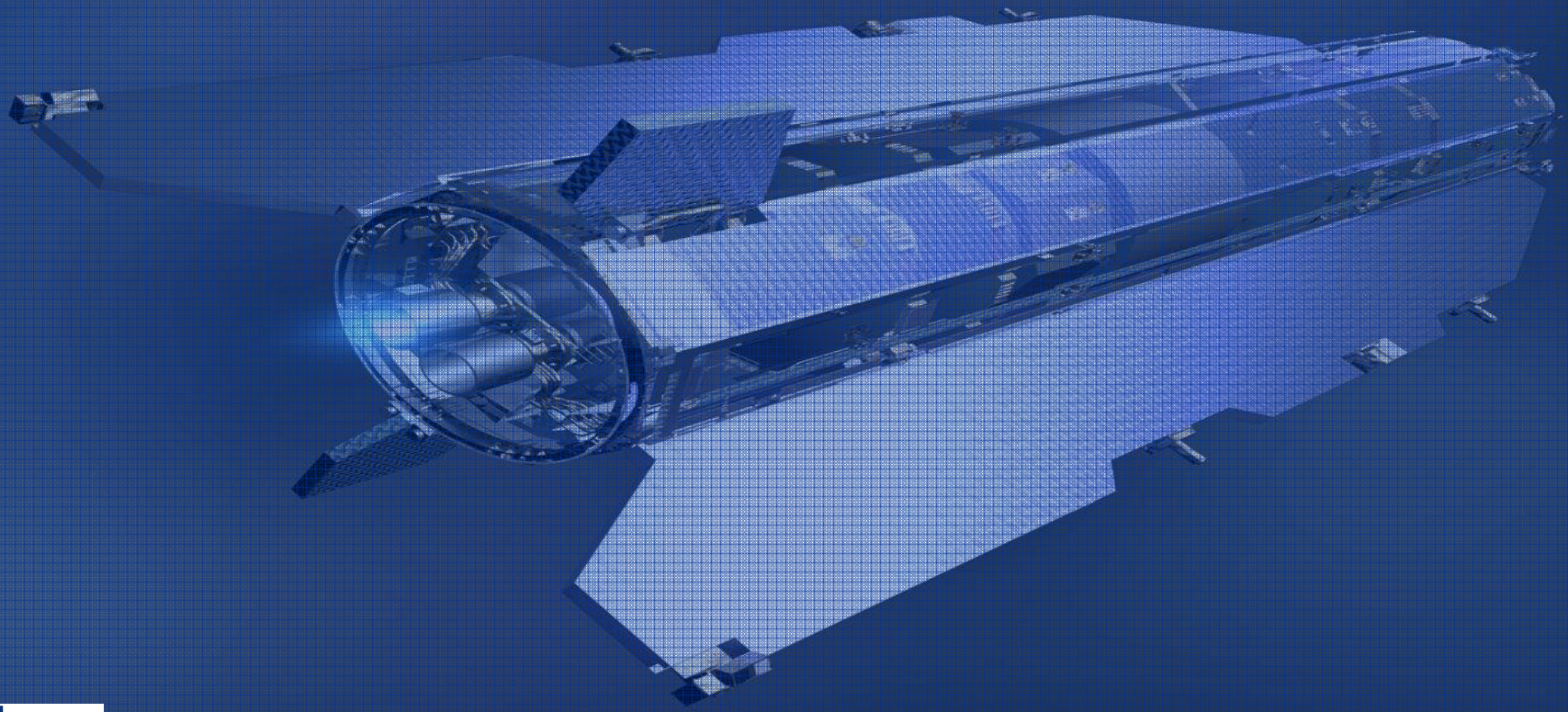
The POD gravity field model for GDR-E: EIGEN-GRGS.RL03-v2.MEAN-FIELD



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CNES - Department of Terrestrial and Planetary Geodesy
Toulouse, France

Data: EGM-DIR-5

LAGEOS-1/2 SLR data:

- 1985 – 2010 of GRGS release 2 normal equations to degree/order 30

GRACE GPS-SST and K-band range-rate data:

- Feb 2003 – Dec 2012 of GRGS release 3 normal equations to degree 175

☞ One GRACE/LAGEOS normal equation up to d/o 175, reduced above degree 130 before accumulating with GOCE normal equations

+

GOCE data:

- SGG data (Txx, Tyy, Tzz, Txz) from 01 November 2009 – 20 October 2013
- weighting per measurement (based on RMS of residual), cos-latitude weighting
- normal equations for each SGG component (4) up to degree/order 300
- application of a (120 – 8) s band-pass filter for all four SGG components
    - *The SGG signal is filtered-out below degree ~ 45*

