Global Gravity Field Determination from Future Satellite-Gravimetric Missions analysed by IGG and GFZ

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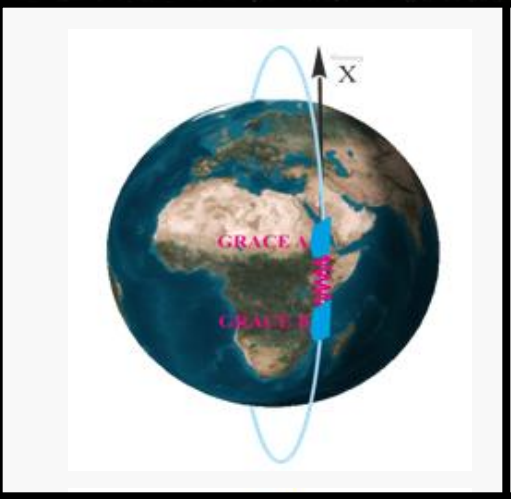
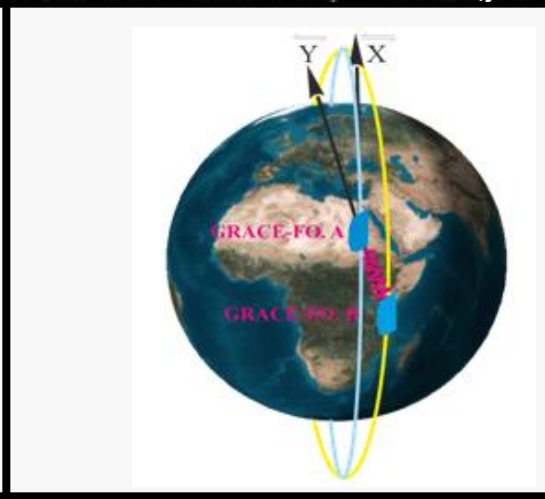
Outline

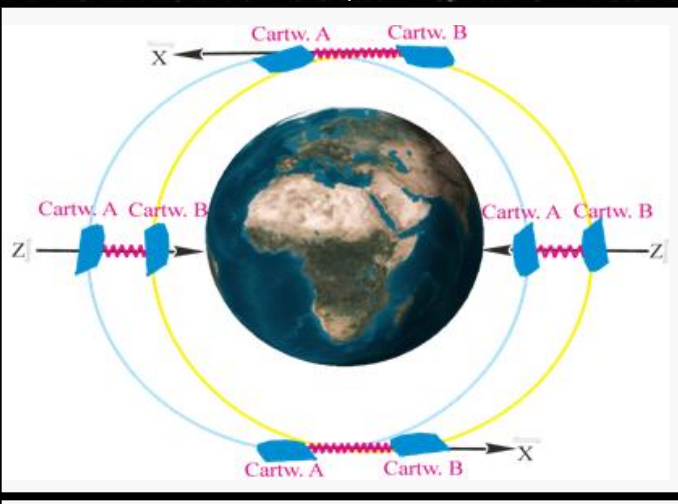
- Simulated mission configurations
- Models used for the simulations
- Simulated data and errors used for simulation scenarios
- Results in the spectral domain
- Results in the spatial domain
- Summary

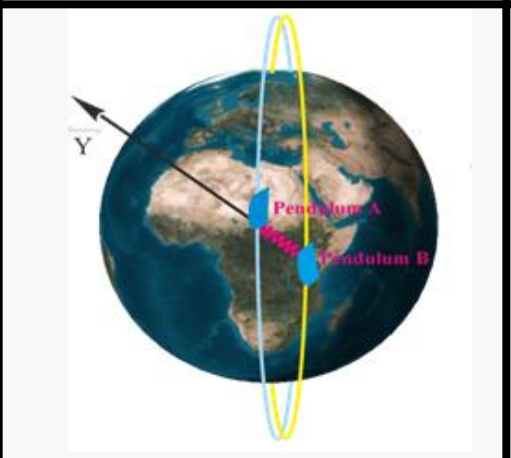
Simulated mission configurations

GRACE (ρ_x =220 km) (Alternative) GRACE-FO ($\rho_{x,y}$ =220/25 km) Cartwheel ($\rho_{x,z}$ =100/50 km)







