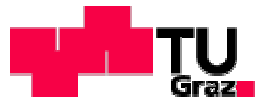# The satellite-only global gravity field model GOCO02S

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Objectives and Principles

- **Parametrization of model**: spherical harmonic series expansion

$$V(r, \vartheta, \lambda) = \frac{GM}{R} \sum_{l=0}^{l_{max}} \left(\frac{R}{r}\right)^{l+1} \sum_{m=0}^{l} \overline{P}_{lm}(\cos \vartheta)\left[\overline{C}_{lm} \cos(m\lambda) + \overline{S}_{lm} \sin(m\lambda)\right]$$

- **Basic equation**: combination of consistent normal equation systems

$$(N_1 + N_2 + ...)x = (n_1 + n_2 + ...)$$

- **Optimum solution**: variance component estimation

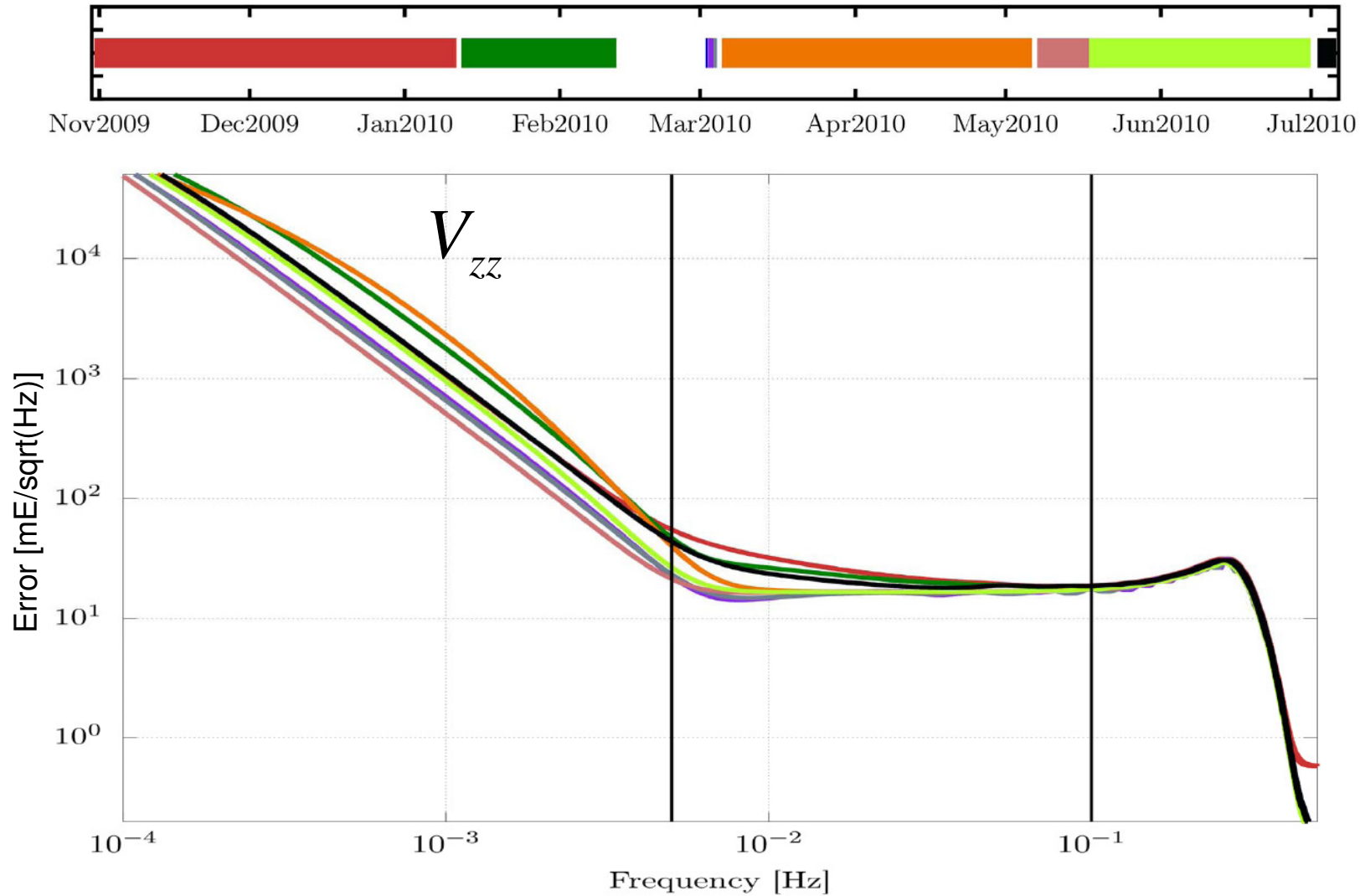$$(w_1 N_1 + w_2 N_2 + ...)x = (w_1 n_1 + w_2 n_2 + ...)$$

