

## The new COST-G fitted signal model

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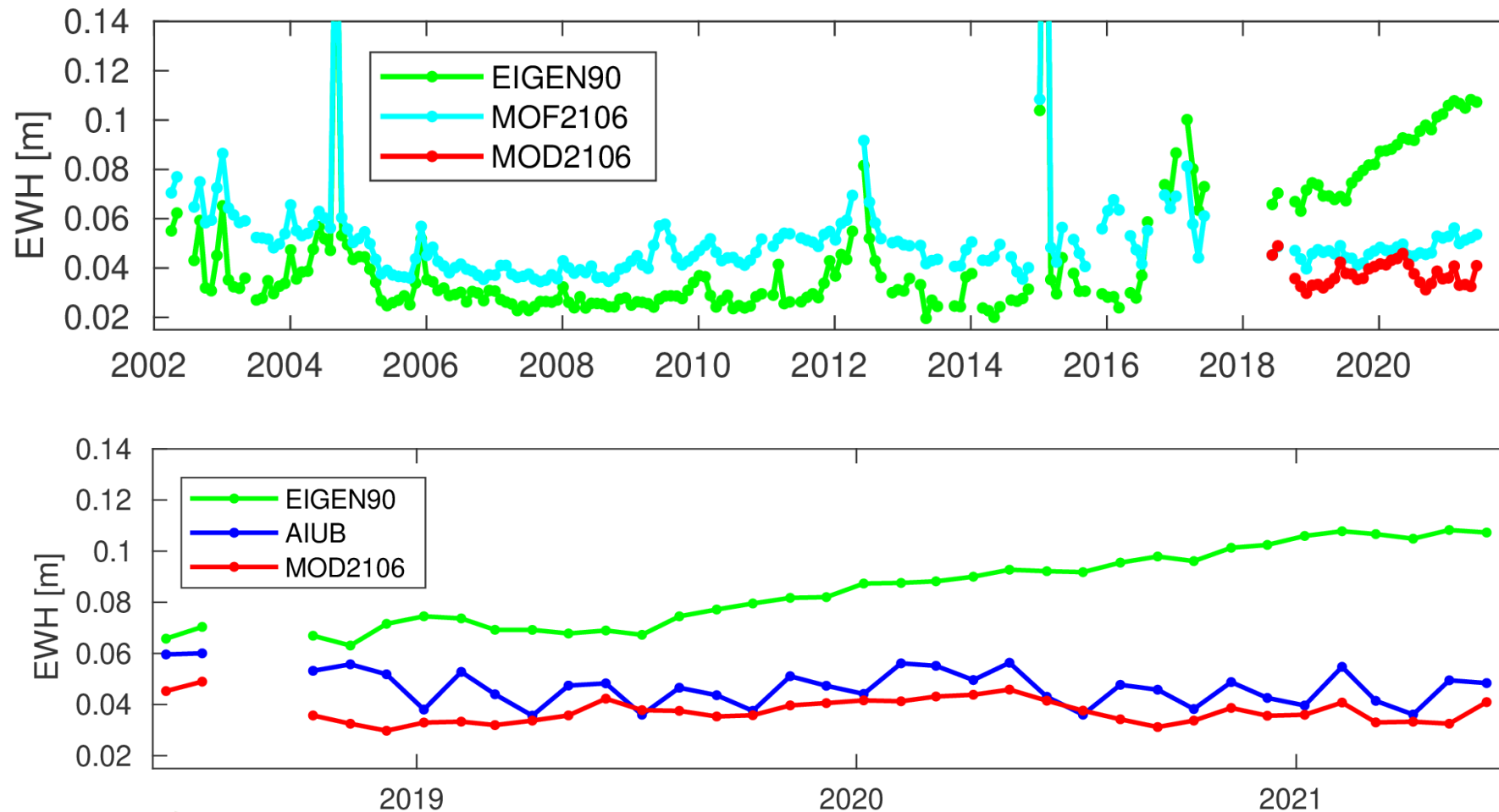
