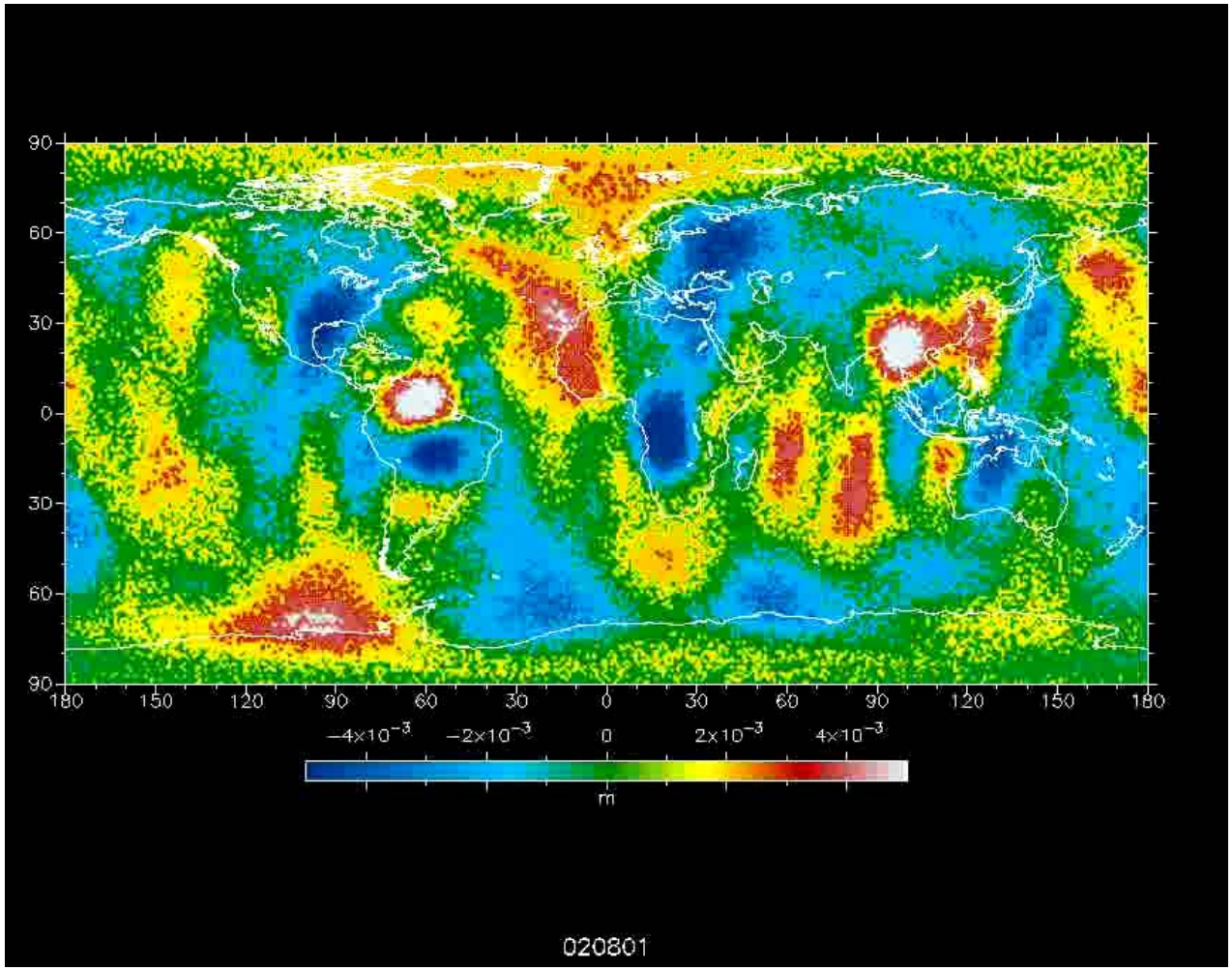
Temporal gravity from GRACE



Tapley et al.,
Science, 2004

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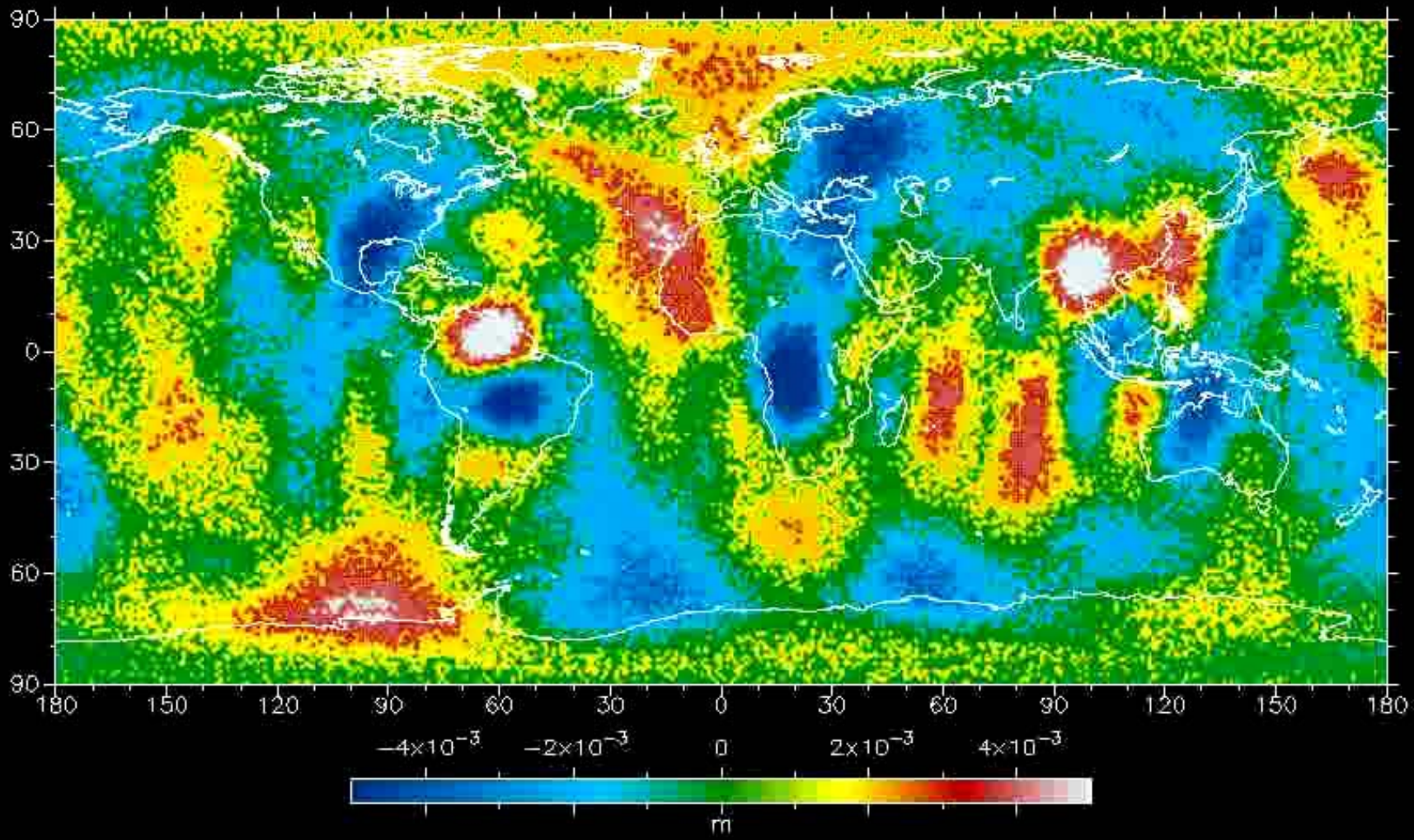
90
60
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90
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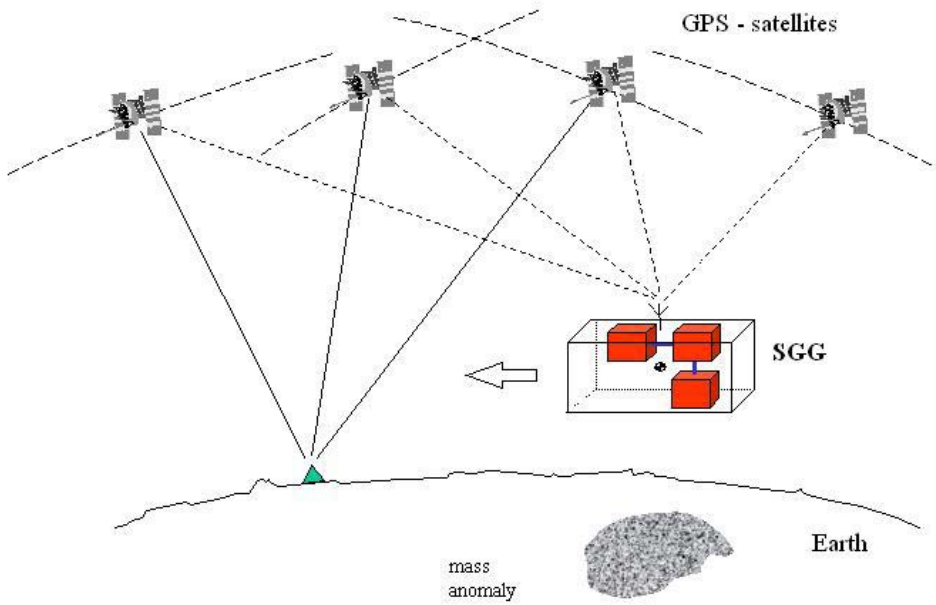