Data Sets

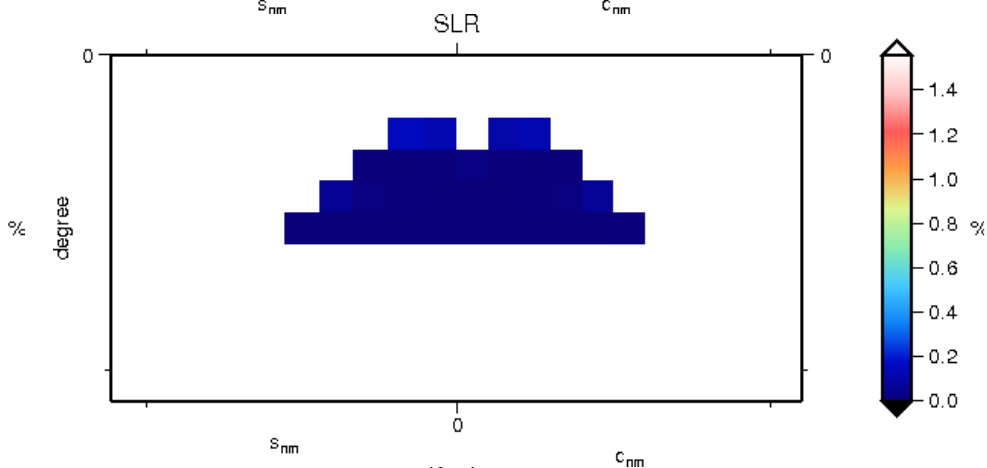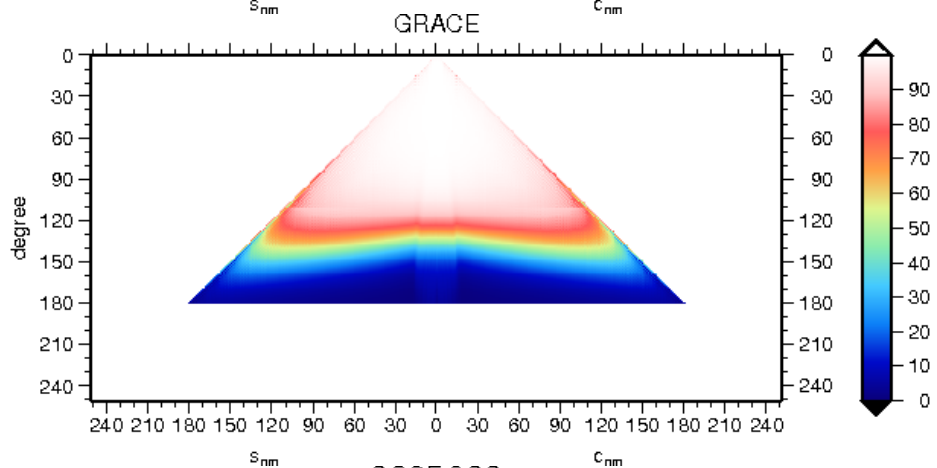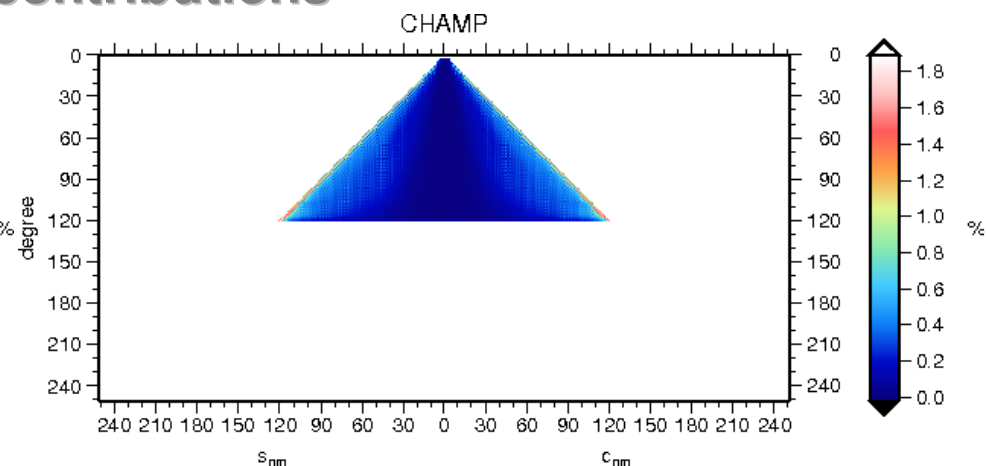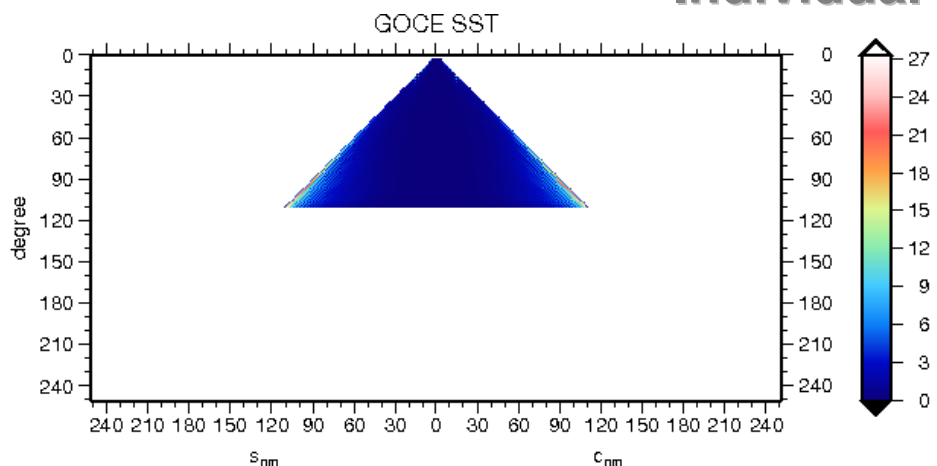| Data set	GOCO01S d/o 224	GOCO02S d/o 250	GOCO02S #obs. [Mio.]
ITG-Grace2010s	d/o 180 7 years	d/o 180 7 years	85
GOCE SGG Satellite gravity gradients	d/o 224 2 months	d/o 250 8 months	57
GOCE SST-hl Sat.-to-sat. tracking in high-low		d/o 110 12 months	72
CHAMP		d/o 120 8 years	63
SLR		d/o 5 5 years, 5 sat.	2
Kaula Regularization	d/o 170-224	d/o 180-250	
			280

GOCE SGG data set

- gradient analysis:
  - determination of observation segments
  - outlier detection
  - noise handling: estimation of individual filters for realistic stochastic modelling

