COST-G
Combination Service for Time-variable Gravity Models

The new COST-G deterministic signal model

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G2.1 Precise Orbit Determination for Geodesy and Earth Science

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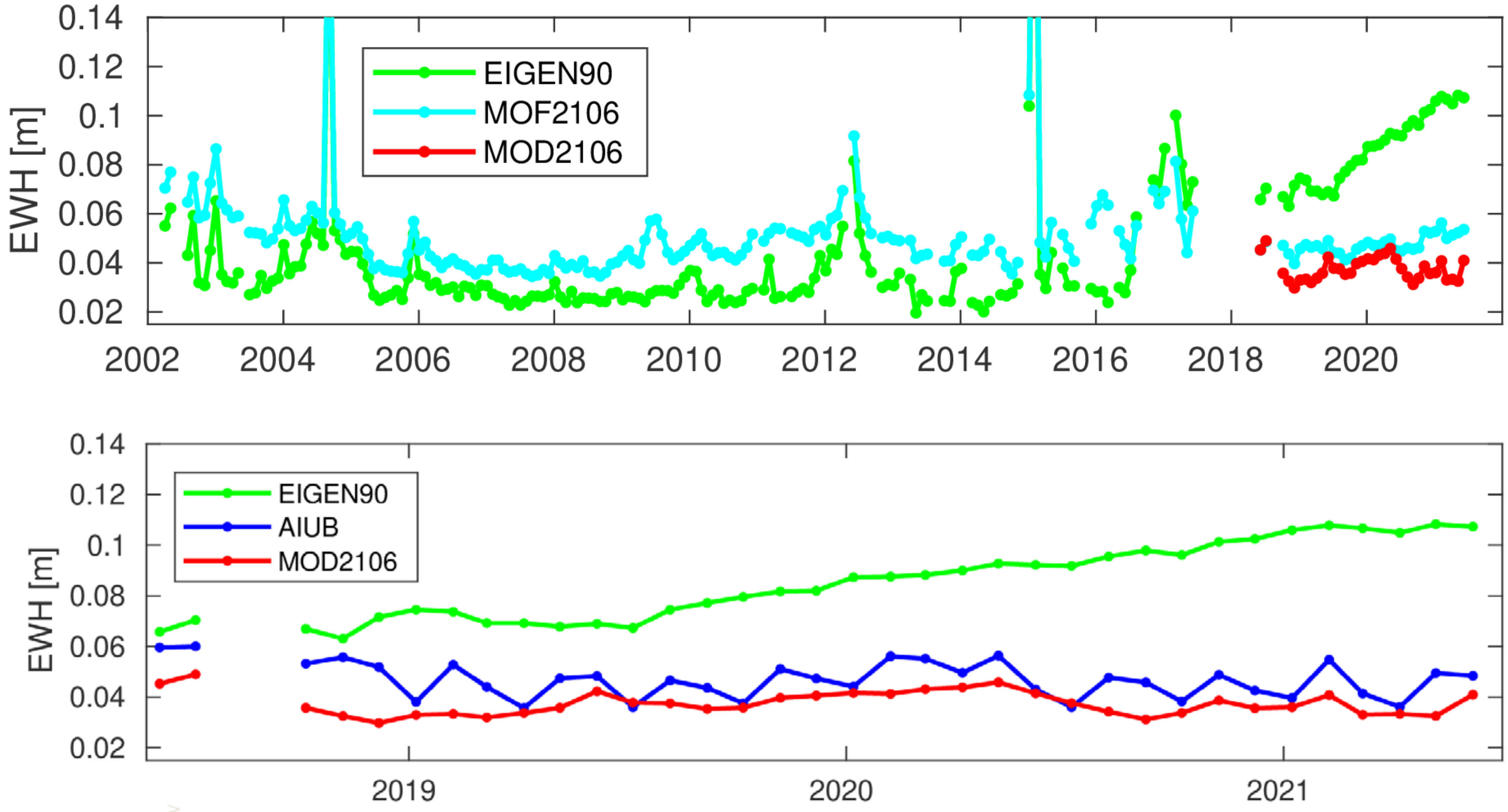
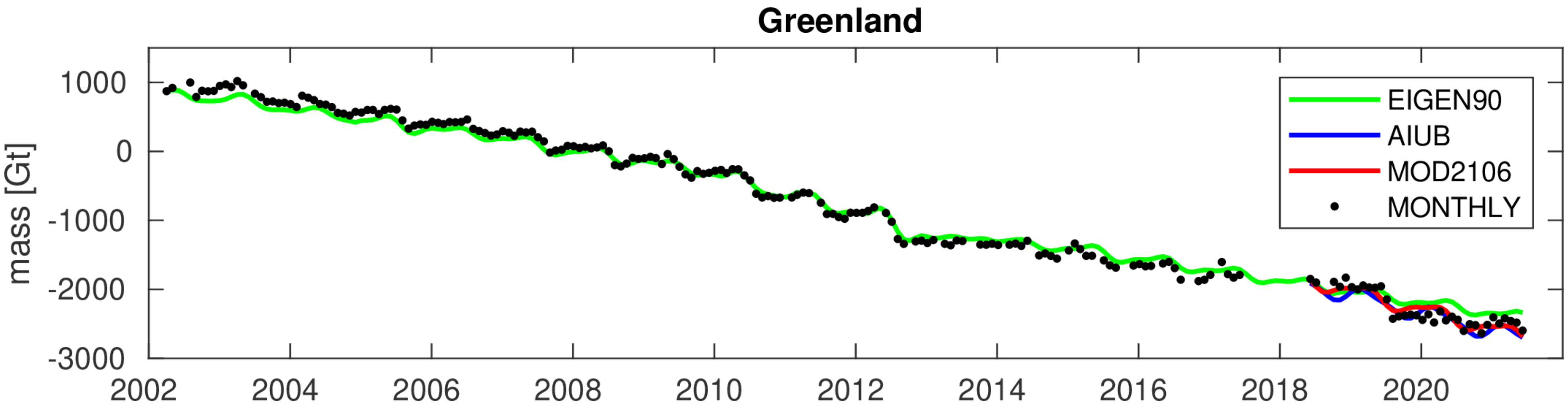
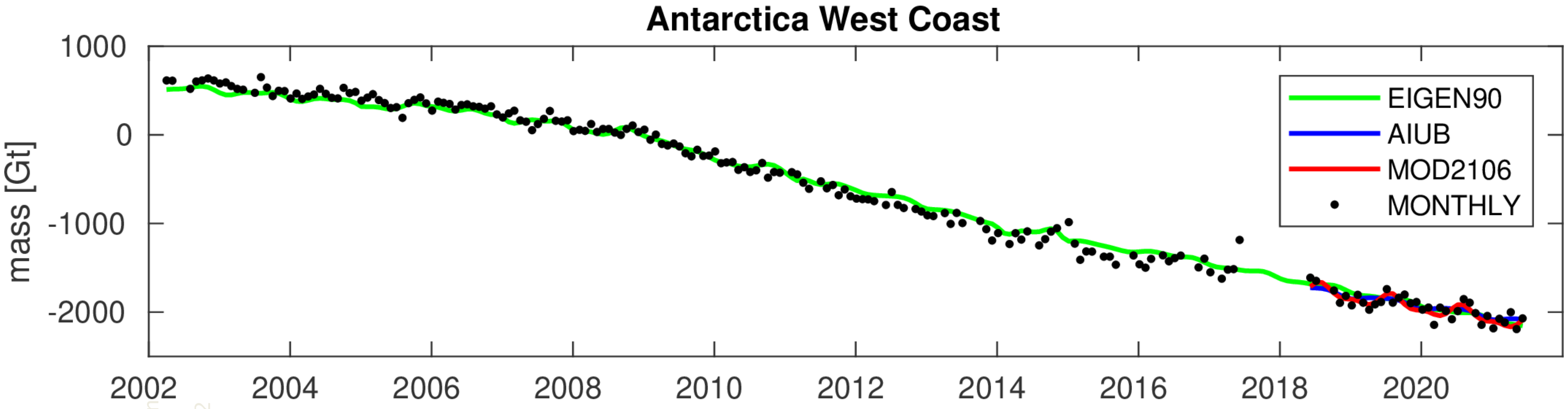
RMS of differences (over land, 300 km Gauss) to monthly fields