Data: EIGEN-GRGS.RL03-v2.MEAN-FIELD

Degrees 81-300 = EGM-DIR-5

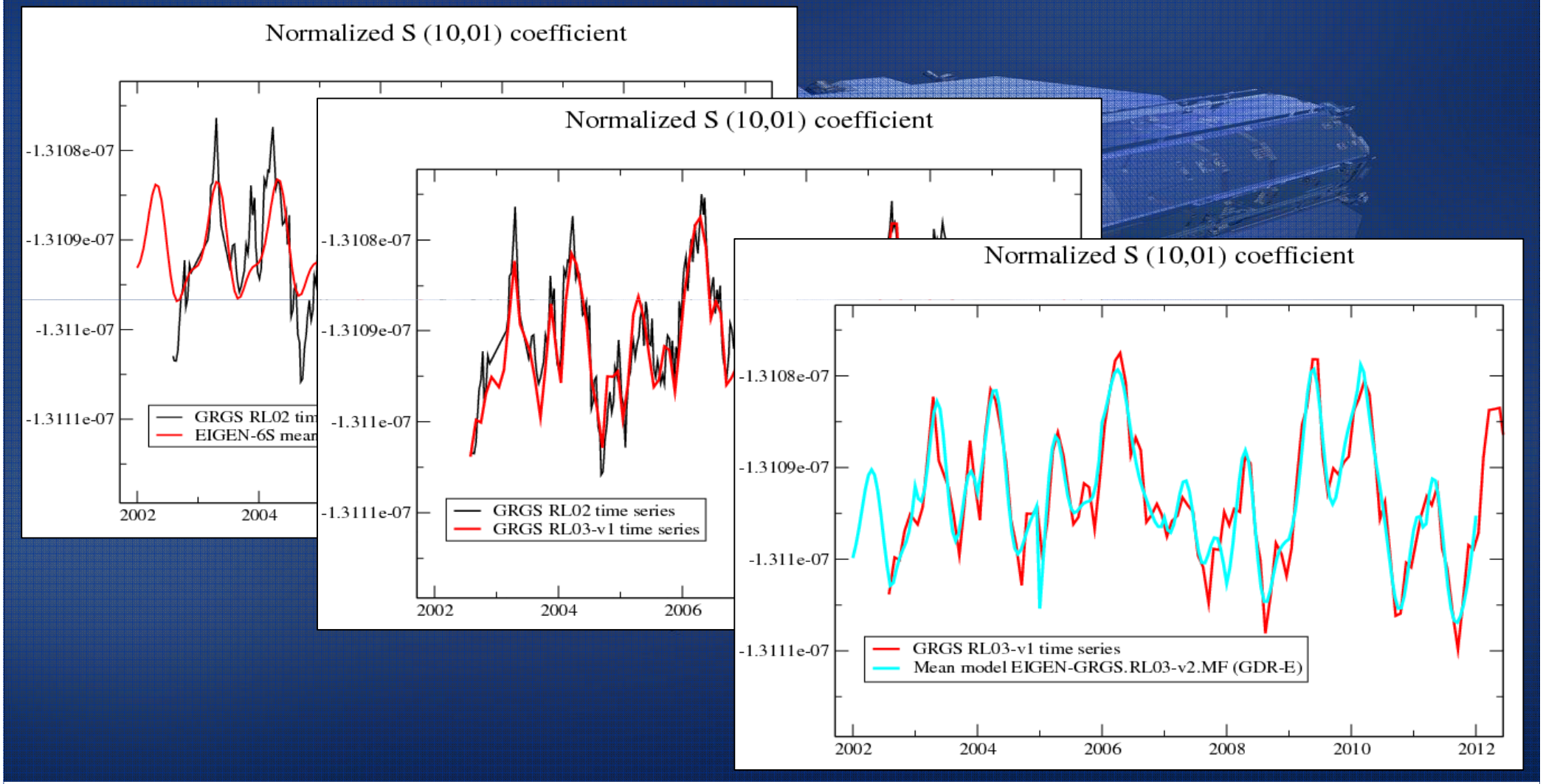
Degrees 2-80: Time-variable coefficients obtained by regression

Coefficient(t) = Mean(t) + slope(t) + annual(t) + semi-annual(t)

NB: slope + periodic terms *per year*

EIGEN high resolution gravity field models include a time-variable part, which becomes more and more realistic

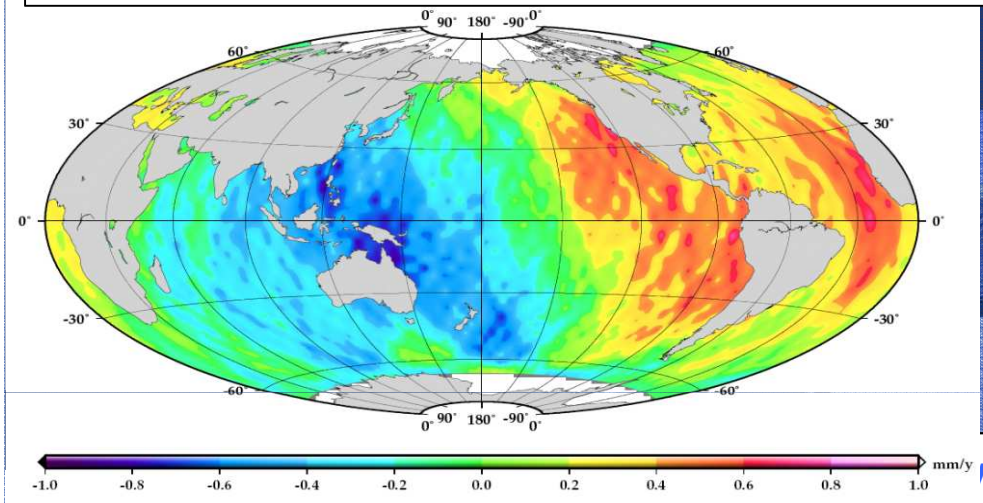
“bias and slope” vs. “piece-wise-linear”