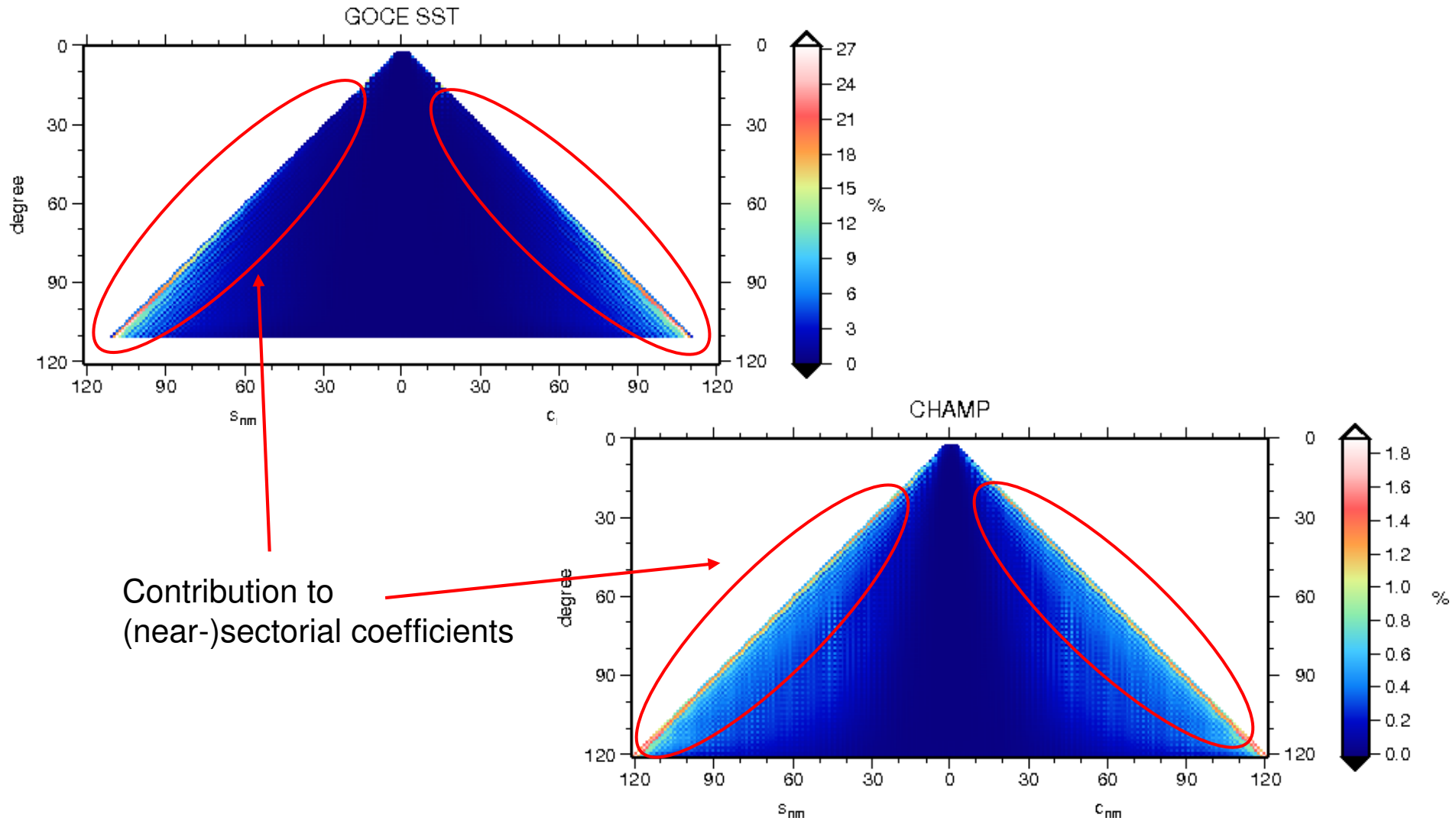- Full normal equation system up to d/o 250 without the use of any prior gravity information
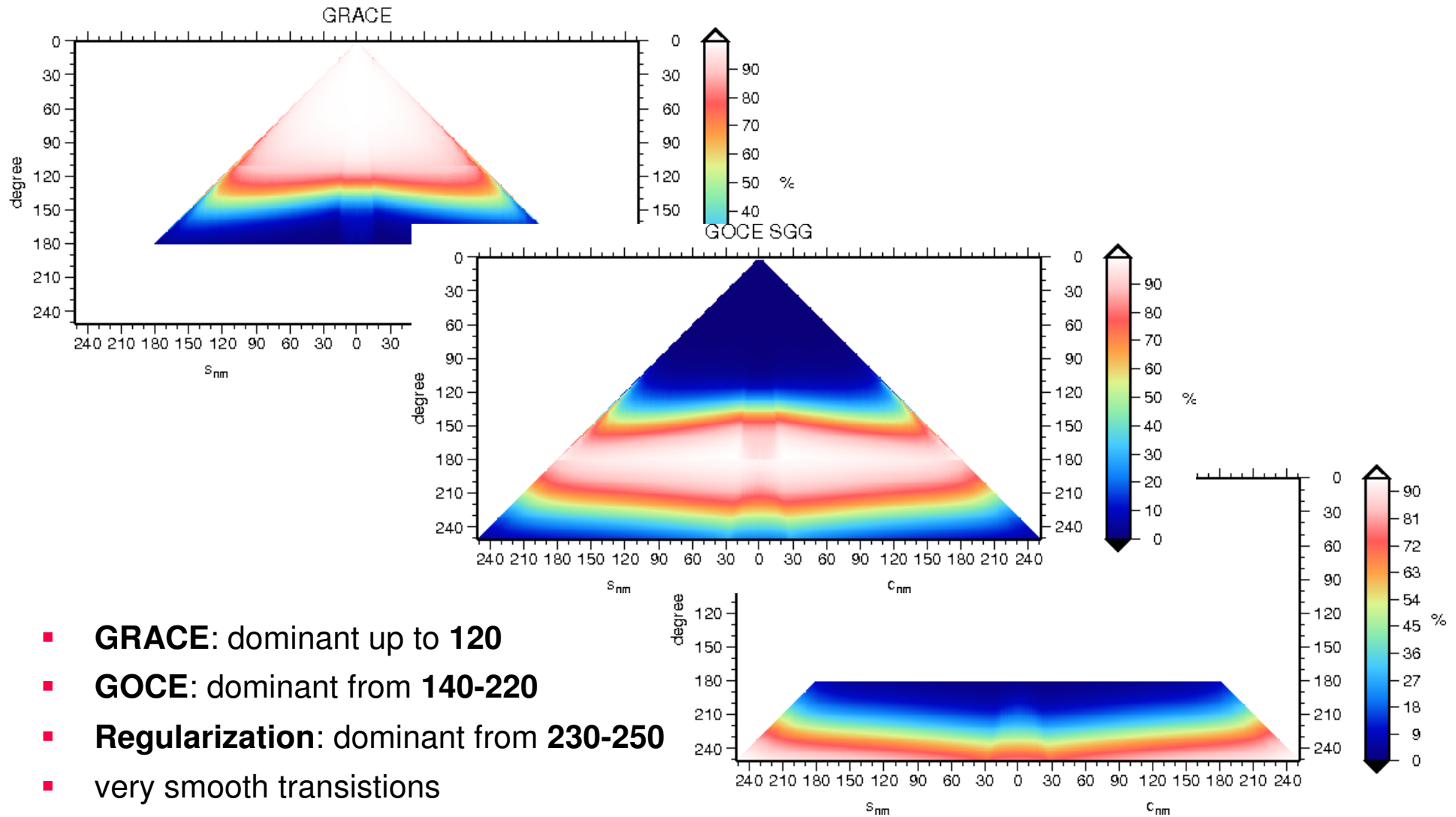
GOCE SGG data set

