The new ITSG-Grace2016 release

Matthias Ellmer, Torsten Mayer-Gürr, Saniya Behzadpour, Beate Klinger, Andreas Kvas, and Norbert Zehentner

Institute of Geodesy
NAWI Graz, Graz University of Technology

AOGS 2016, Beijing

Outline

- Methods, Models
- Processing details
- Unconstrained monthly solutions
- Summary & Conclusions

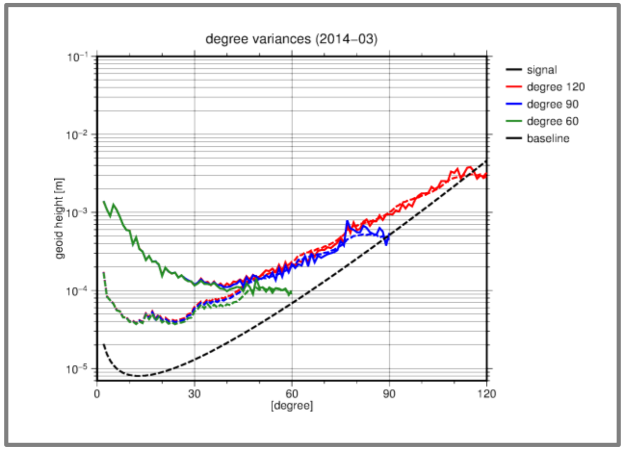
ITSG-Grace2016

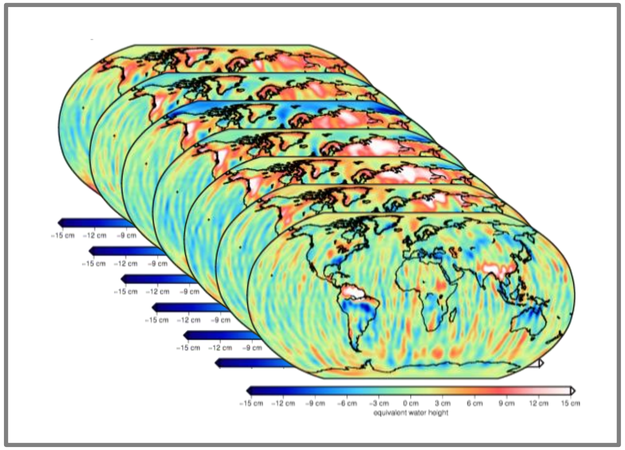
Method:
- Variational equations
- 24h arc length
- 3h covariance length

Input:
- GRACE Level-1B data from 2002-04 to 2016-03
- ITSG orbit product (Zehentner et al. 2015)
- Improved satellite attitude (Klinger et al. 2014)

Unconstrained monthly solutions:
- Degree 60, 90, 120
- Full normal equations in SINEX format are published

Daily Kalman smoothed solutions:
- Degree 40

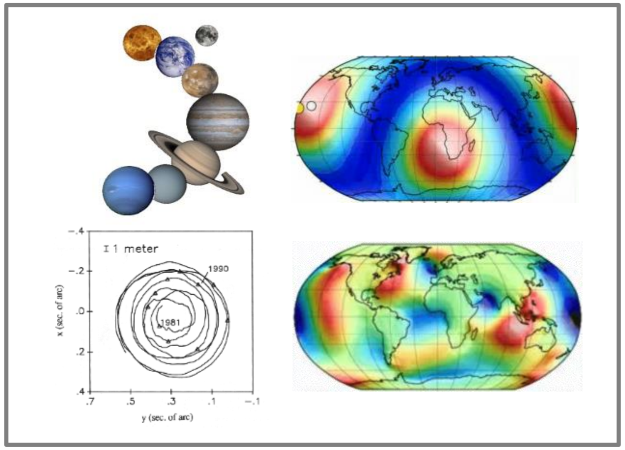




ITSG-Grace2016

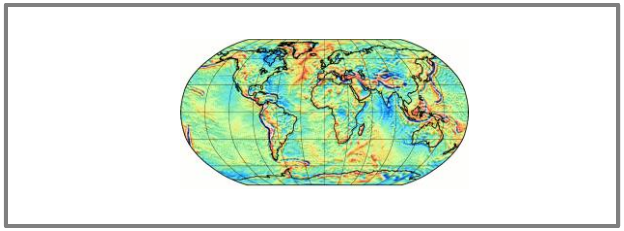
Background models:

- Third body forces: JPL DE421
- Solid earth tides: IERS 2010
- Pole tides: IERS 2010
- Ocean tides: EOT11a
- Ocean pole tides: Desai 2004
- Atmospheric tides: Van Dam & Ray 2010
- Dealiasing: AOD1B RL05
- Relativistic effects: IERS 2010