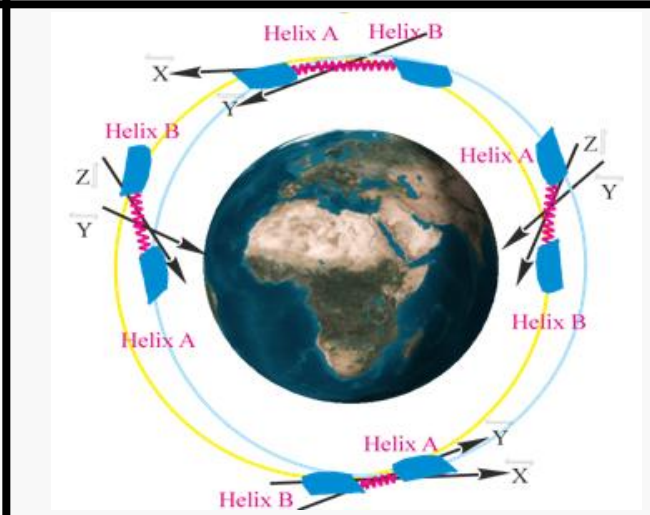


3 Pendulum formations

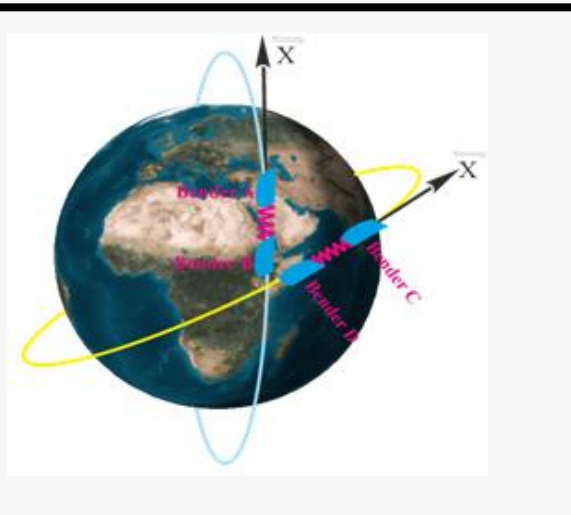
Pendulum ($\rho_{x,y}$ = 96/43 km)

Pendulum V1 ($\rho_{x,y}$ = 166/166 km)

Pendulum V2 ($\rho_{x,y}$ = 83/83 km)



Helix ($\rho_{x,y,z}$ = 50 /150 km)



Bender (ρ_x = 100 km)

Simulation Scenarios

- 7 possible future missions are investigated plus GRACE as reference
- 6 missions were treated as drag-free but for GRACE and GRACE-FO non conservative forces were considered.
- It was decided that GFZ will provide IGG with orbits, SST data, accelerometer and star-trackers data.
- The simulation period was set to 32 days corresponding to the repeat cycle for an altitude of 335km.
- The integration step-size was set to 5 seconds
- GFZ-EPOS and IGG-GROOPS softwares have been used to estimate the gravity field solutions (up to d/o 120)

Models used for the simulations

- Static gravity field model EIGEN-GL04C
- Time-variable background model AOHIS ESA Model Version 2
- Ocean tides model EOT08a (Q1,O1,P1,K1,M2,N2,K2,S2) up to 50x50
- Planetary ephemerides: DE405 (only Sun and Moon)
- Permanent tide: C20 from EIGEN-GL04C
- Models for non-gravitational forces (transformed to acc. data)
- air drag, solar radiation pressure, albedo.
- no precession, no nutation, no polar motion
- Simple Earth rotation only by

$\theta = 2\pi\,(0.7790572732640+1.00273781191135448\,(MJDUTC-51544.5)$

- no Earth tides model, no pole and ocean tide models,
- no relativity

Simulated measurements and errors used

- **Simulated Data:**
  - **SST range-rate observations**
  - **GPS to LEO satellites observations (code + phase)**
  - **Accelerometer data for the non-drag free missions**
  - **Star-trackers data**

- **Simulated Errors :**
  - **SST observations: colored noise from ife-iFR**
  - **Accelerometer data: colored noise from ife-iFR**
  - **No orbit error was introduced**