Individual contributions

Individual contribution

Contribution to
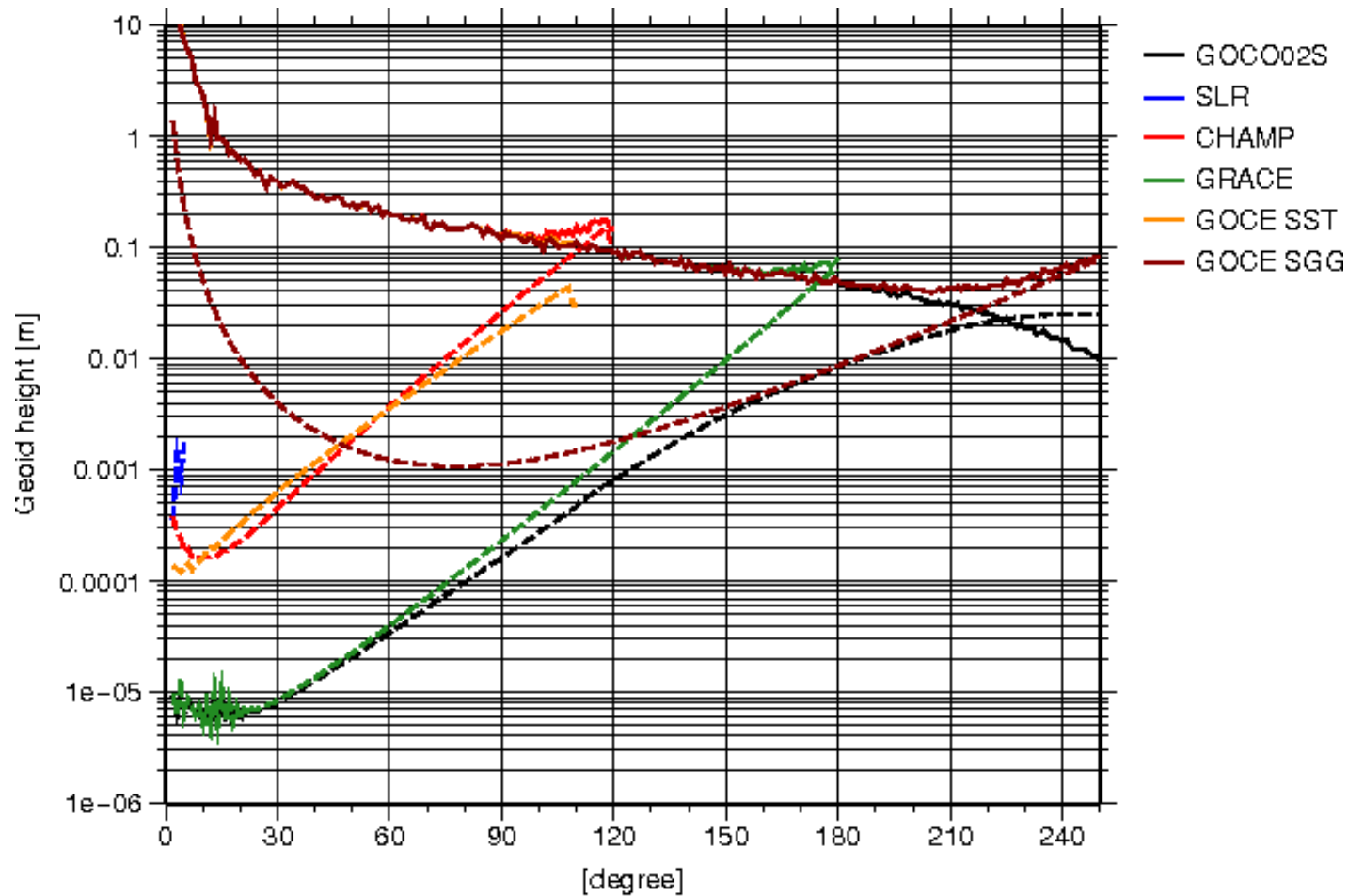(near-)sectorial coefficients