0
30
60
90
120
150
180
−4×10−3
−2×10−3
0
2×10−3
4×10−3
m

020801

GOCE:
- ESA
- Launch 2007

- Lifespan 1.5-2 years
- Inclination 96°
- Altitude 240-250 km

"Piece de resistance"



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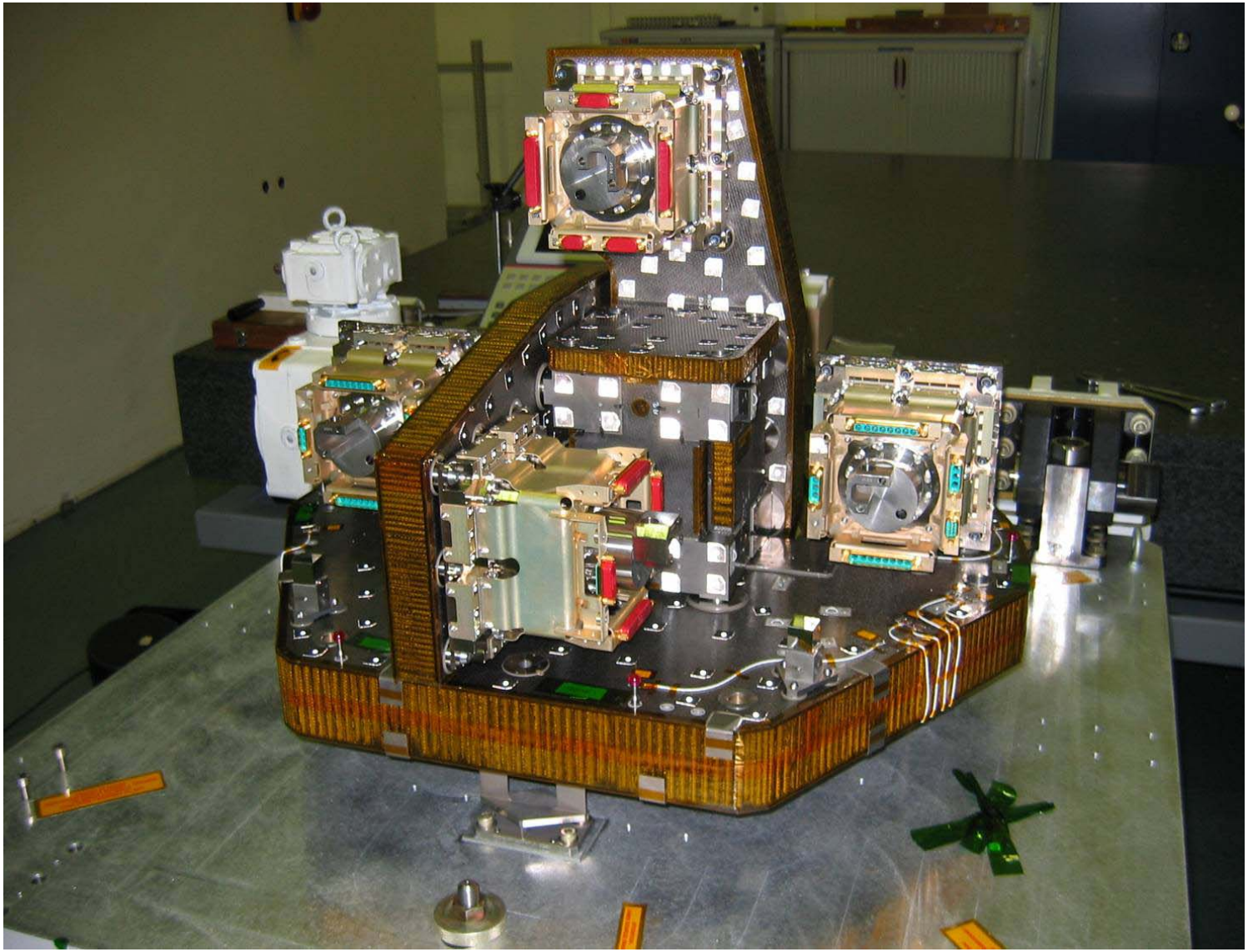