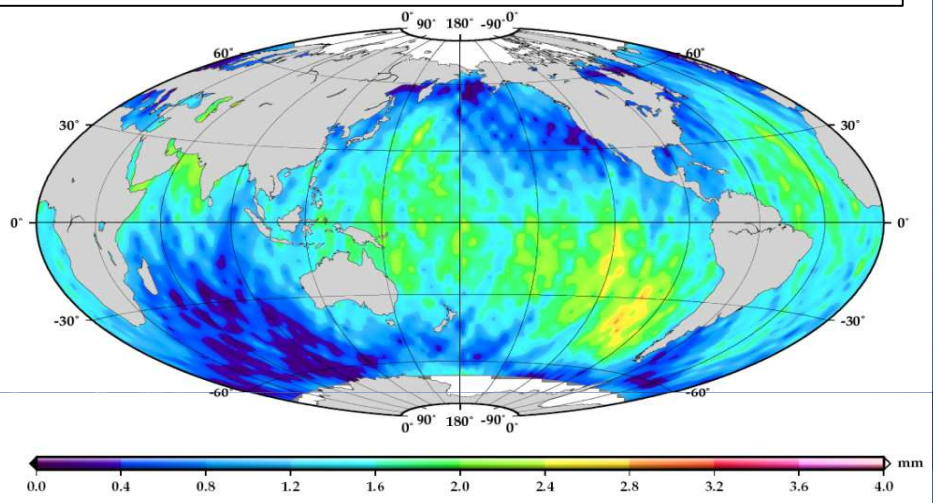
Validation time-variable part of the model (A. Couhert)

J2 (GDR-E dyn. + RL02bis TVG) – (JPL15A red. dyn.)

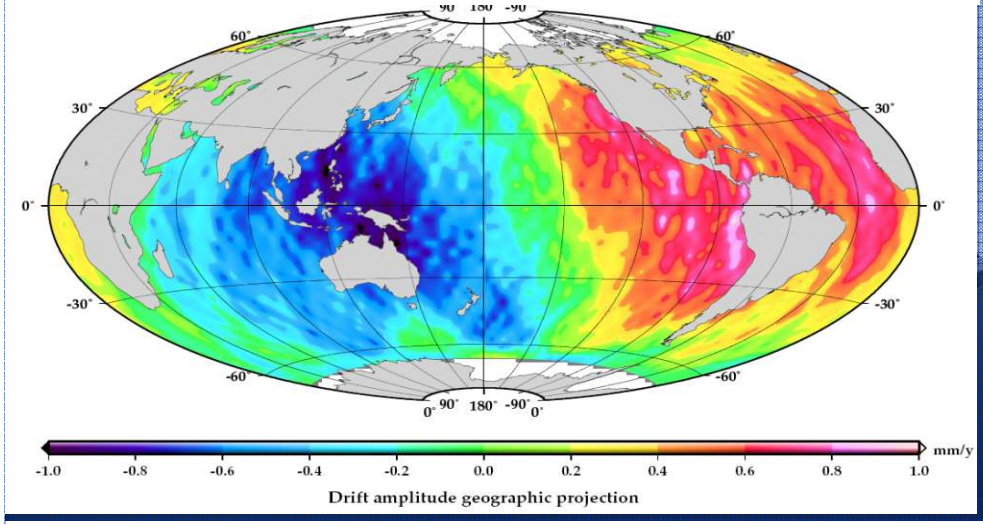
J2 (GDR-E dyn. + RL03v2 TVG + 31 est.) – (JPL15A red. dyn.)



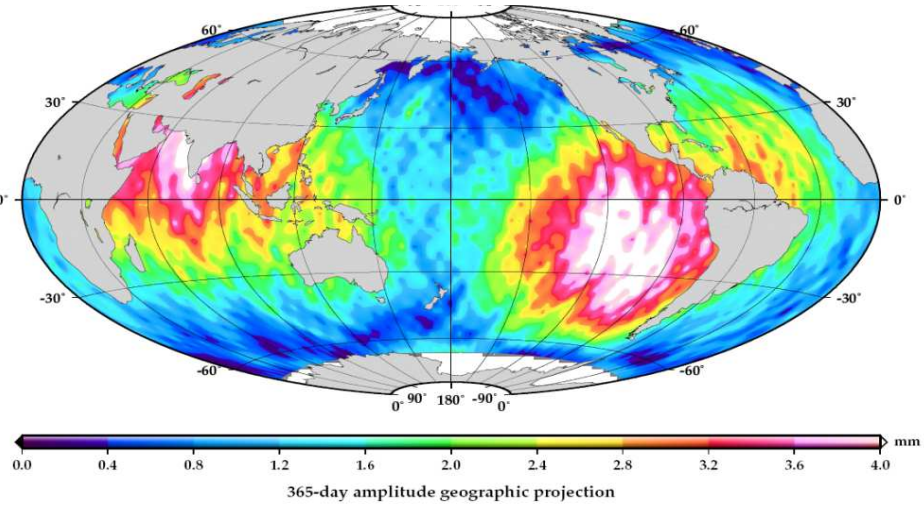
SLR
1.27 cm



r2 TVG)