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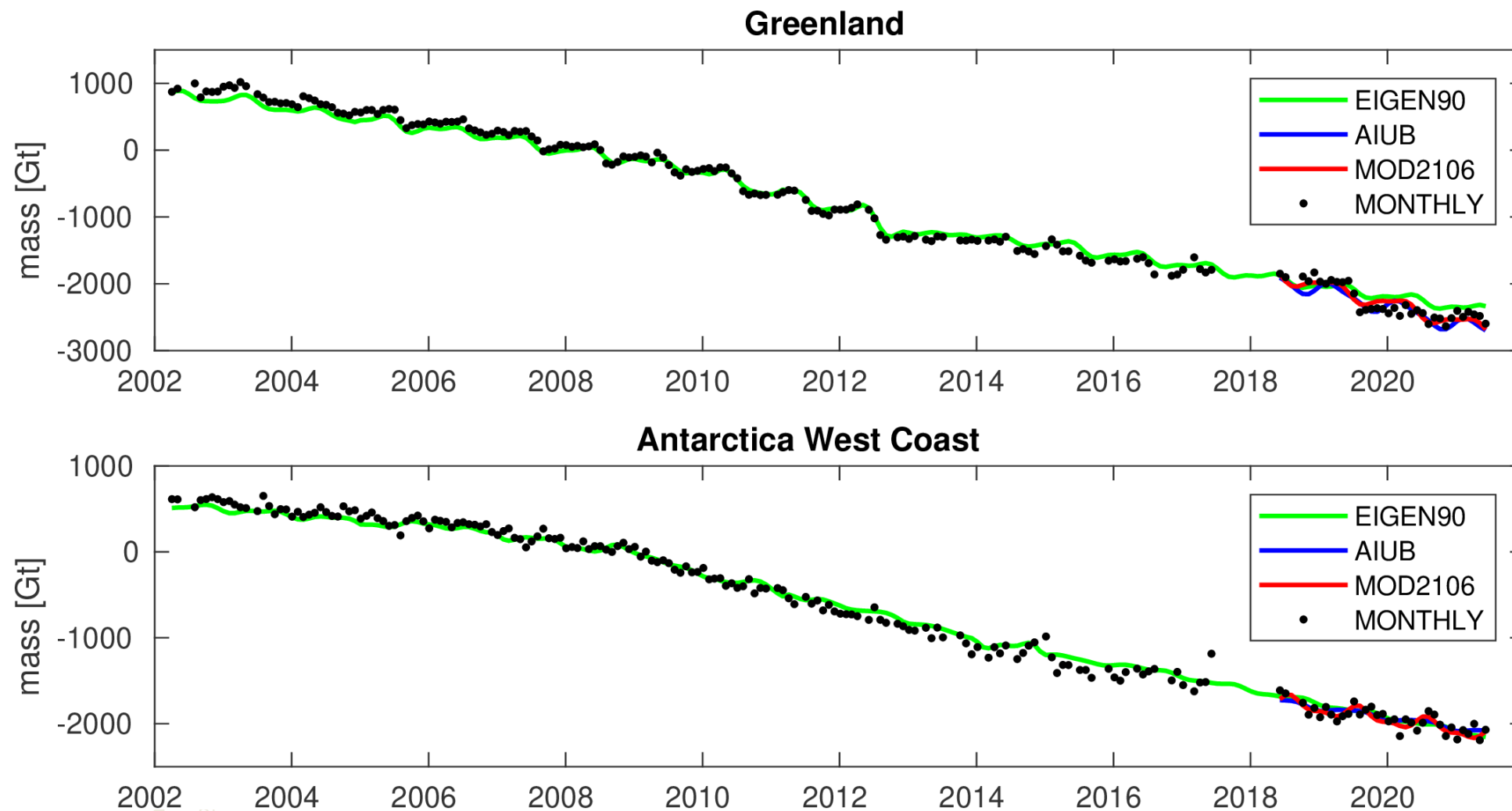
G2.1 Precise Orbit Determination for Geodesy and Earth Science