Software packages used for Simulations

- **The GFZ simulations are based on the GFZ EPOS software:**

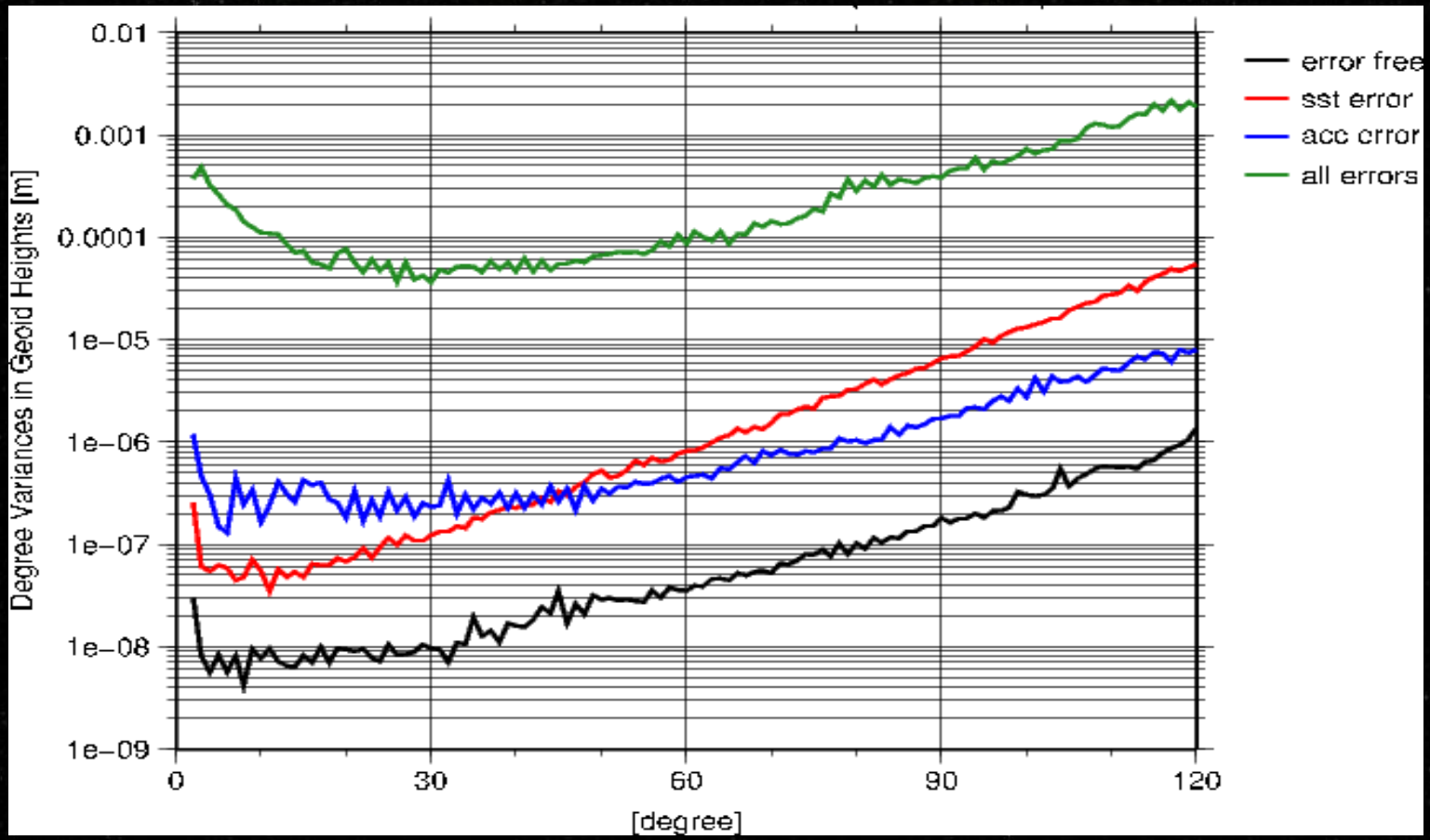
- Package operated with a symmetric Adams-Cowell integrator of order seven
- Using the full dynamical approach

- **The IGG simulations are made with the IGG GROOPS software:**

- Package procedure is based on the solution of Newton's equation as
- Solution of a boundary value problem (Fredholm integral equation of the second kind).
- 35 minutes arcs are used to compute observation equations and normal equations