Individual contribution

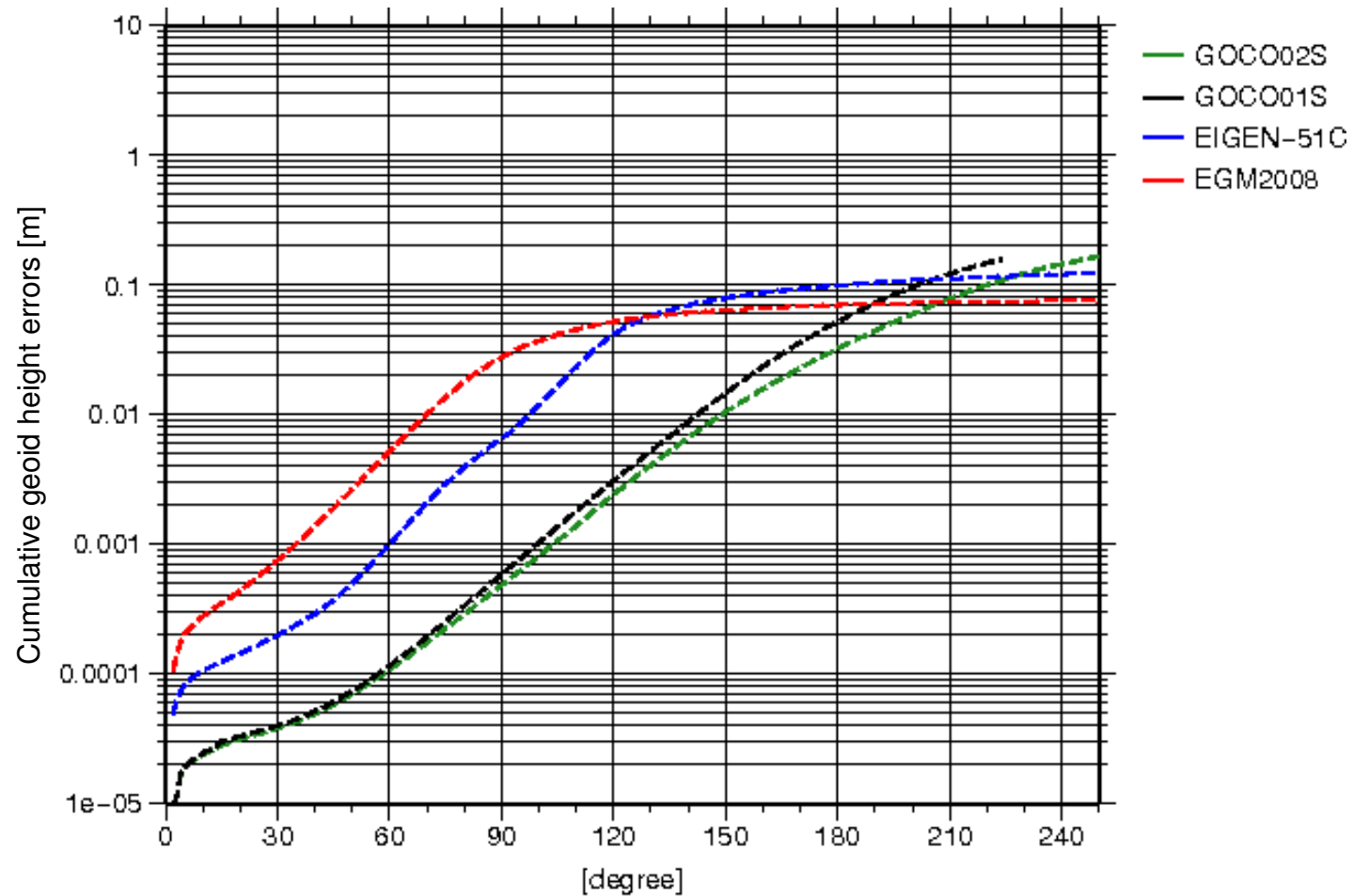
- **GRACE**: dominant up to **120**
- **GOCE**: dominant from **140-220**
- **Regularization**: dominant from **230-250**
- very smooth transistions

Individual contribution
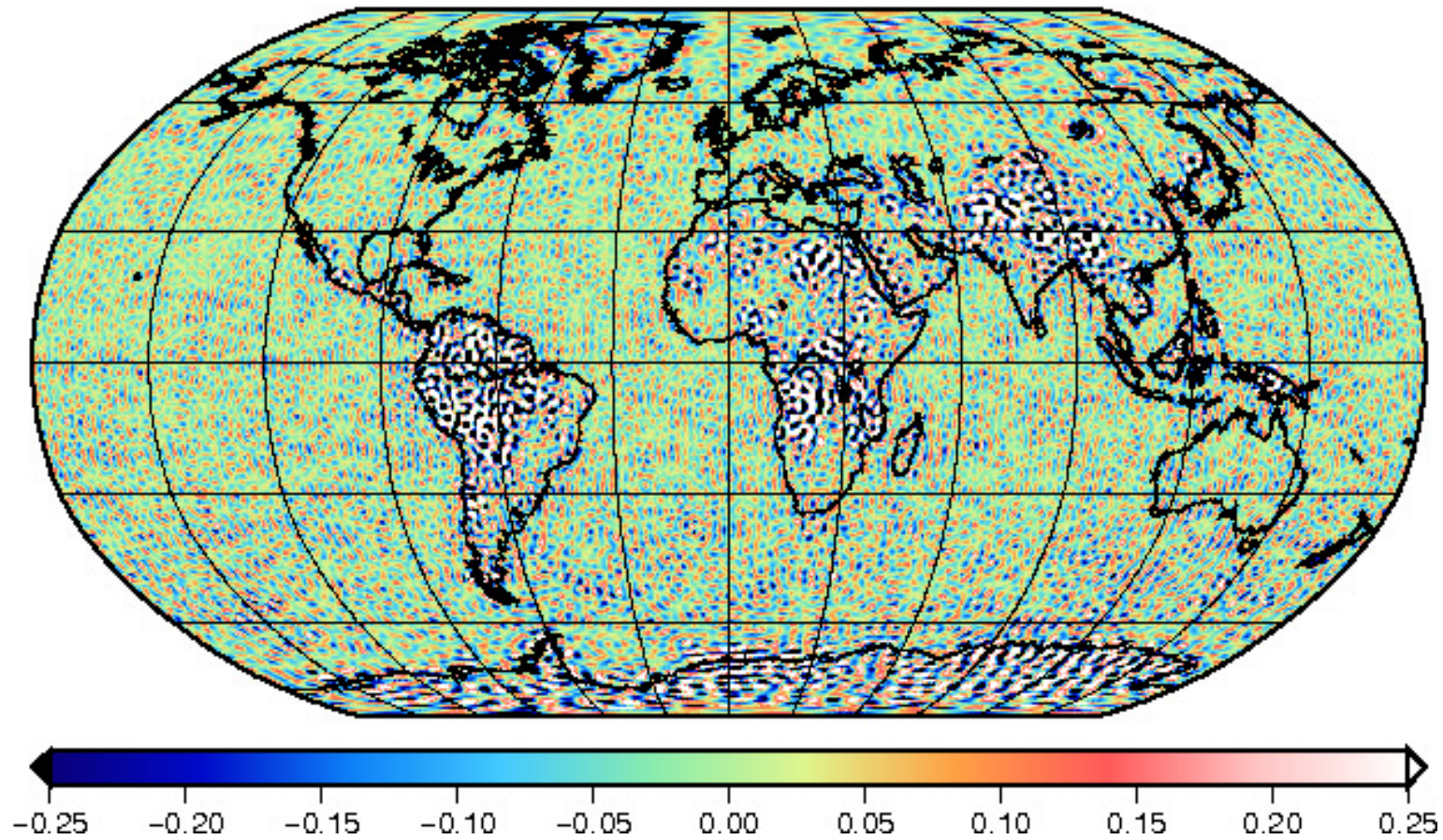
Degree variances of error estimates