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



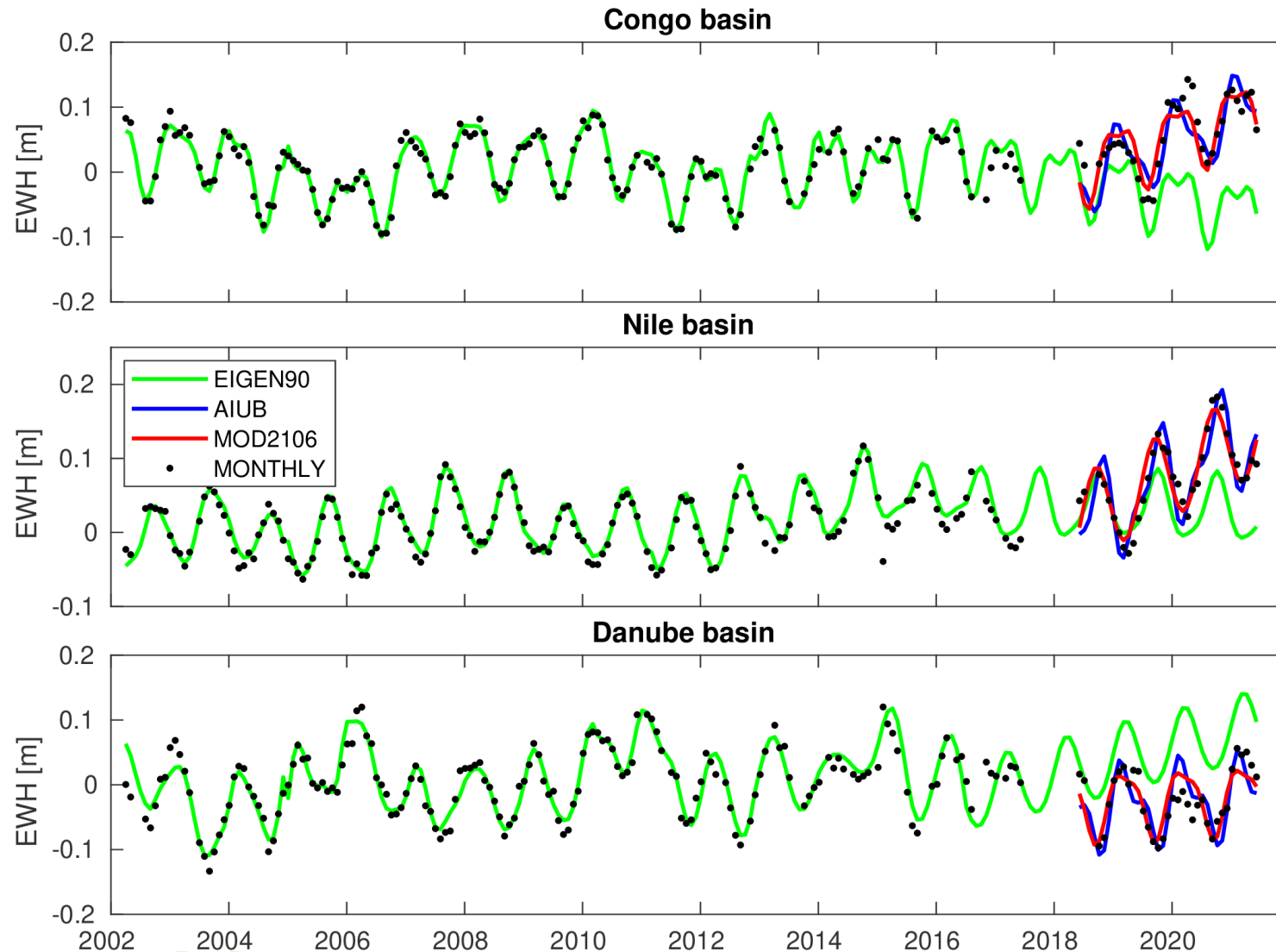
Operational precise orbit determination (POD) of low Earth orbiters (LEO) relies on a gravity field with modeled time variations. The EIGEN-GRGS-RL04 model (green) has been the standard for LEO-POD of altimeter satellites, but the extrapolation to the GRACE-FO period reveals large prediction errors.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