Operational precise orbit determination (POD) of low Earth orbiters (LEO) relies on a gravity field with modeled time variations. The EIGEN-GRGS-RL04 model (green) has been the standard for LEO-POD of altimeter satellites, but the extrapolation to the GRACE-FO period reveals large prediction errors. For comparison a model fitted to COST-G GRACE-FO gravity fields is shown (red).

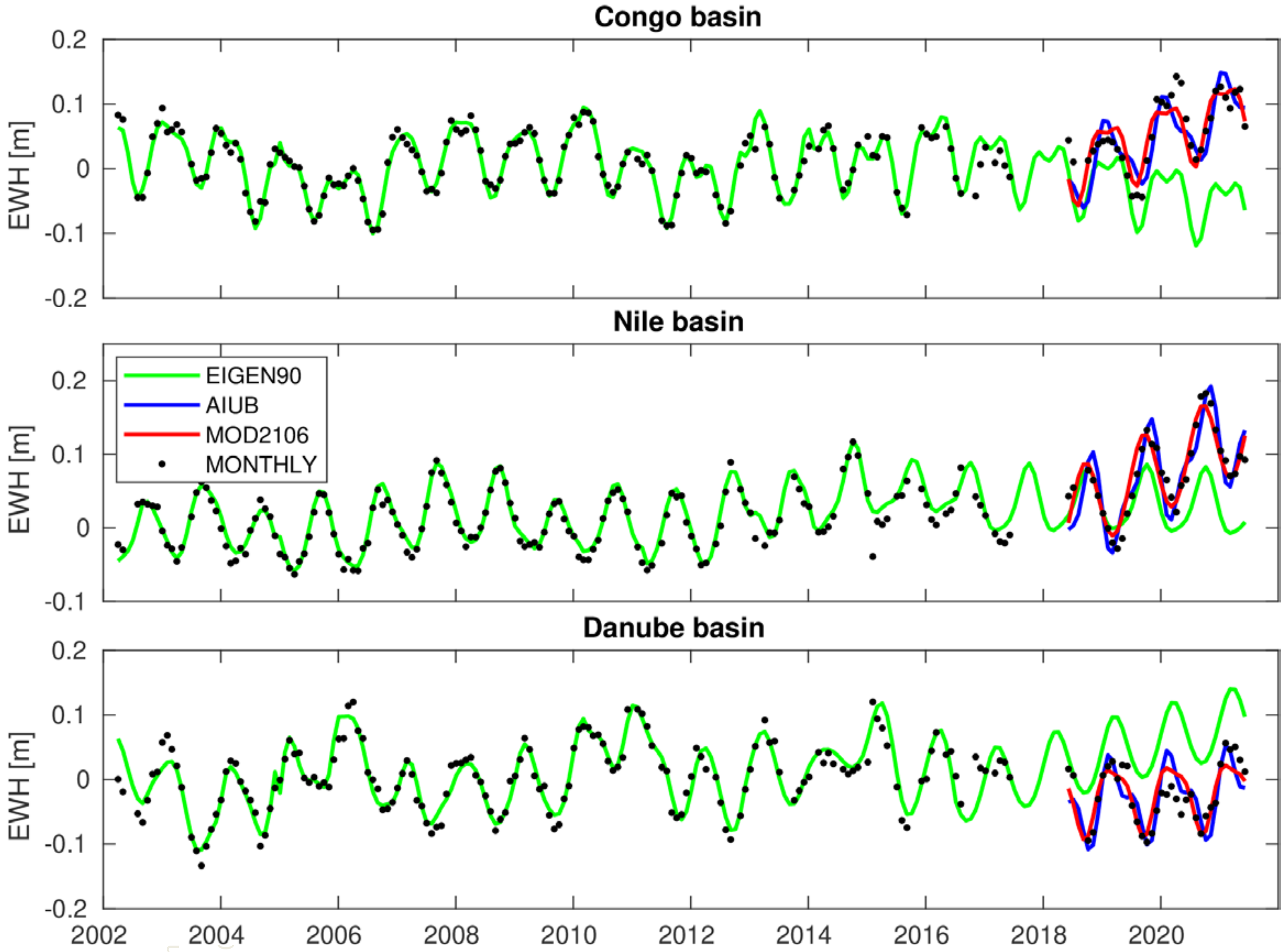
Polar mass trend (no filter)