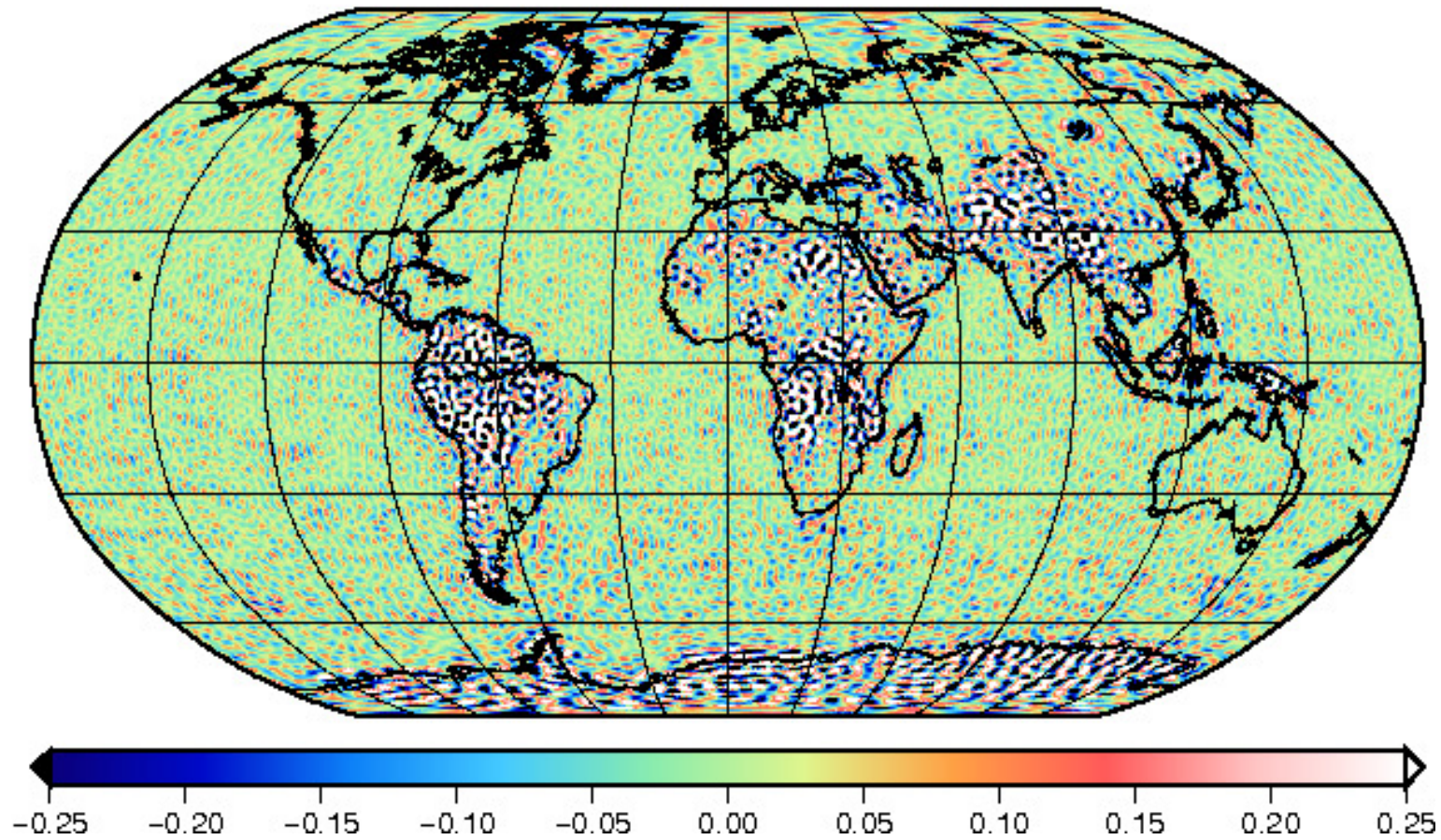# Cumulative geoid height error estimates

Geoid height deviations [m] EGM2008 – GOCO01S up to d/o 180

(min=−3.60047, max=2.41614, avg=0.0794857, rms=0.131936)