# Polar mass trend (no filter)



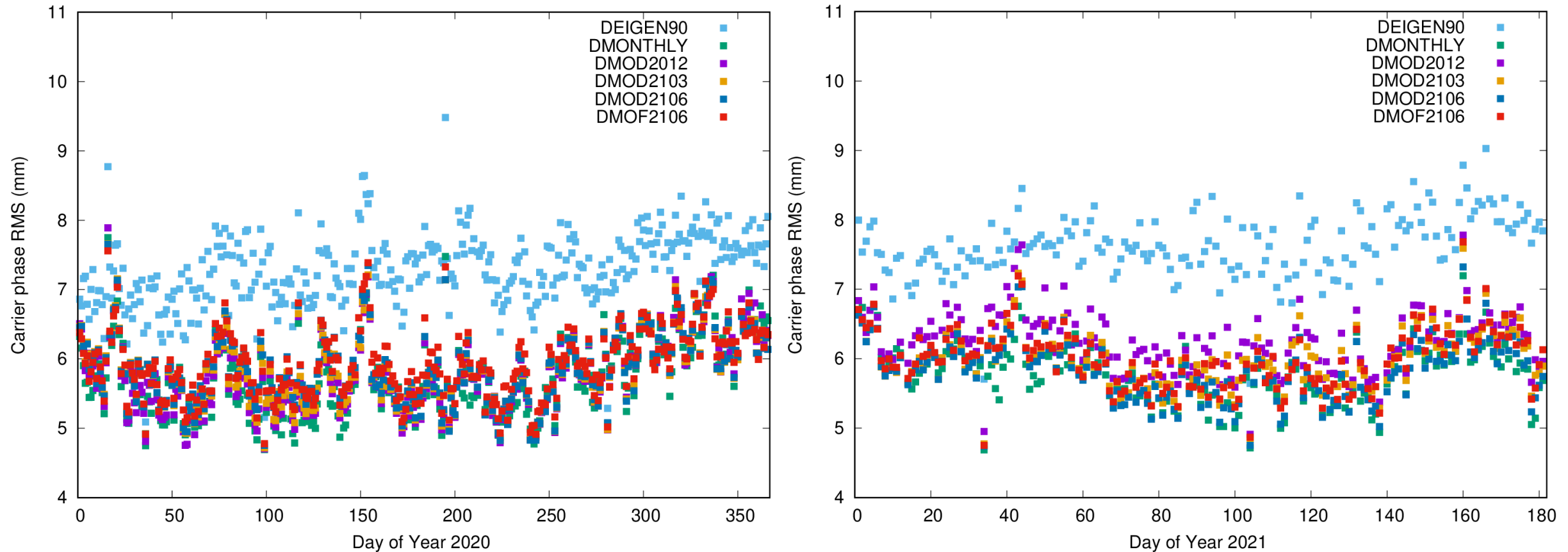
Surprisingly, the reason for the prediction error in the EIGEN-GRGS-RL04 model (green) seems not to be in regions with strong mass trends.

# Hydrological cycle in large river basins (300 km Gauss)



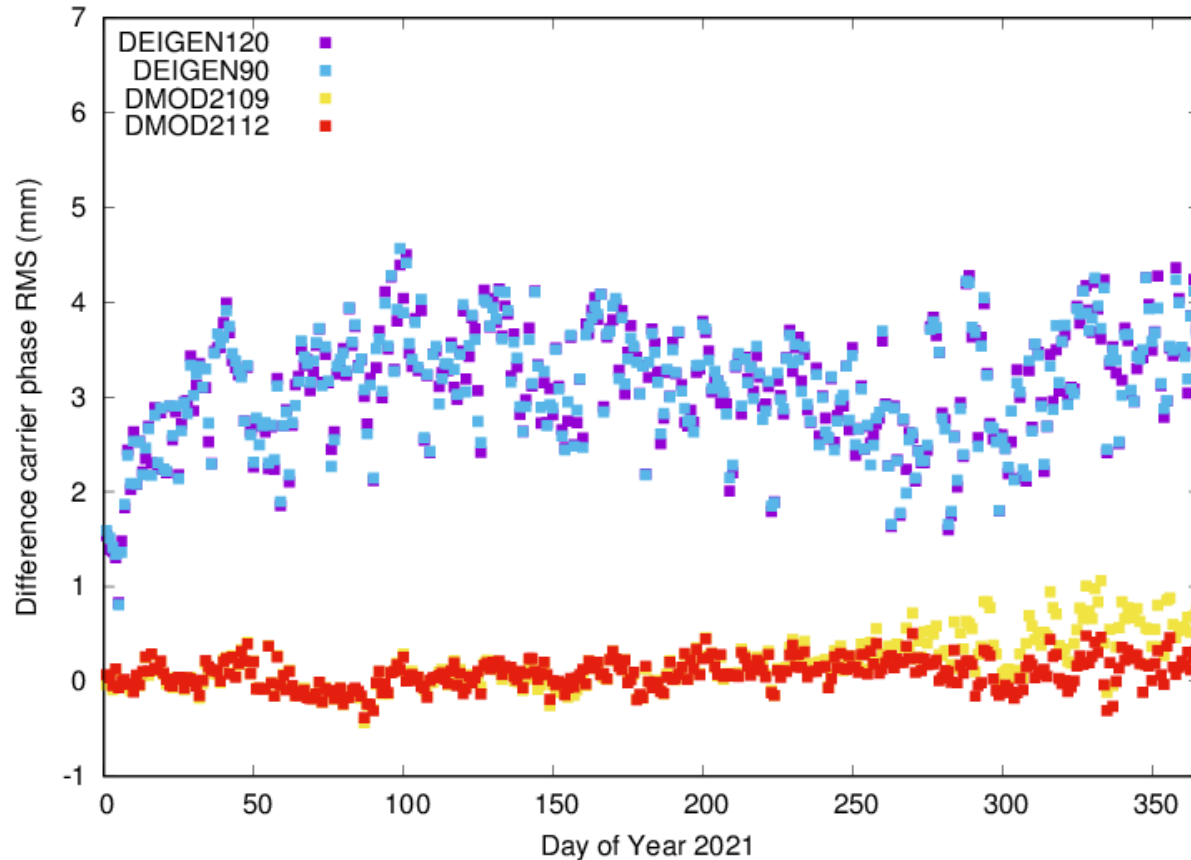
The time-series of monthly GRACE gravity fields was fitted in yearly batches for the EIGEN-GRGS-RL04 model. While the fit in the GRACE period is very good, the extrapolation of the last of these batches leads to large errors in river basins with strong non-seasonal variations.