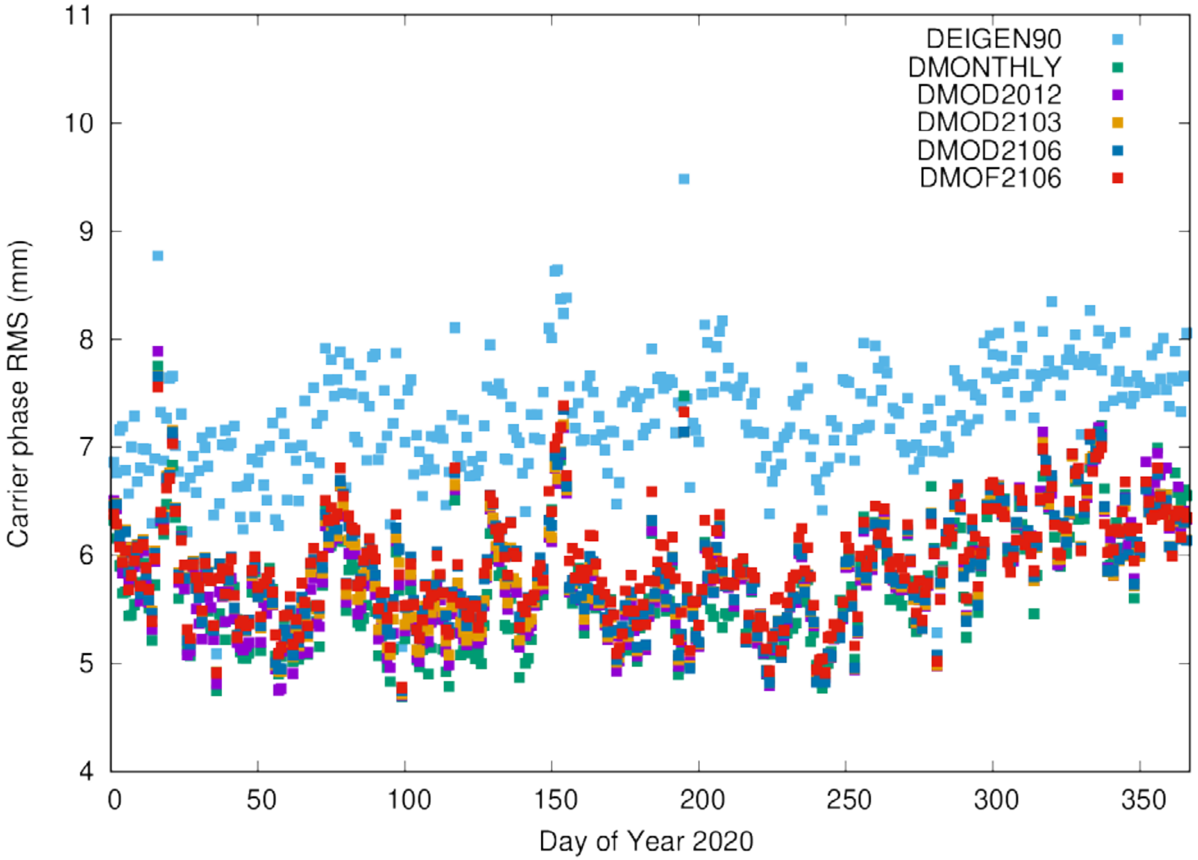
Surprisingly, the reason for the prediction error in the EIGEN-GRGS-RL04 model (green) seems not to be in regions with strong mass trends.