Results in the spectral domain

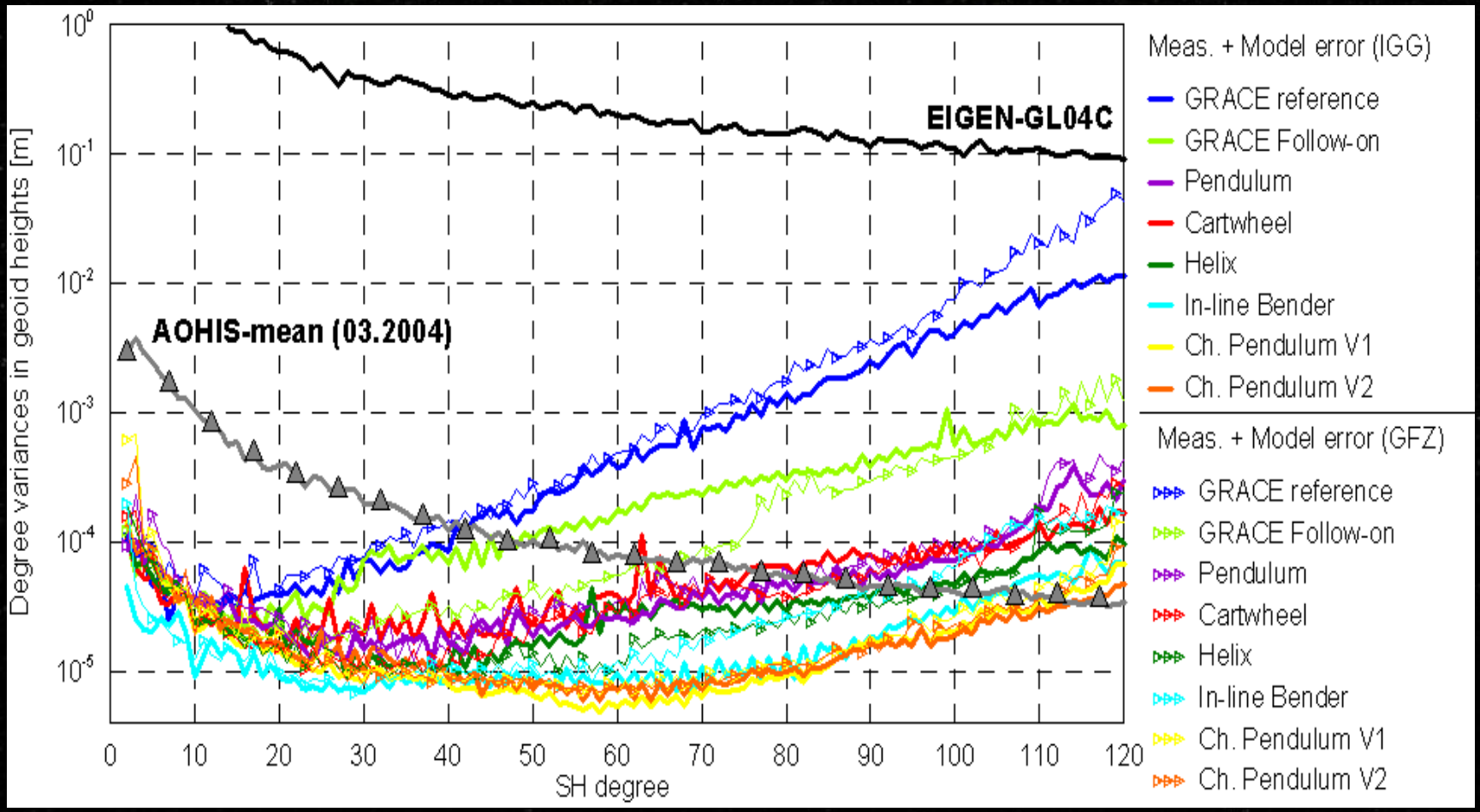
Different error influences on (alternative) GRACE-FO (GFZ-EPOS)