# Sentinel - 3B (altitude 811 km) orbit determination

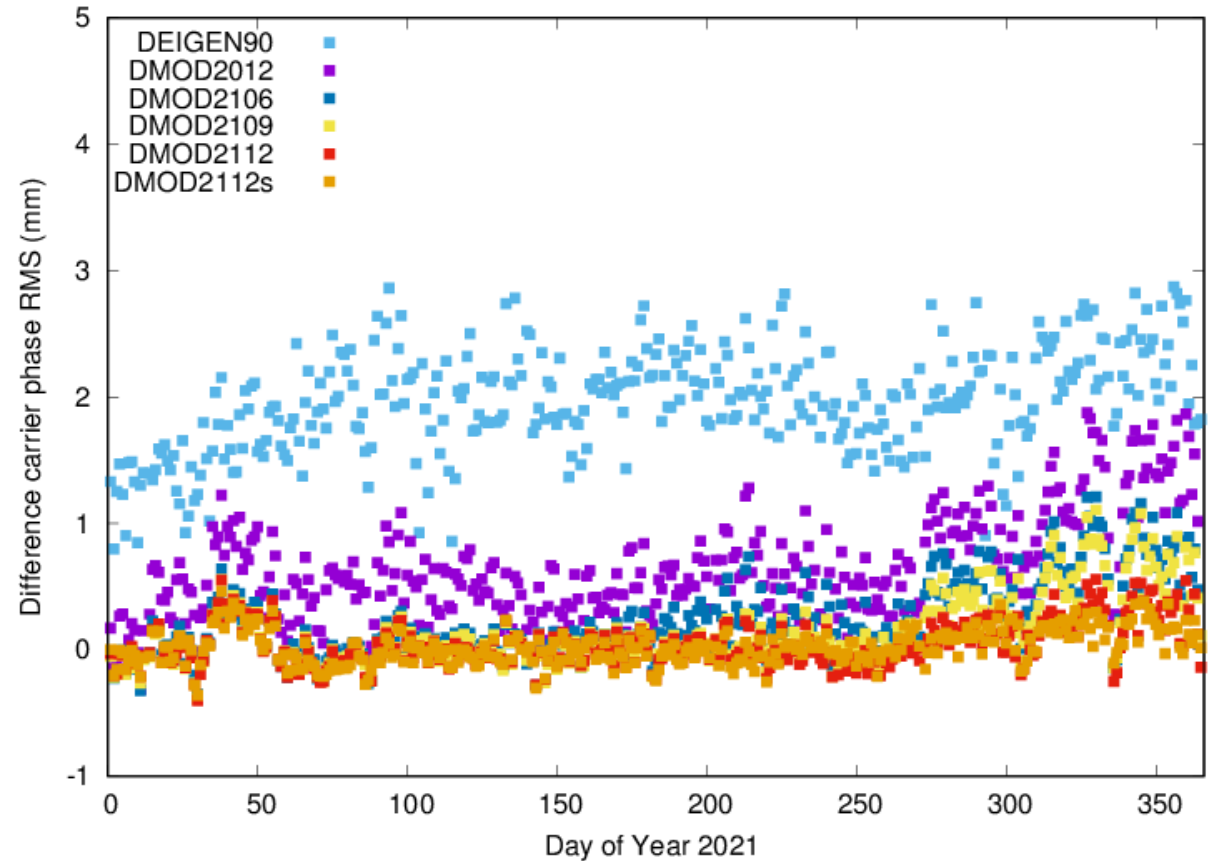


The carrier phase RMS of dynamic Sentinel-3B satellite orbits (orbit altitude 811 km) based on monthly GRACE-FO gravity fields (green) or different fitted signal models reveals the benefit of up-to-date models.