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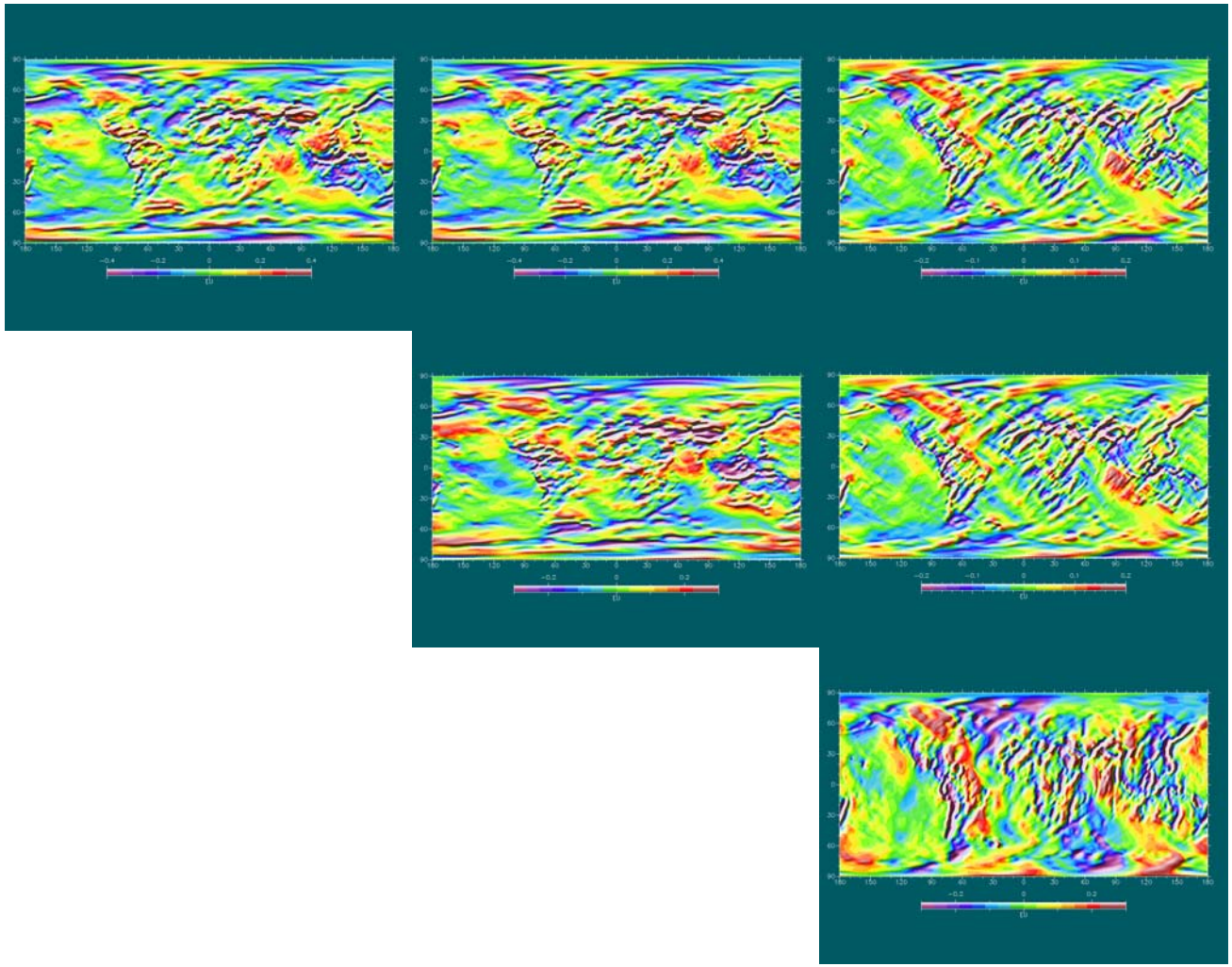
Space-borne gravity gradiometry