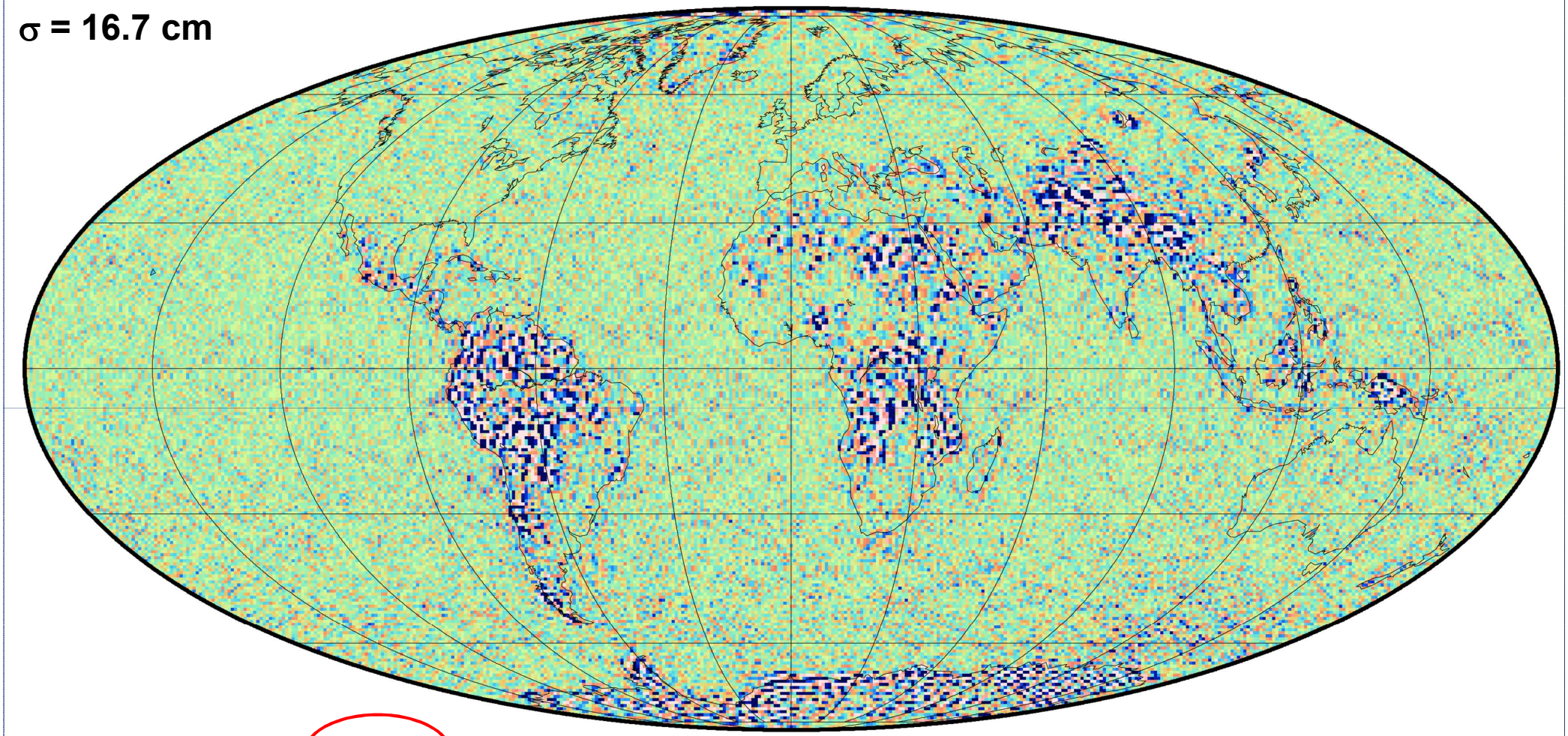
SLR
1.29 cm



EGM-DIR-5 compared with EGM2008: spatial

Geoid height differences (meter) EGM2008 vs. EGM-DIR-5

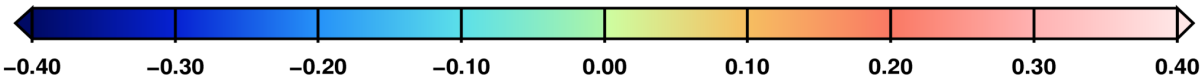
σ = 16.7 cm



DIR–5 vs. EGM2008 max 240

ζ, 0.75° x 0.75°

wrms about mean / min / max = 0.1665 / –3.47 / 3.155 meter