# 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)

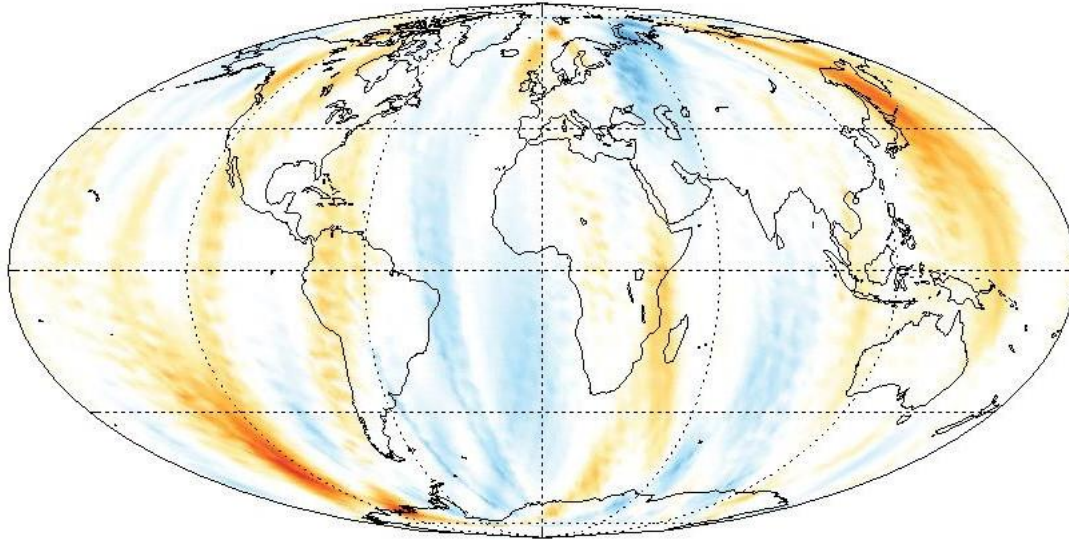
LEO POD profits from monthly gravity fields

The fitted signal models perform close to the monthly gravity fields

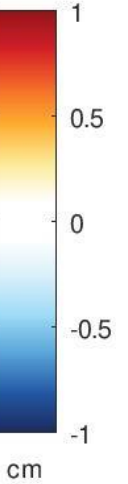
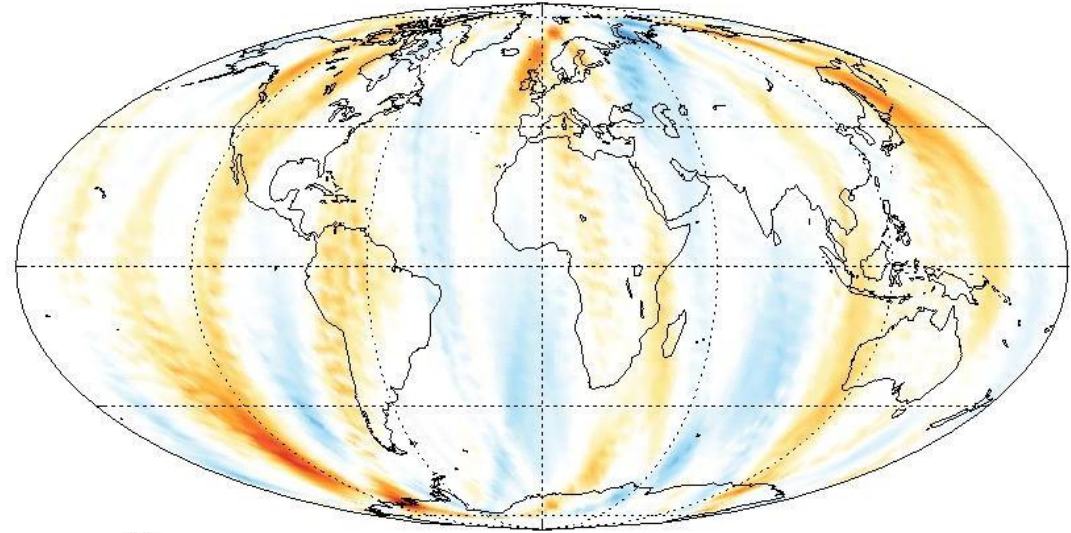
Reduced dynamic LEO POD is less sensitive to model deficiencies.