Upward

North

East



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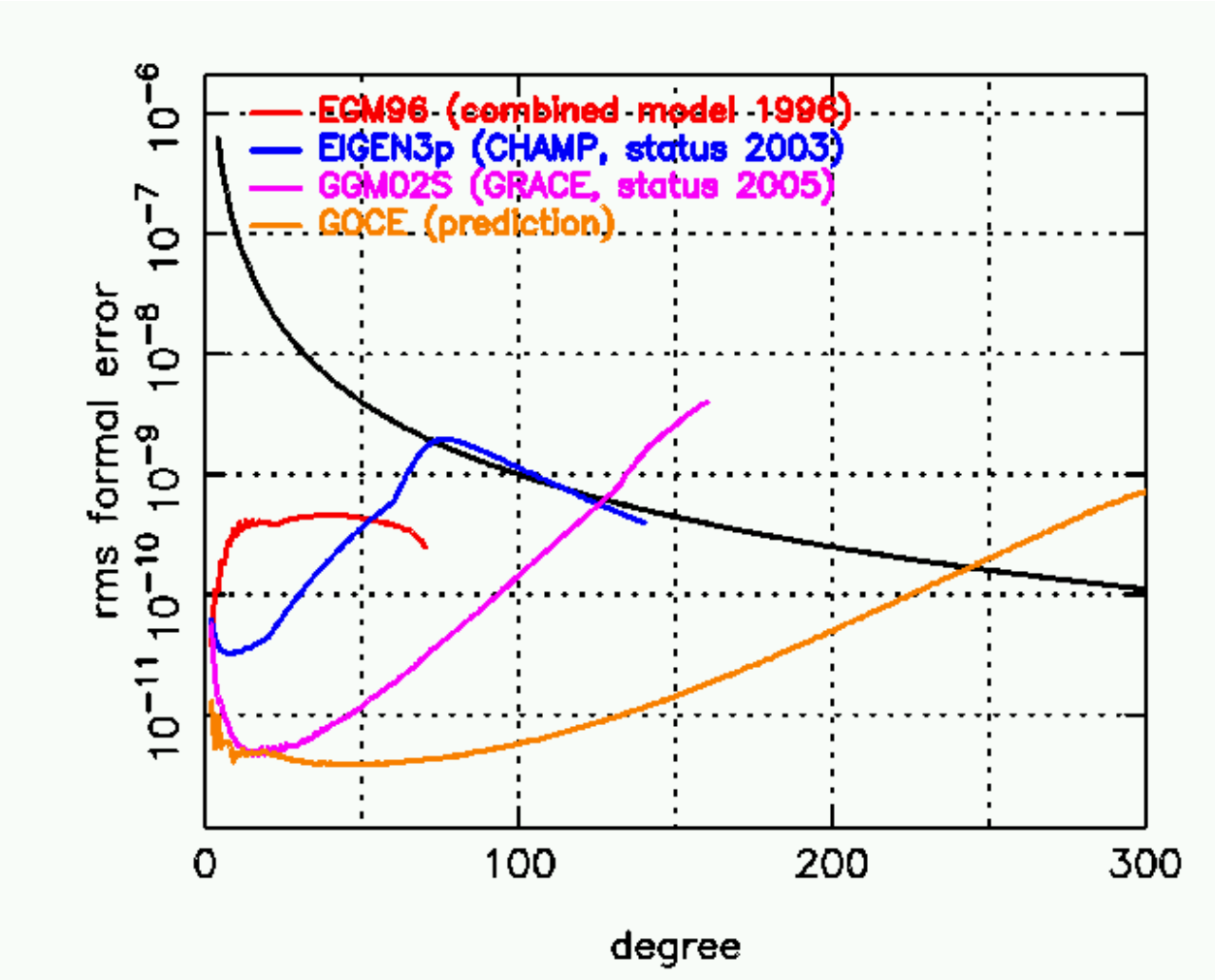
Progress



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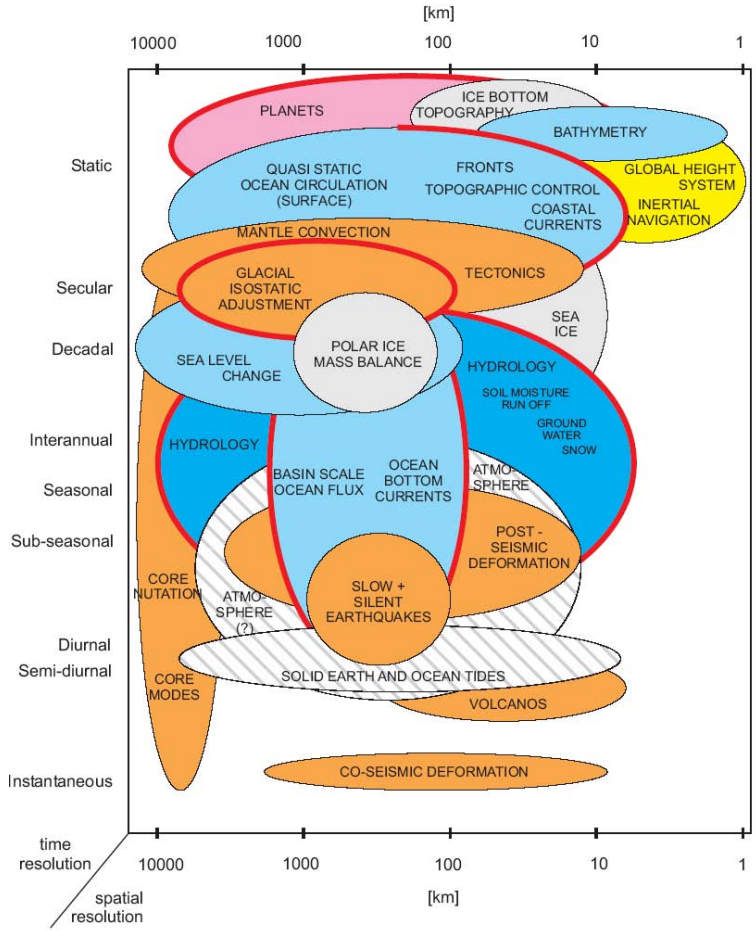
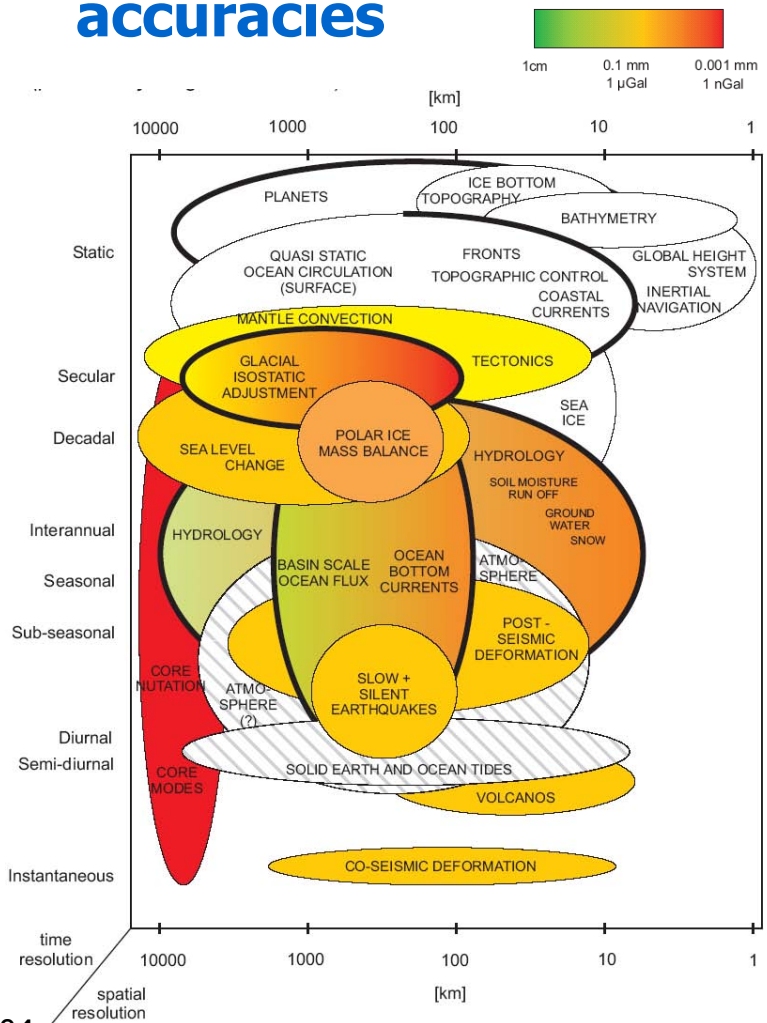
Spatial and temporal scales of geophysical process