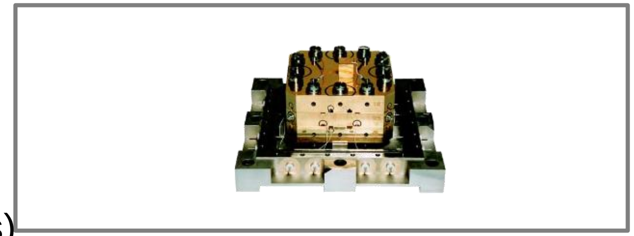
Restored models:

- Static field: GOCO05s
- Trend, Annual: GOCO05s



Non-gravity parameters:

- Once per day: satellite state vector
- Once per day: accelerometer bias per axis (basis splines)
- Once per day: accelerometer scale factors



Processing details

Improvements since ITSG-Grace2014

Multiple improvements within the processing chain:

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Improvements since ITSG-Grace2014

Multiple improvements within the processing chain:

1) Updated background models

Improvements since ITSG-Grace2014

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1) Updated background models
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3) Improved accelerometer calibration
4) Improved numerical orbit integration
5) Improved covariance function estimation
6) Co-estimation of constrained daily variations:
   constraints based on improved error estimates for the dealiasing models

Accelerometer calibration

Accelerometer bias & scale factors:

- Two-step approach: a-priori calibration for data screening
- Calibration equation: $\mathbf{a}_{\mathrm{true}} = \mathbf{S}\ \mathbf{a}_{\mathrm{obs}} + \mathbf{b}$

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(1) Bias:

- Estimation: once per day
- Parameterization: uniform cubic basis splines (UCBS), with a 6h knot interval

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(2) Scale factors:

- Estimation: once per day
- Parameterization: fully-populated scale factor matrix
- Off-diagonal elements: non-orthogonality of accelerometer axes (cross-talk), misalignment between SRF and AF

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Paper submitted (Klinger et. al.)

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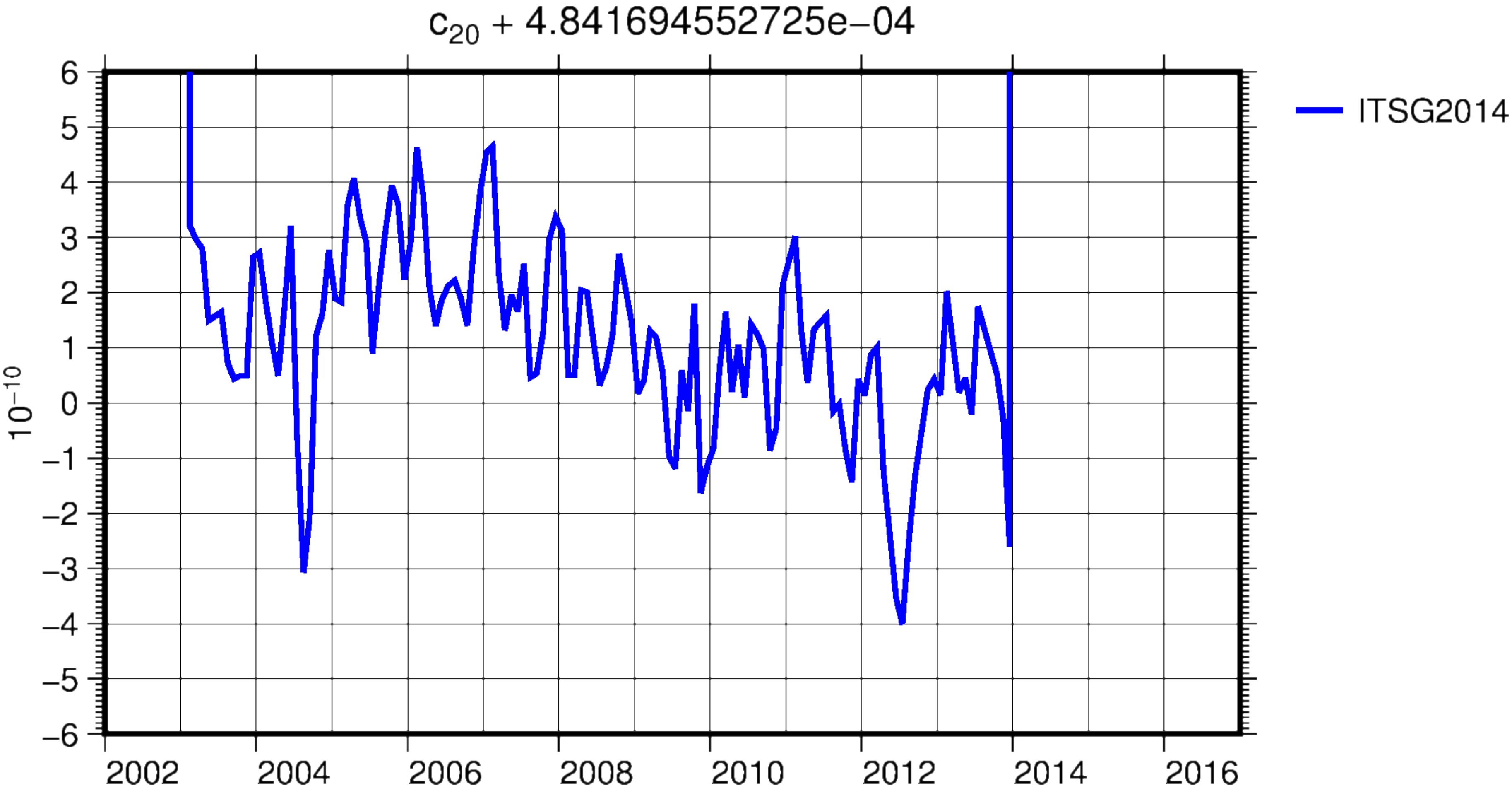
Accelerometer calibration – Impact on C20