# Sentinel-3B orbit differences

## EIGEN-Monthly



## EIGEN-Model

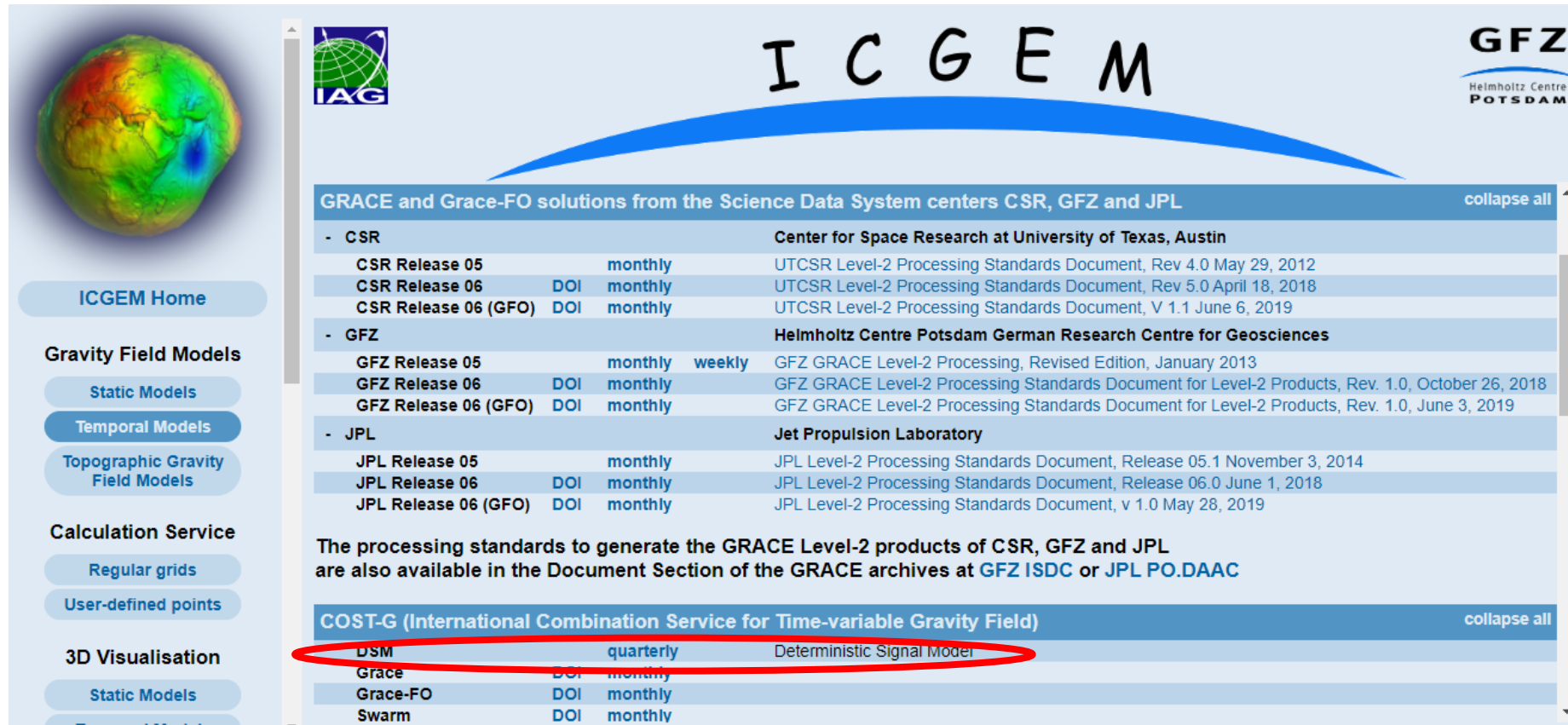


The differences in the background force model mainly affect the empirical 1 /rev orbit parameters. Differences of EIGEN-GRGS-RL04 with respect to the monthly solutions or the fitted signal model are consistent, but association with differences in the gravity field models is not easily possible.



# Where to get the COST-G fitted signal model?

<http://icgem.gfz-potsdam.de/series>



The screenshot shows the ICGEM website interface. On the left is a sidebar with navigation links: ICGEM Home, Gravity Field Models (Static Models, Temporal Models, Topographic Gravity Field Models), Calculation Service (Regular grids, User-defined points), and 3D Visualisation (Static Models, Temporal Models). The main content area features the ICGEM logo and a table of GRACE and Grace-FO solutions. The table is organized by center: CSR (Center for Space Research at University of Texas, Austin), GFZ (Helmholtz Centre Potsdam German Research Centre for Geosciences), and JPL (Jet Propulsion Laboratory). Each center lists its release versions (05, 06) and frequencies (monthly, weekly). A red circle highlights the 'COST-G (International Combination Service for Time-variable Gravity Field)' section, which includes a row for 'DSM' (Deterministic Signal Model) with a frequency of 'quarterly'. Other rows in this section include 'Grace', 'Grace-FO', and 'Swarm', all with 'monthly' frequencies. The website also includes a 'collapse all' button and a 'The processing standards to generate the GRACE Level-2 products of CSR, GFZ and JPL are also available in the Document Section of the GRACE archives at GFZ ISDC or JPL PO.DAAC' notice.

GRACE and Grace-FO solutions from the Science Data System centers CSR, GFZ and JPL				collapse all