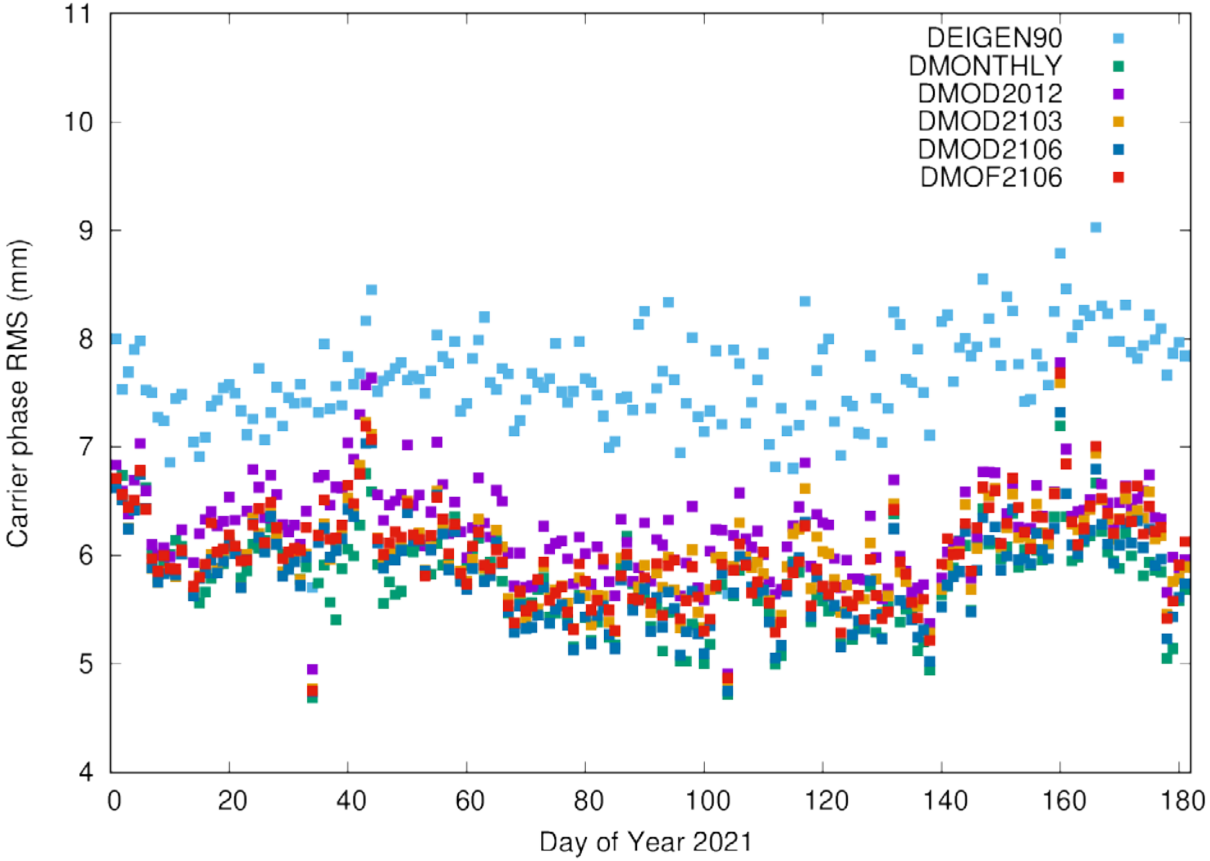
Hydrological cycle in large river basins (300 km Gauss)



The time-series of monthly GRACE gravity fields was fitted in yearly batches for the EIGEN-GRGS-RL04 model. While the fit in the GRACE period is very good, the extrapolation of the last of these batches leads to large errors in river basins with strong non-seasonal variations.

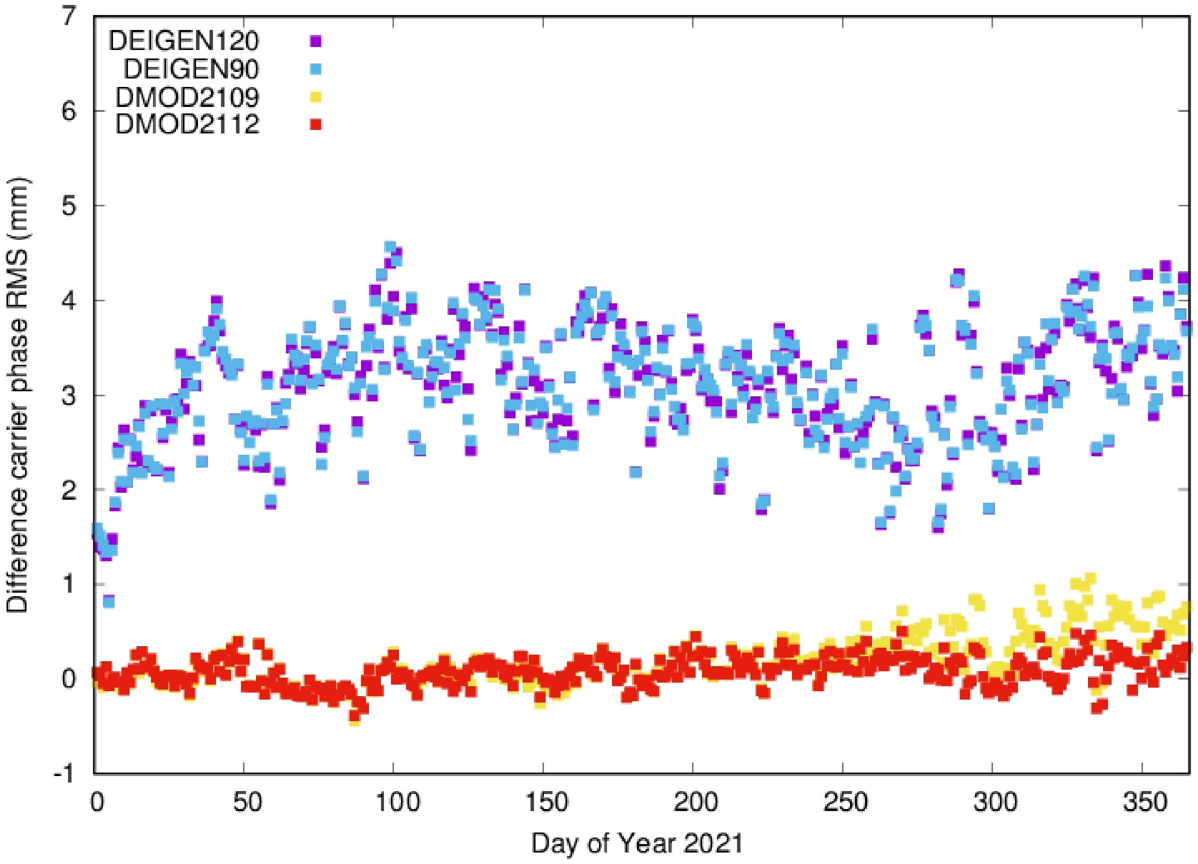
Sentinel - 3B (altitude 811 km) orbit determination