EGM-DIR-5 + terrestrial data: EIGEN-6C4

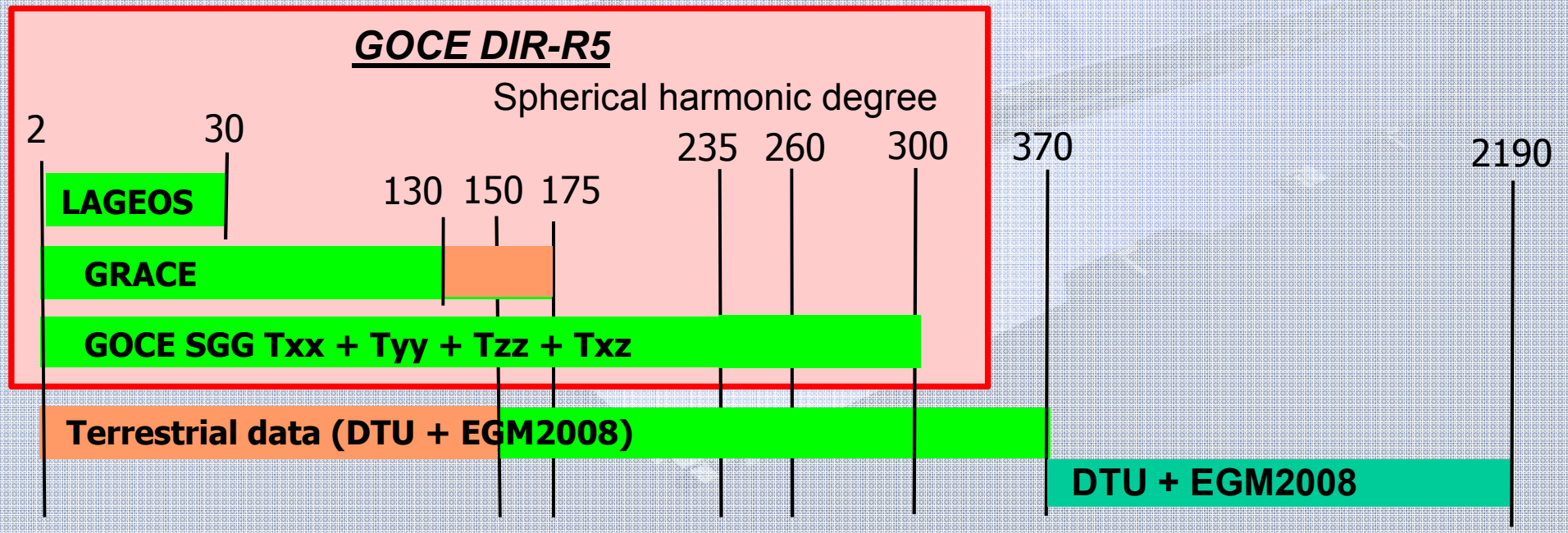
Accumulation of a full normal matrix up to d/o 370:

~200.000 parameters, ~ 250 GByte

contribution to the solution EIGEN-6C4:

eliminated beforehand (block matrix reduction):

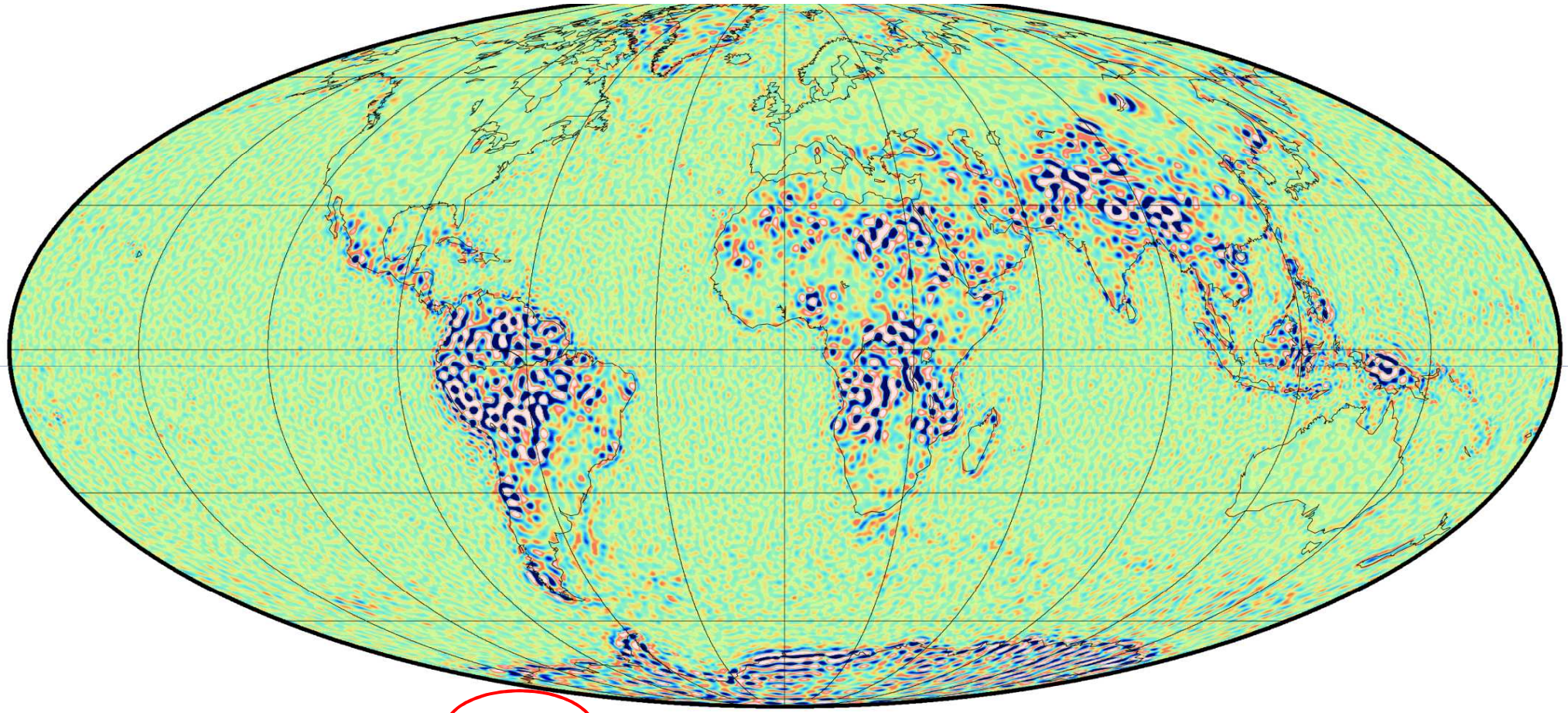
Separate block diagonal solution:



EGM-DIR-5 + terrestrial data: EIGEN-6C4

Geoid height differences (meter) EGM2008 vs. EIGEN-6C4

σ = 12.4 cm → this number represents the impact of GOCE



Validation: GOCE orbit fit

Dynamic orbit computation

60 arcs, arc length = 1.25 days

Mean RMS values in cm of the orbit fit residuals

Gravity field model / max degree	120	180
EGM2008	4.0	2.8
ITG-Grace2010s	3.3	1.7
GOCO03s	3.2	1.6
EGM-DIR-1	3.9	2.4
EGM-DIR-2	3.5	2.1
EGM-DIR-3	3.2	1.6
EGM-DIR-4	3.2	1.6
EGM-DIR-5	3.1	1.5

Model validation using drifter data - Method

Filtering of the MDT with a gaussian filter

MDT=MSS – EGM_DIR_R5

100 km (DO 200)

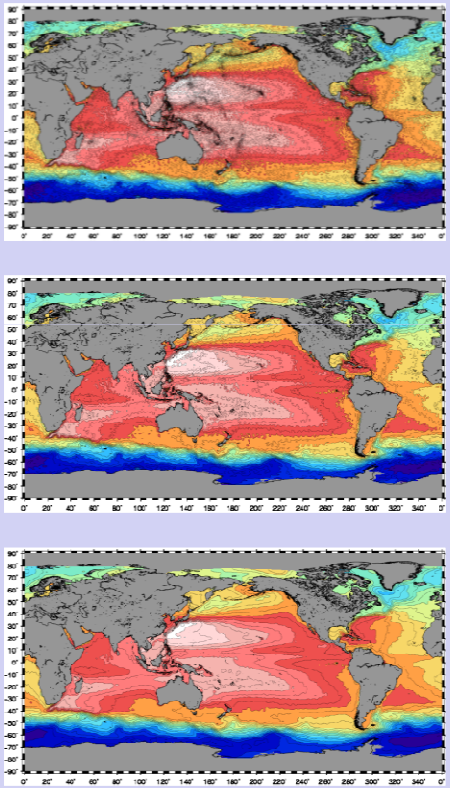
125 km (DO 160)

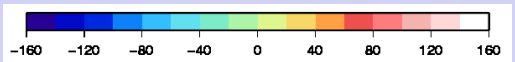
150 km (DO 133)

200 km (DO 100)

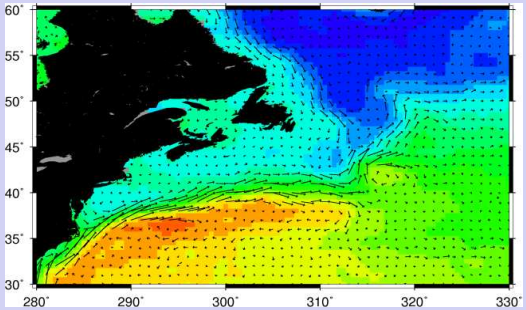
250 km (DO 80)

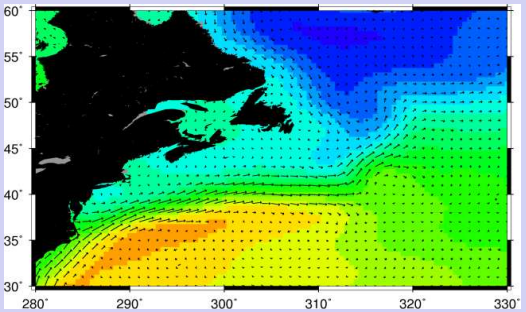
350 km (DO 60)