CHALLENGES



Scales and required accuracies



Source: Earth, Moon, and Planets, 94(1-2), April 2004

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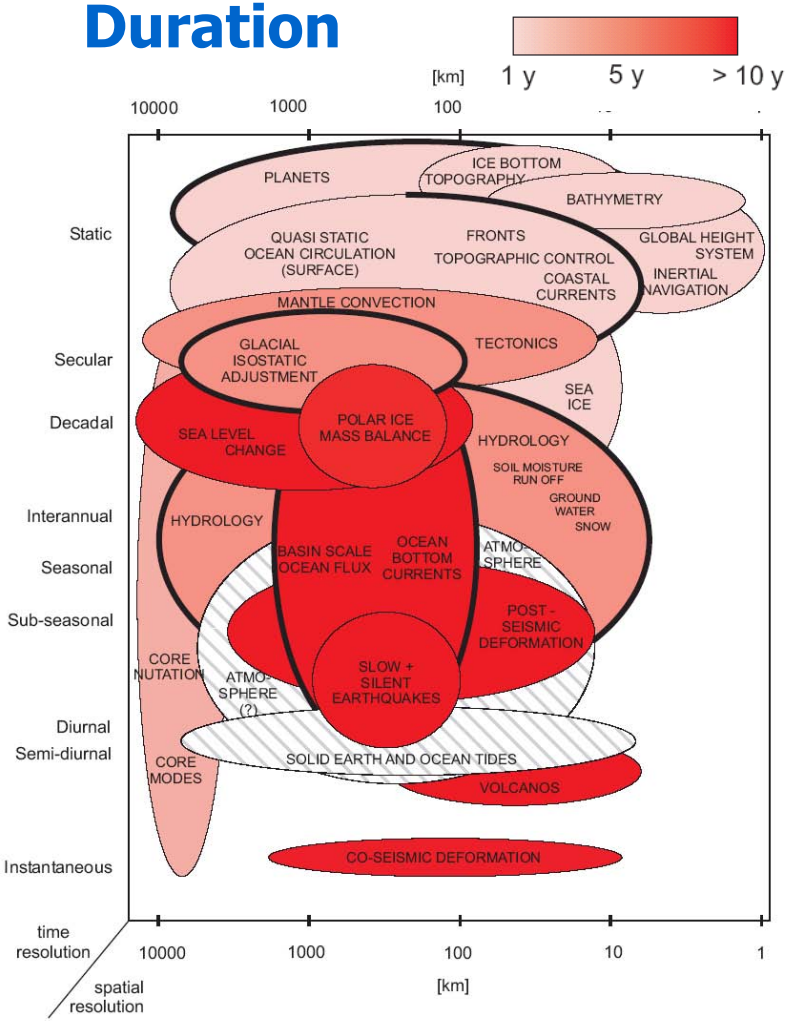
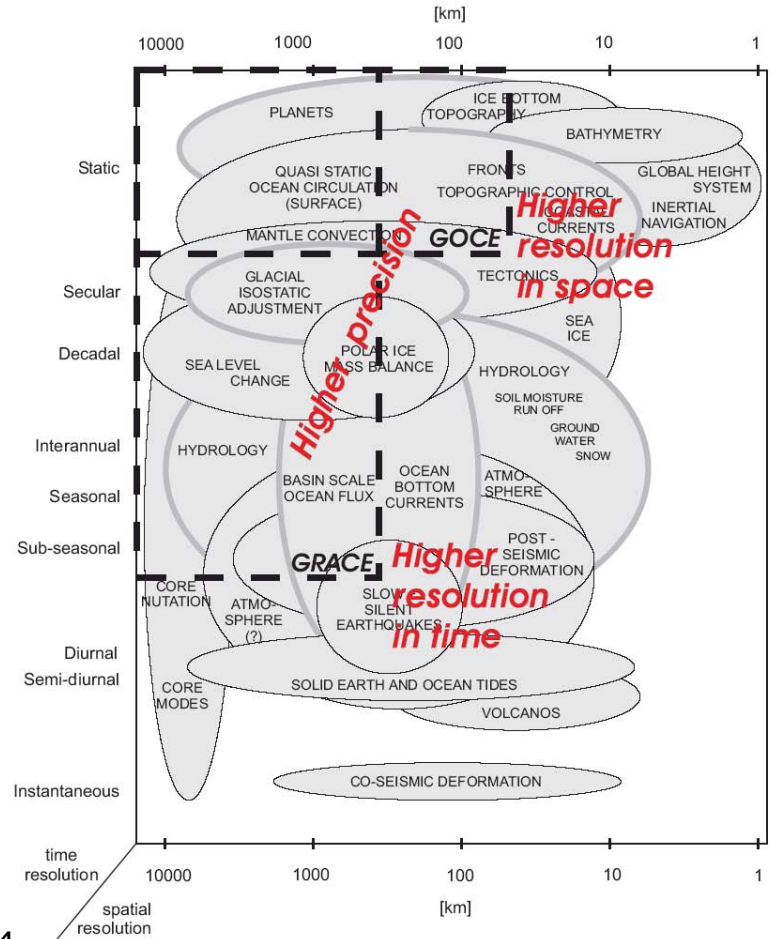
Required Mission Duration