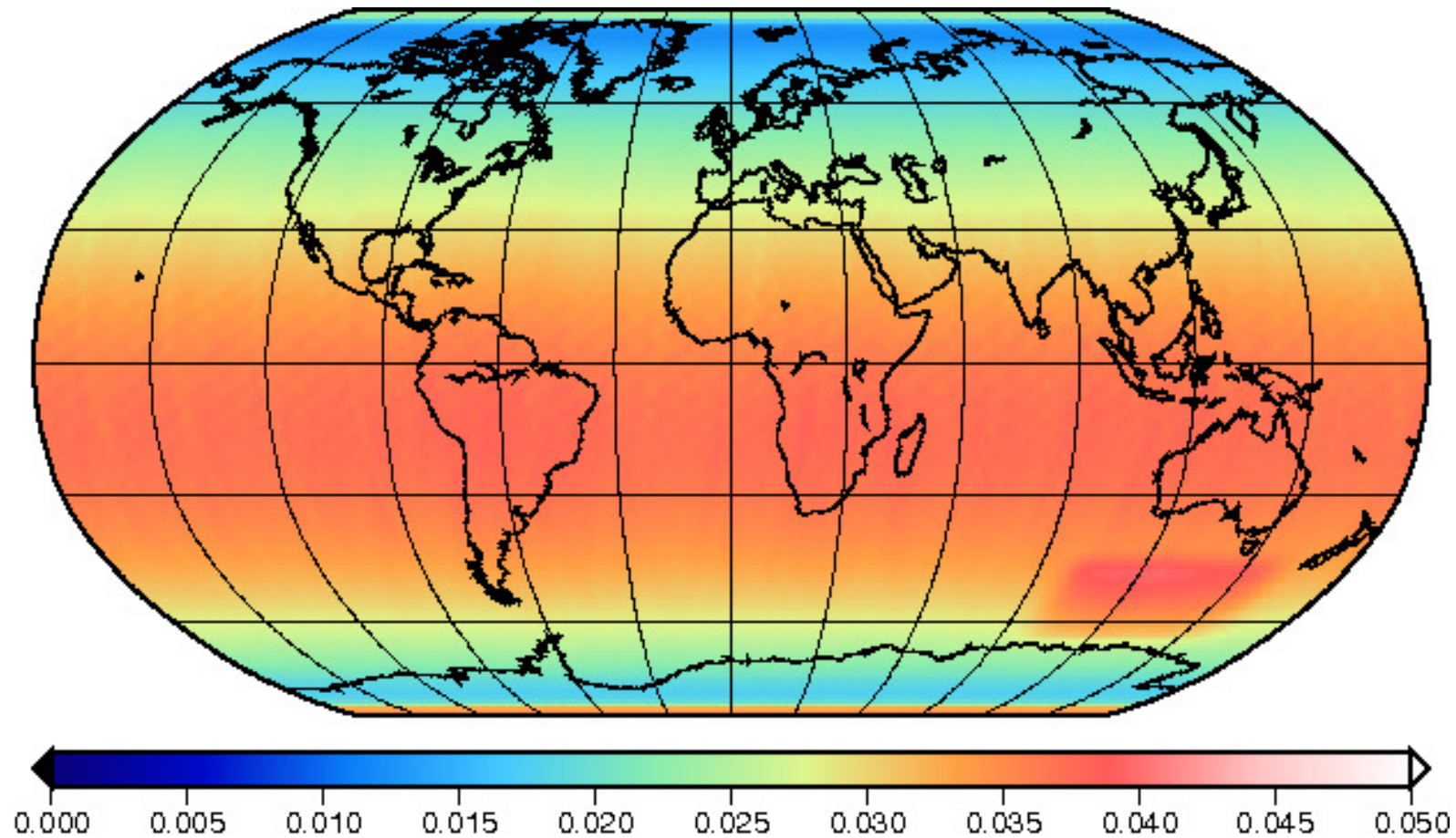## Geoid height deviations [m] EGM2008 – GOCO02S up to d/o 180

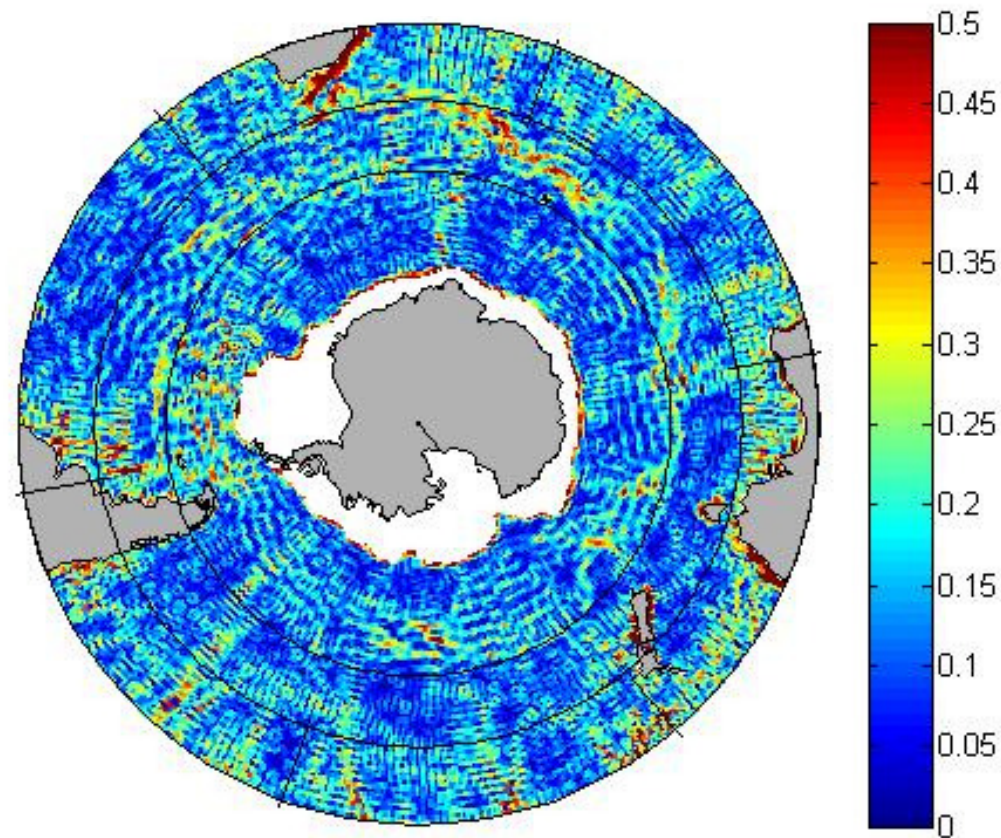(min=−3.65032, max=2.36454, avg=0.0657867, rms=0.123693)