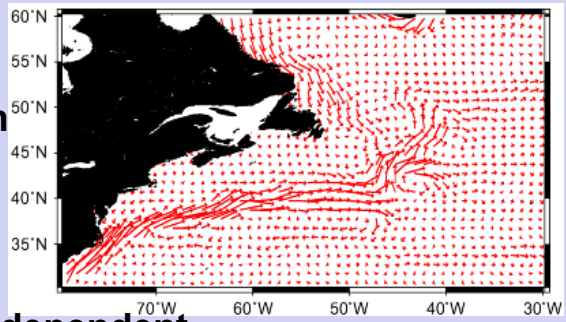
Computation of the mean geostrophic currents





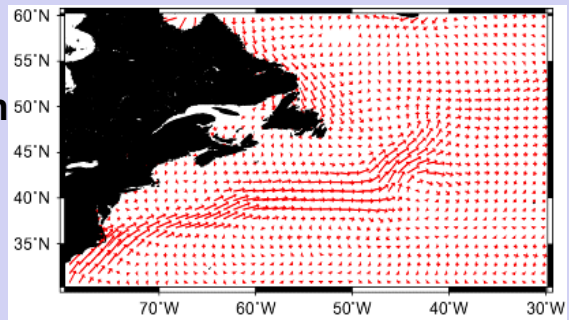
Computation of **synthetic estimate of mean geostrophic velocities** from in-situ oceanographic measurements and altimetry

100 km

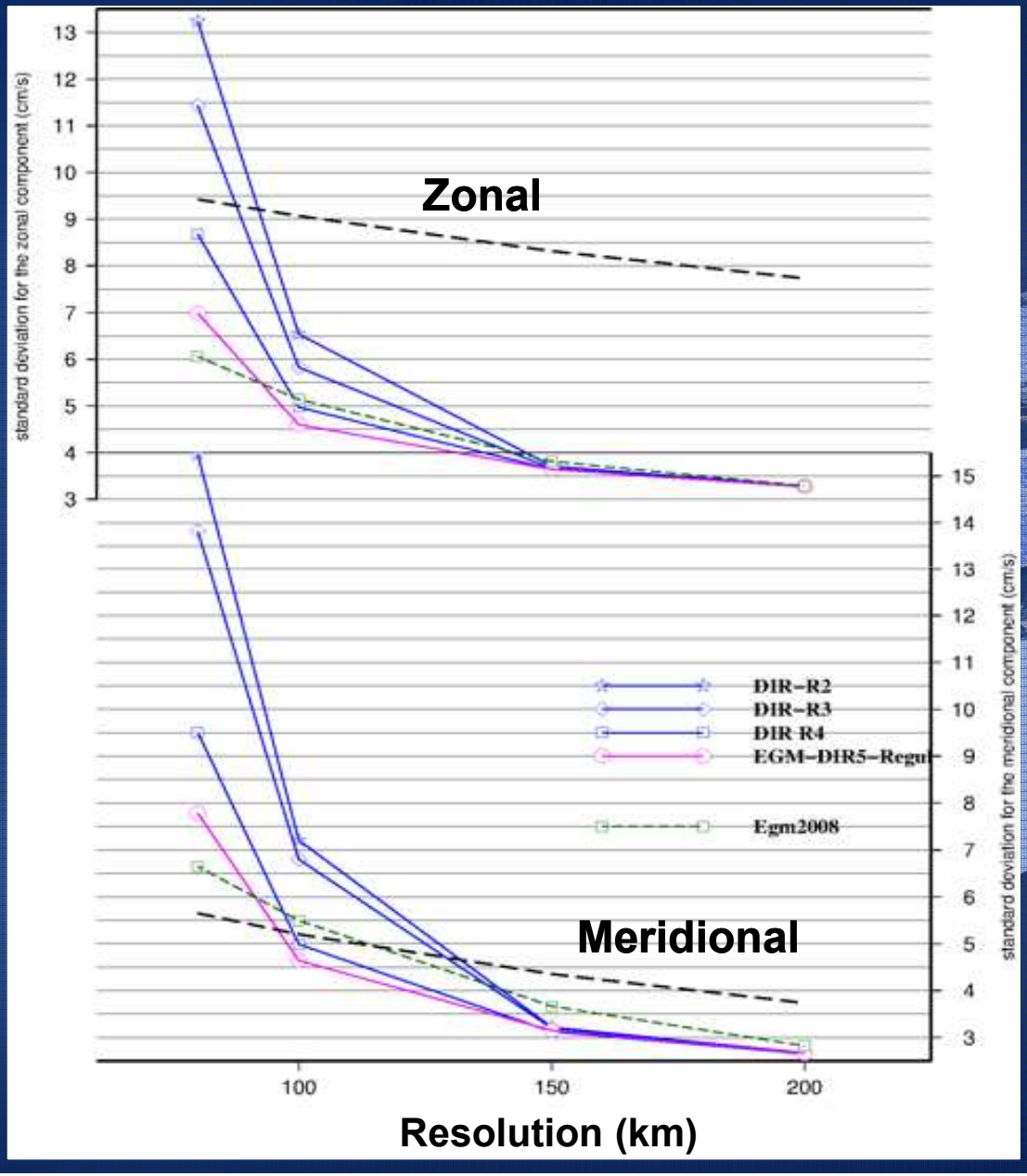


Comparison with independent data over the global ocean

200 km



Model validation using drifter data



Zonal:
(80 km)