Requirements after GRACE and GOCE



Source: Earth, Moon, and Planets, 94(1-2), April 2004

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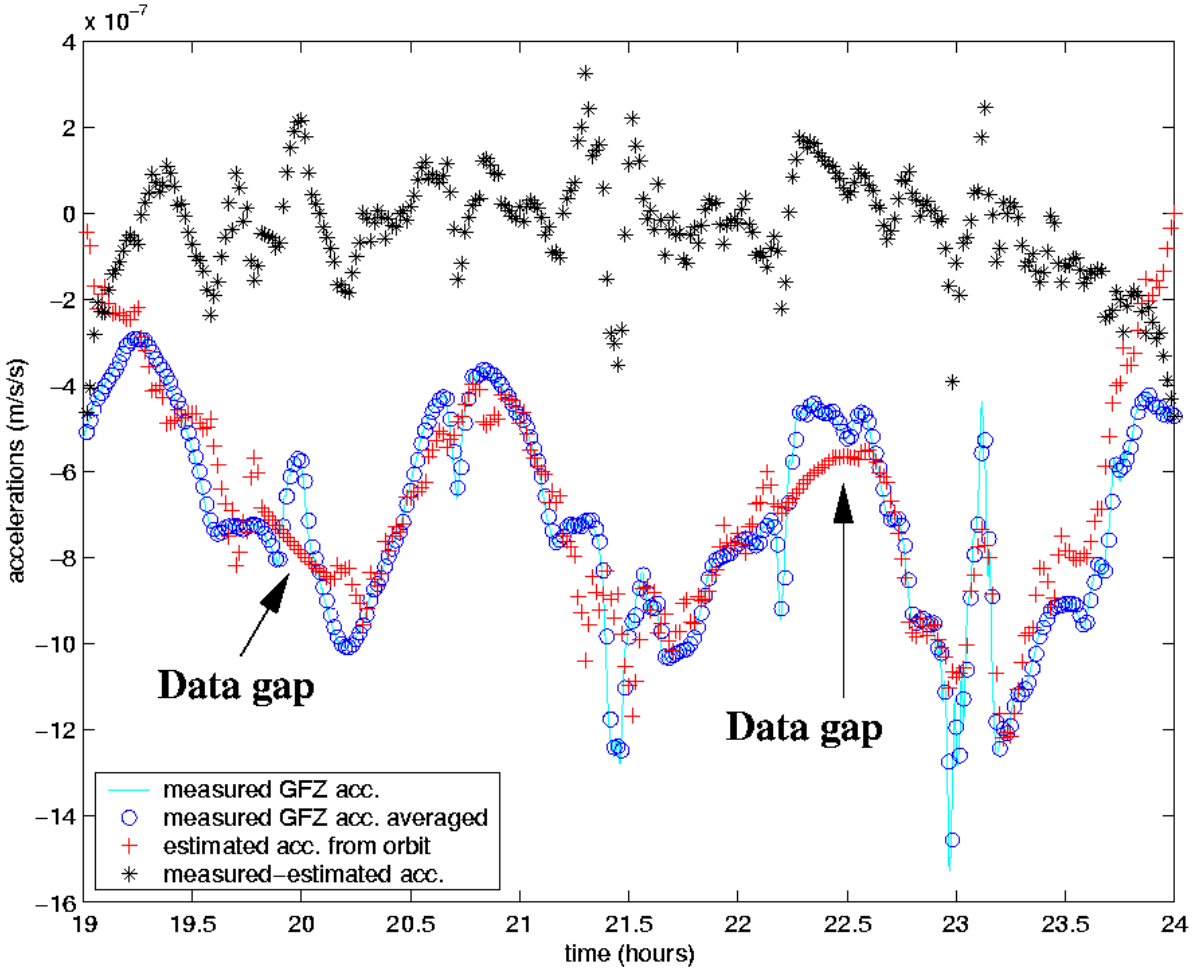
GPS-based accelerometry



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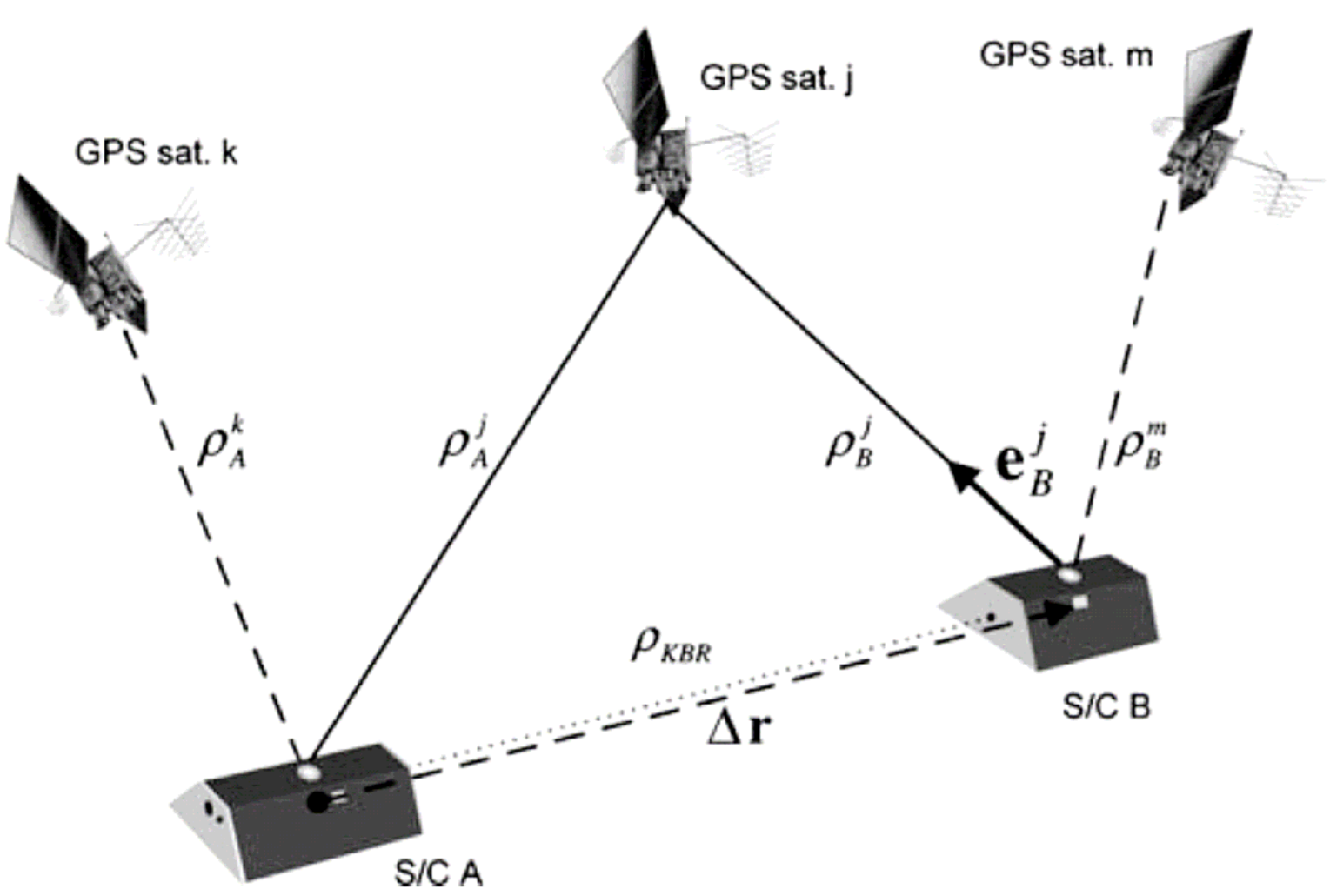