Results in the spectral domain

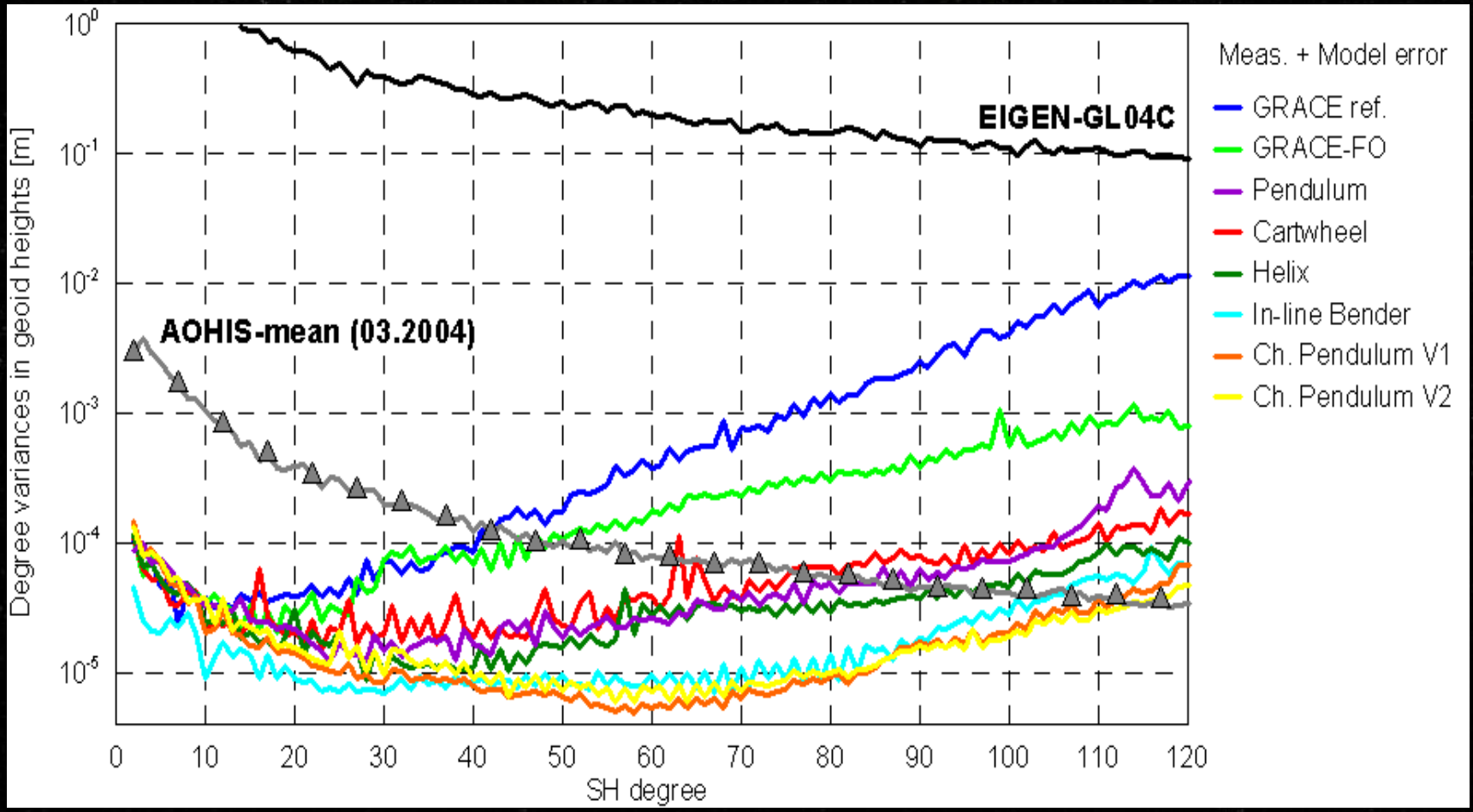
Comparison of the Results between IGG and GFZ