R2=13.2
R3=11.5
R4=8.7
R5=7.0

24%

89%

Comparison of observed (drifters) with calculated (MSS-geoid) currents

The plots on the left show the *Standard deviation of difference* of geostrophic current velocities, cm/s

Smallest scale = 80km

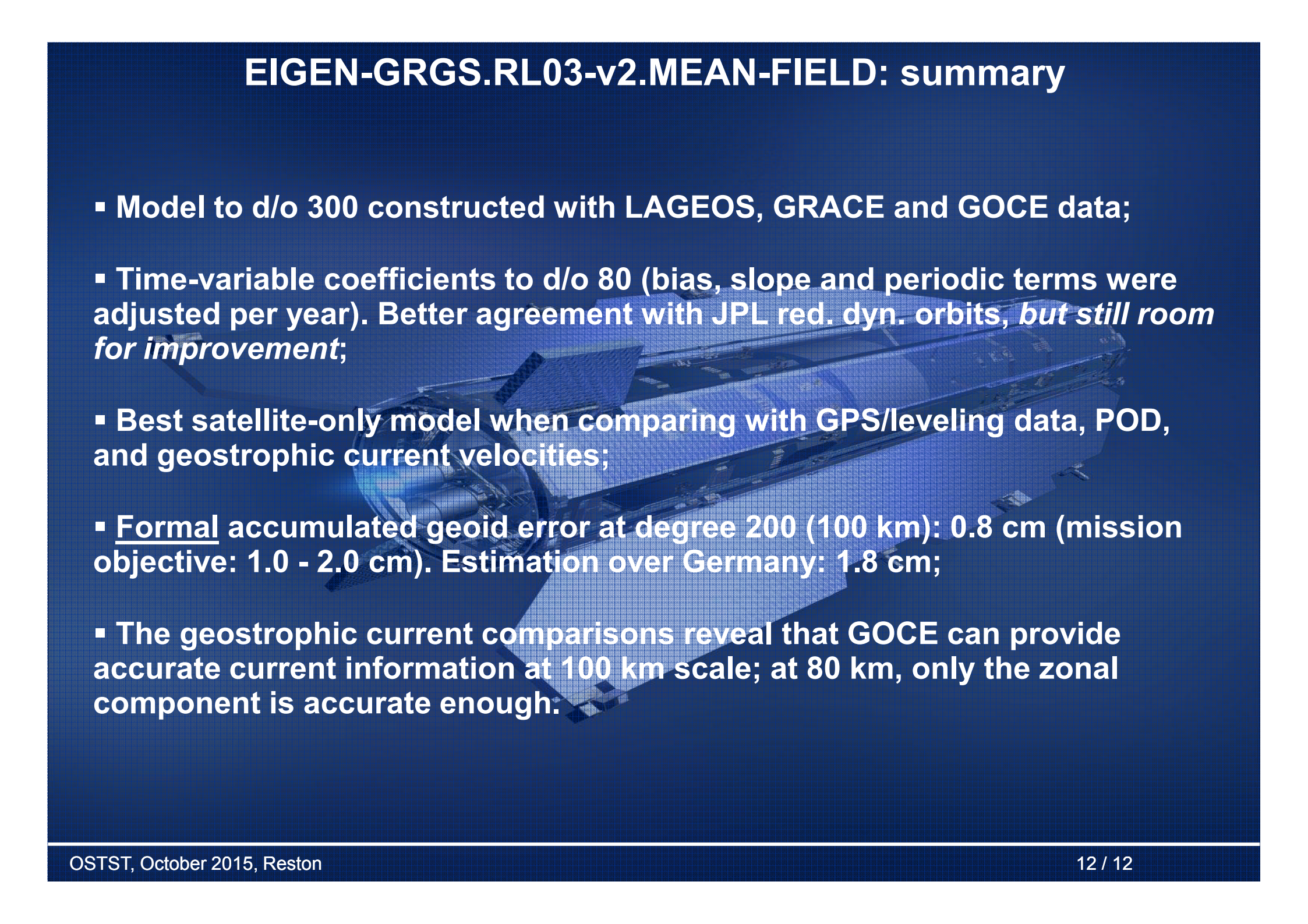
Meridional:
(80 km)

R2=15.5
R3=13.8
R4=9.5
R5=7.8

22%

99%

EIGEN-GRGS.RL03-v2.MEAN-FIELD: summary



- **Model to d/o 300 constructed with LAGEOS, GRACE and GOCE data;**
- **Time-variable coefficients to d/o 80 (bias, slope and periodic terms were adjusted per year). Better agreement with JPL red. dyn. orbits, *but still room for improvement*;**
- **Best satellite-only model when comparing with GPS/leveling data, POD, and geostrophic current velocities;**
- **Formal accumulated geoid error at degree 200 (100 km): 0.8 cm (mission objective: 1.0 - 2.0 cm). Estimation over Germany: 1.8 cm;**
- **The geostrophic current comparisons reveal that GOCE can provide accurate current information at 100 km scale; at 80 km, only the zonal component is accurate enough.**