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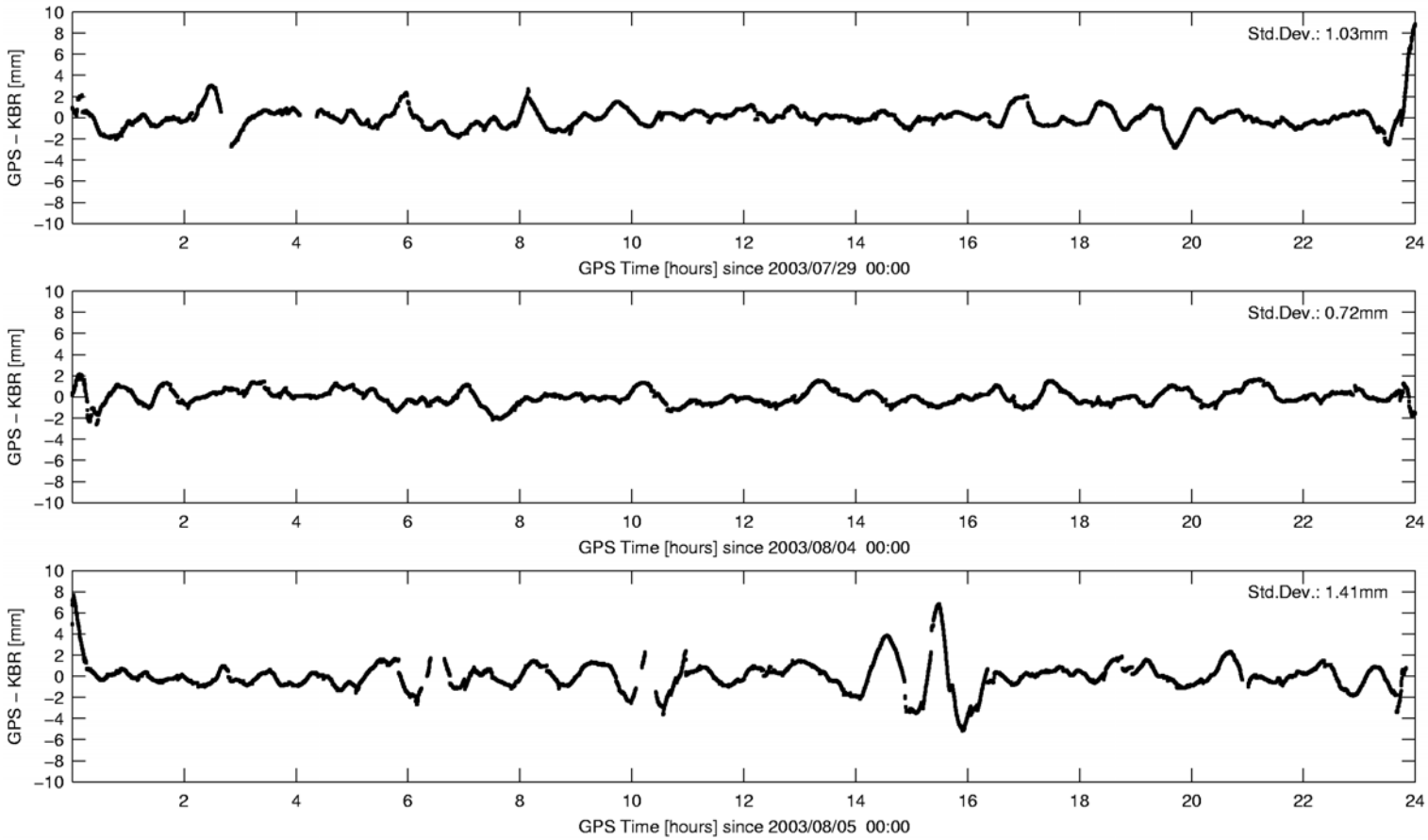
Consistency GRACE baseline by differential GPS and KBR (reduced-dynamic relative POD)