Covariance propagation to geoid height errors [m] up to d/o 180
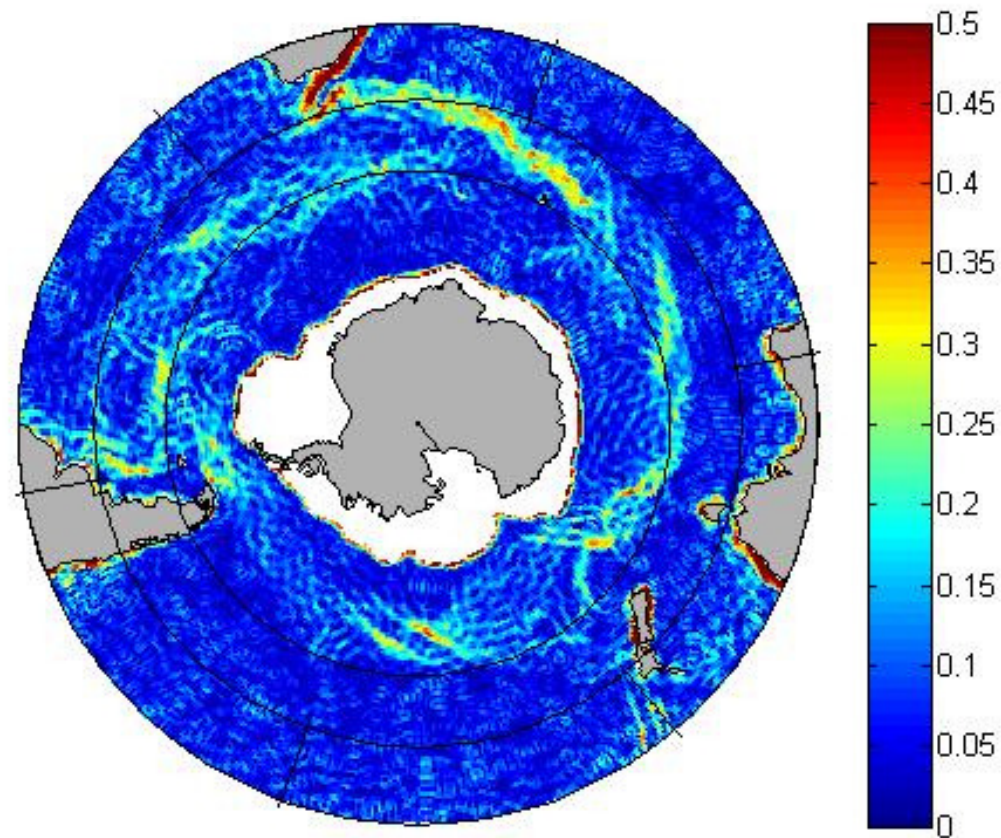
Surface velocities [m/s] derived from MDT (up to d/o 180)
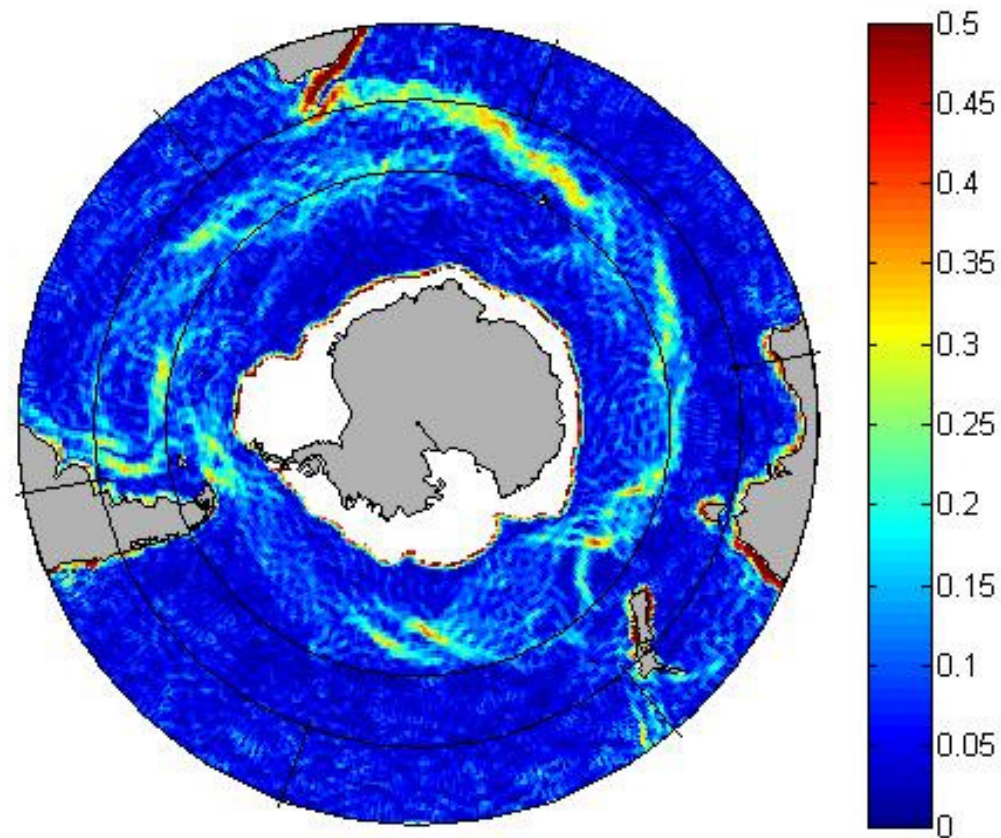
ITG-Grace2010s

Surface velocities [m/s] derived from MDT (up to d/o 180)

GOCO01S

Surface velocities [m/s] derived from MDT (up to d/o 180)

GOCO02S

RMS of geoid height differences between gravity field models and GPS-leveling observations

	#points	GOCO02S	GOCO01S	ITG-Grace2010s	TIM2*	EIGEN-51C
		σN [cm]				
d/o 100						
Canada	430	14,4	14,4	14,6	14,4	14,3
Germany	675	3,8	3,9	3,9	3,7	3,8
Japan	837	10,3	10,3	10,2	10,3	10,2
d/o 150						
Canada	430	14,4	14,3	14,7	14,5	14,0
Germany	675	4,5	4,5	4,6	4,4	3,5
Japan	837	10,2	10,3	10,5	10,3	10,6
d/o 200						
Canada	430	15,4	17,3	30,3	15,7	14,0
Germany	675	6,8	14,2	26,3	6,7	4,4
Japan	837	11,5	13,3	34,9	11,6	11,6

*ESA GOCE-only model based on time-wise approach

Summary and Outlook

- major improvements in areas where only a few and less accurate terrestrial measurements are available

- continuously increasing availability of GOCE and GRACE data

- further improvements due to extended GOCE mission can be assured

- inclusion of terrestrial data → work in progress

- Project webpage & Downloads (within upcoming weeks)

  http://www.itsg.tugraz.at/goco

- International Centre for Global Earth Models webpage:

  http://icgem.gfz-potsdam.de/ICGEM