<b>- CSR</b>				
Center for Space Research at University of Texas, Austin				
CSR Release 05		monthly	UTCSR Level-2 Processing Standards Document, Rev 4.0 May 29, 2012	
CSR Release 06	DOI	monthly	UTCSR Level-2 Processing Standards Document, Rev 5.0 April 18, 2018	
CSR Release 06 (GFO)	DOI	monthly	UTCSR Level-2 Processing Standards Document, V 1.1 June 6, 2019	
<b>- GFZ</b>				
Helmholtz Centre Potsdam German Research Centre for Geosciences				
GFZ Release 05		monthly weekly	GFZ GRACE Level-2 Processing, Revised Edition, January 2013	
GFZ Release 06	DOI	monthly	GFZ GRACE Level-2 Processing Standards Document for Level-2 Products, Rev. 1.0, October 26, 2018	
GFZ Release 06 (GFO)	DOI	monthly	GFZ GRACE Level-2 Processing Standards Document for Level-2 Products, Rev. 1.0, June 3, 2019	
<b>- JPL</b>				
Jet Propulsion Laboratory				
JPL Release 05		monthly	JPL Level-2 Processing Standards Document, Release 05.1 November 3, 2014	
JPL Release 06	DOI	monthly	JPL Level-2 Processing Standards Document, Release 06.0 June 1, 2018	
JPL Release 06 (GFO)	DOI	monthly	JPL Level-2 Processing Standards Document, v 1.0 May 28, 2019	
The processing standards to generate the GRACE Level-2 products of CSR, GFZ and JPL are also available in the Document Section of the GRACE archives at <a href="#">GFZ ISDC</a> or <a href="#">JPL PO.DAAC</a>				
<b>COST-G (International Combination Service for Time-variable Gravity Field)</b>				collapse all
DSM		quarterly	Deterministic Signal Model	
Grace	DOI	monthly		
Grace-FO	DOI	monthly		
Swarm	DOI	monthly		

Peter H. et al. (2022): COST-G gravity field models for precise orbit determination of Low Earth Orbiting Satellites. *Advances in Space Research*, Vol 69(12), DOI 10.1016/j.asr.2022.04.005



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G2.1: Precise Orbit Determination for Geodesy and Earth Science