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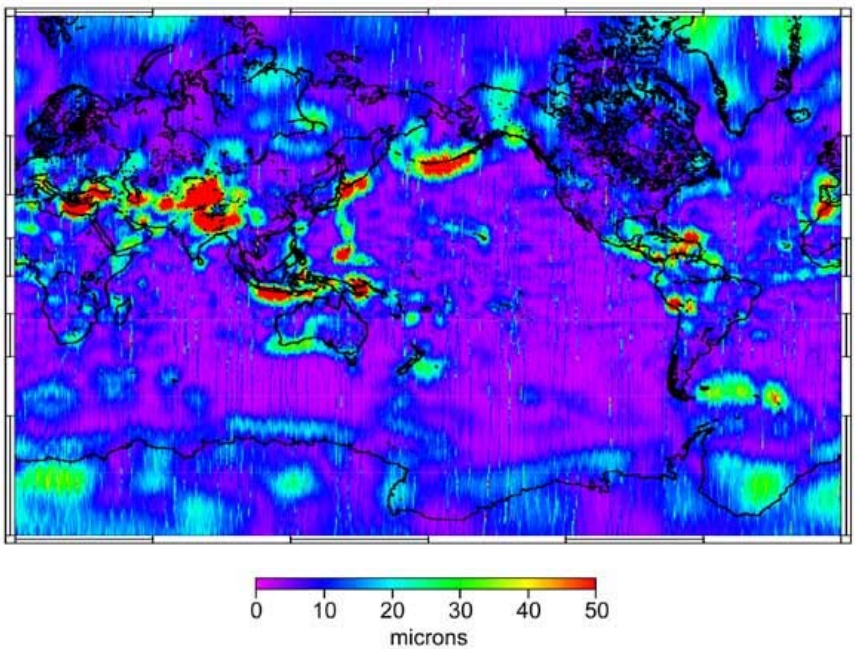
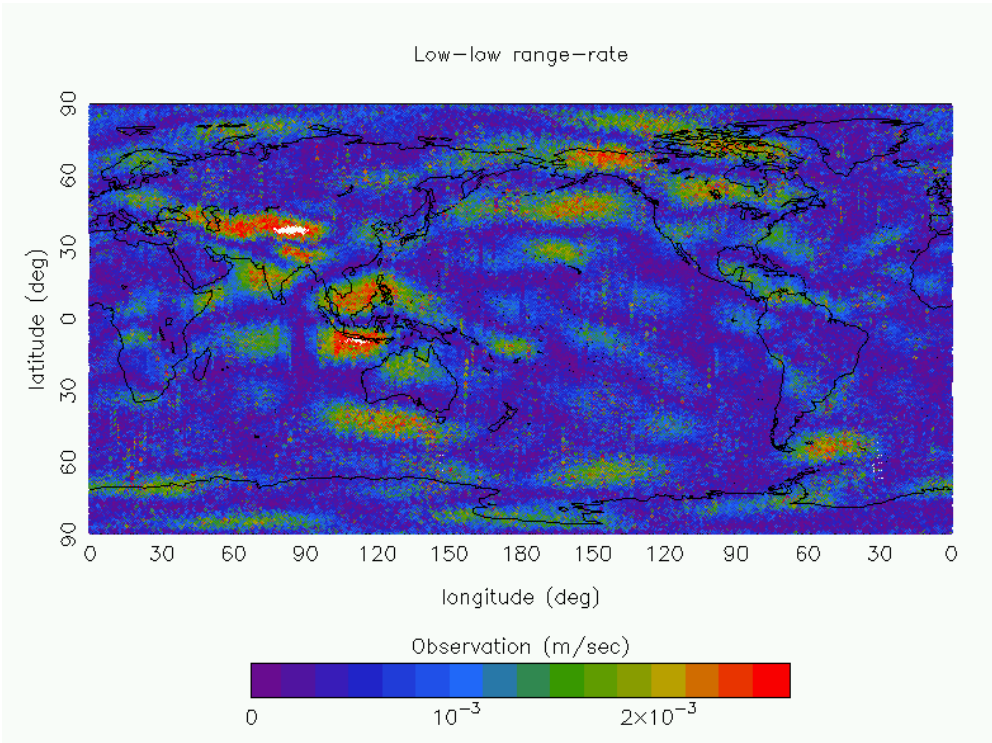
High-pass filtered GRACE inter-satellite ranging

From KBR



From GPS



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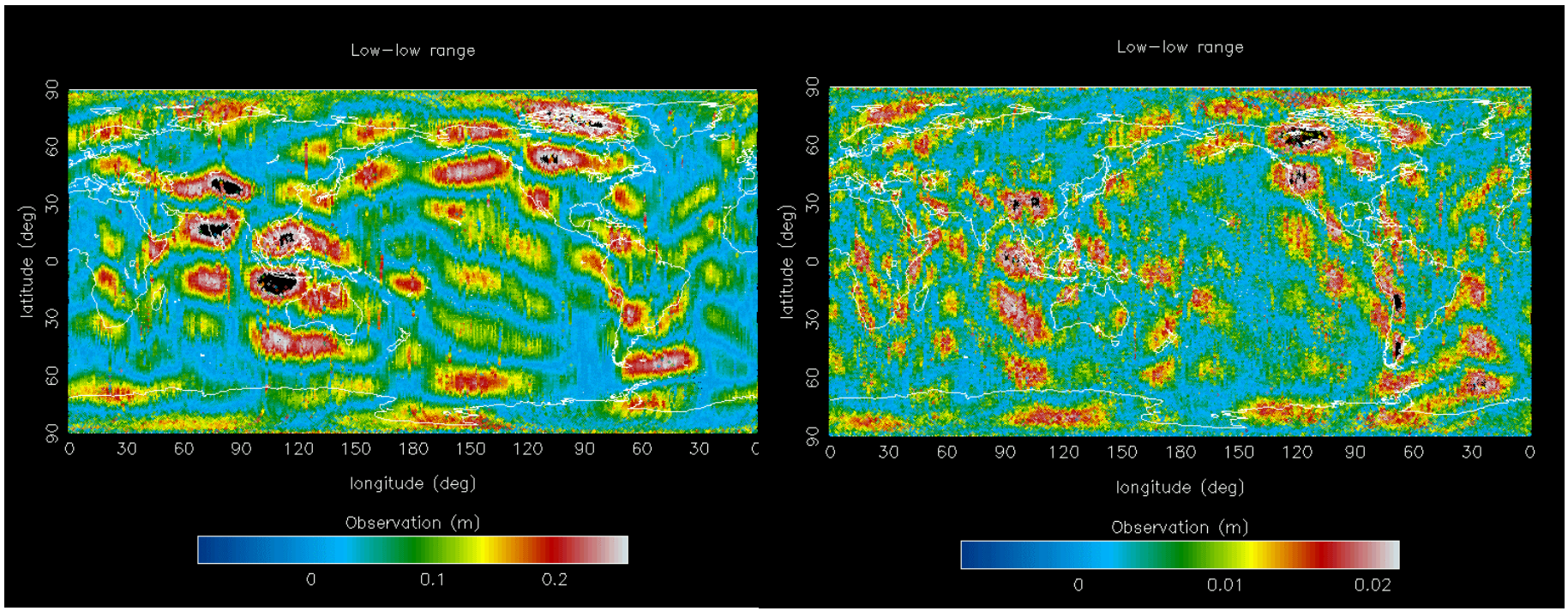
GPS based GRACE radial (left) and cross-track (right) baseline perturbations (high-pass filtered)



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Outlook

Enabling technologies for GRACE and GOCE follow-ons:

- low-low satellite-to-satellite tracking by laser ("LDI"): precisions of nm/s feasible or even pm/s?
- s/w upgrades (much higher numerical precision required)
- new/upgraded methodology: separation of static and temporal gravity field sources, separation/ elimination of parasitic effects (a.o. on-board perturbations)

Spin-offs of satellite constellations: a.o. COSMIC, *Swarm*!

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