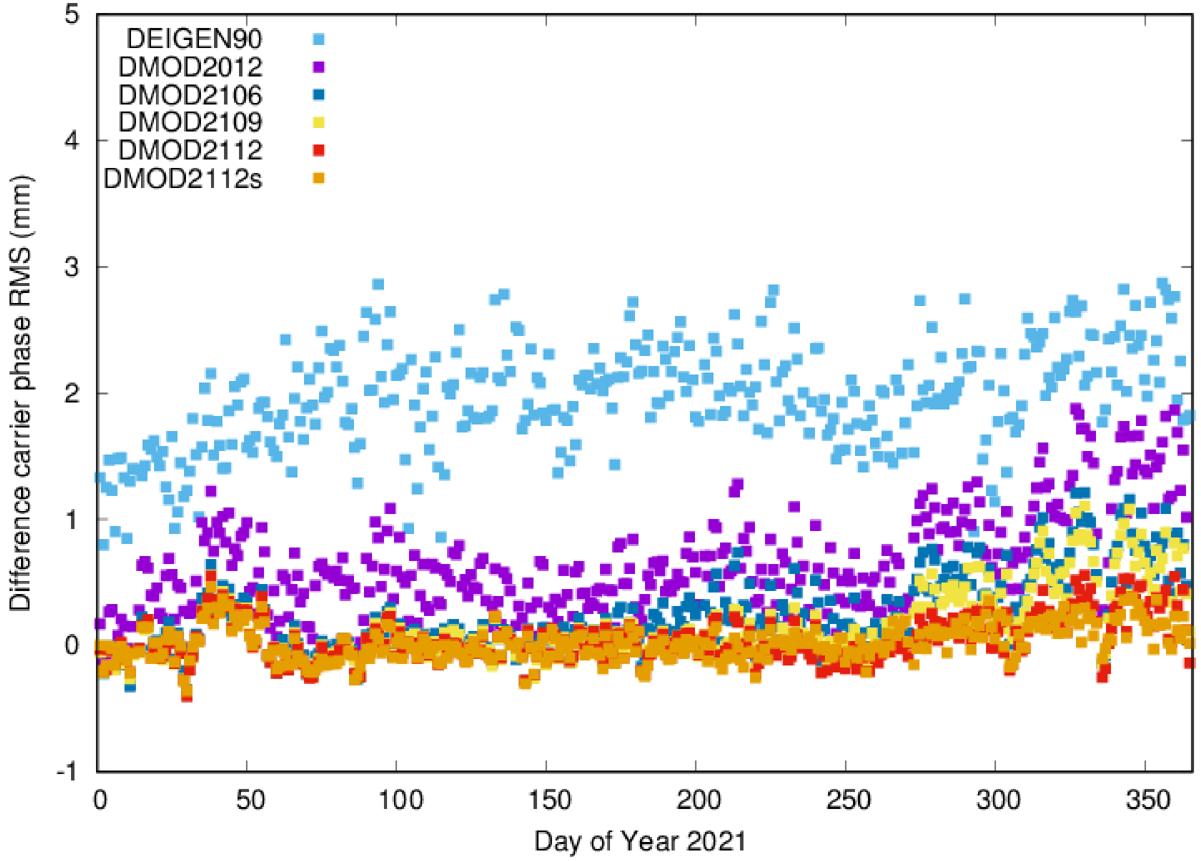


The carrier phase RMS of dynamic Sentinel-3B satellite orbits (orbit altitude 811 km) based on monthly GRACE-FO gravity fields (green) or different fitted signal models reveals the benefit of up-to-date models.

Impact on truncation degree and data period



While the truncation degree (90/120) has little impact on Sentinel-1B orbits (693 km altitude), the data period for the model fit does!



Carrier phase residuals of Sentinel-3B orbits (811 km orbit altitude) confirm the dependence on the data period that entered the model.

SLR-validation Sentinel-3B

Data: Year 2020, Sentinel-3B, SLR validation, 12 stations (cm)

Gravity field model	Mean (cm)	RMS (cm)	Standard deviation (cm)
DEIGEN120	0.29	1.01	0.97