Agreement of current results by 120x120

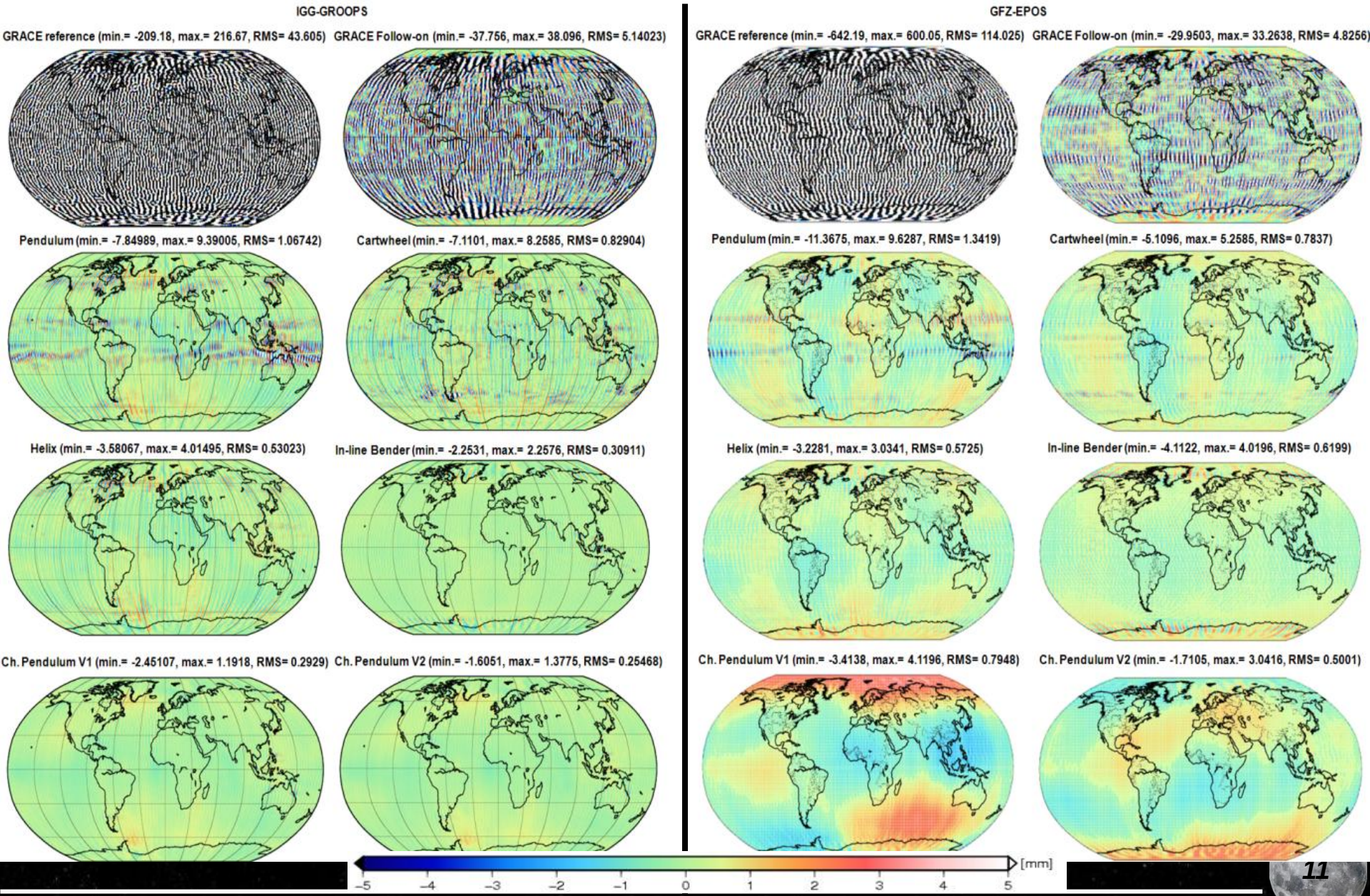


Results in the spectral domain

IGG Results – Spectral domain



Results in the spatial domain



Summary

- Within the frame of future gravity missions project, 8 Basic-formations are investigated.
- Full-scale mission are carried out using two different softwares of GFZ (EPOS) and IGG (GROOPS).
- Generally good agreement in the spectral domain between the EPOS and GROOPS solutions but for a few missions (GRACE, Bender) some discrepancies for d/o > 90.
- It has been found that the aliasing effects are so far the main problem that future missions will face, especially for the GRACE Follow-on configuration.
- Simulations show obvious potential improvements for the (alternative) GRACE-FO formation w.r.t. the GRACE reference.
- Most promising for a future gravity mission (2020+) seems the Bender constellation.

Thank you for your attention