DEIGEN90	0.29	1.01	0.97
D90MONTHLY	0.28	0.91	0.87
D90MODEL2012	0.28	0.92	0.88
RDEIGEN120	0.31	0.91	0.85
RDEIGEN90	0.31	0.91	0.85
RD90MONTHLY	0.31	0.88	0.82

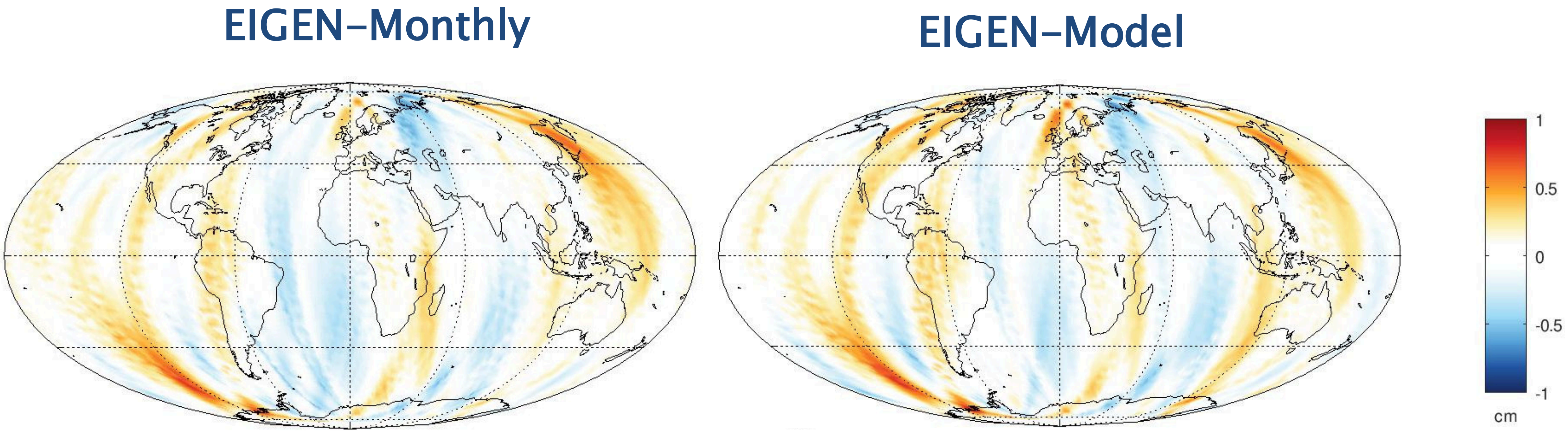
The limited max. degree does not negatively affect LEO POD (S3B)

LEO POD profits from monthly gravity fields

The fitted signal models perform close to the monthly gravity fields

Reduced dynamic LEO POD is less sensitive to model deficiencies.

Sentinel-3B orbit differences



The differences in the background force model mainly affect the empirical 1 / rev orbit parameters. Differences of EIGEN–GRGS–RL04 with respect to the monthly solutions or the fitted signal model are consistent, but association with differences in the gravity field models is not easily possible.