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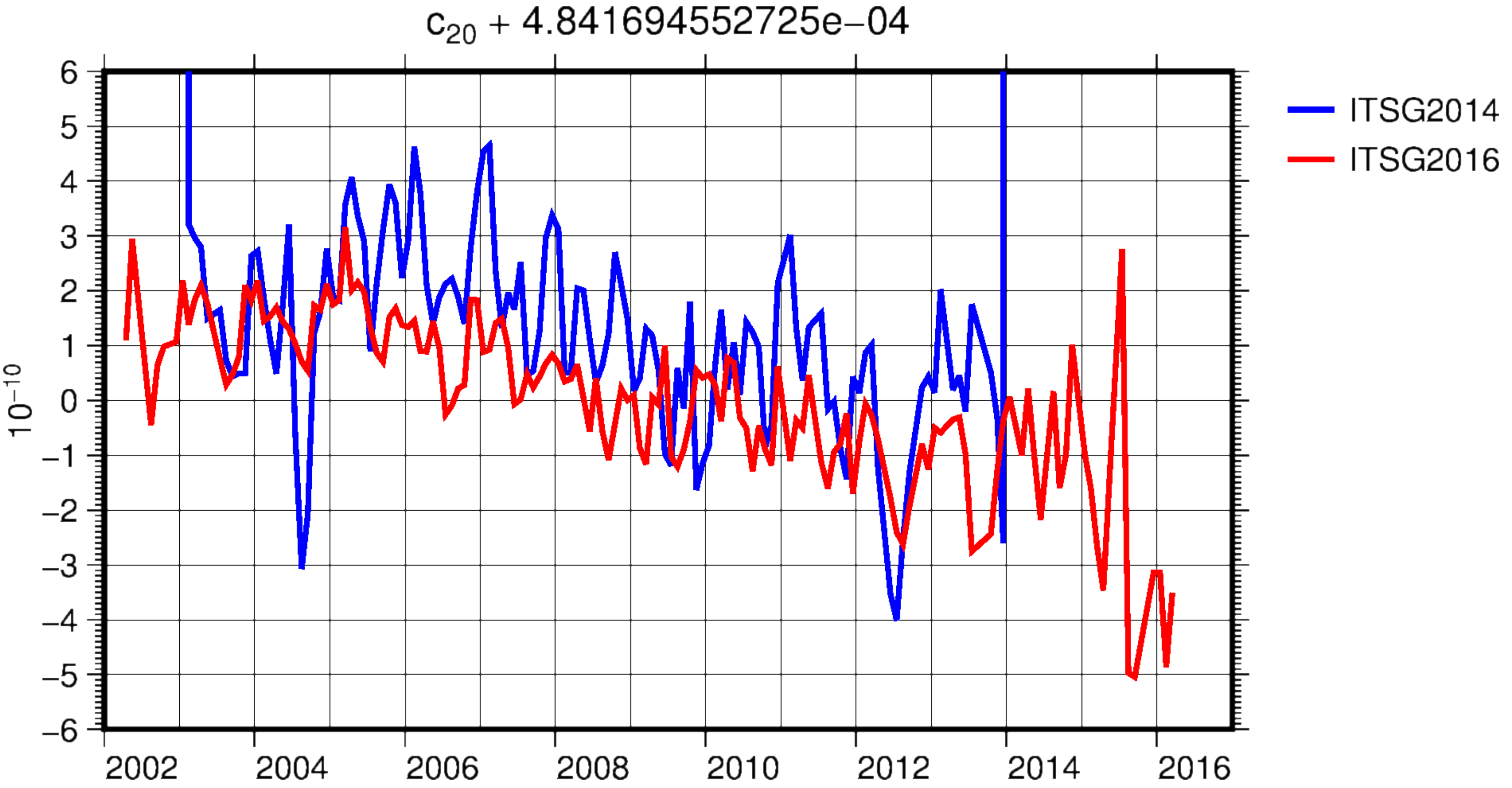

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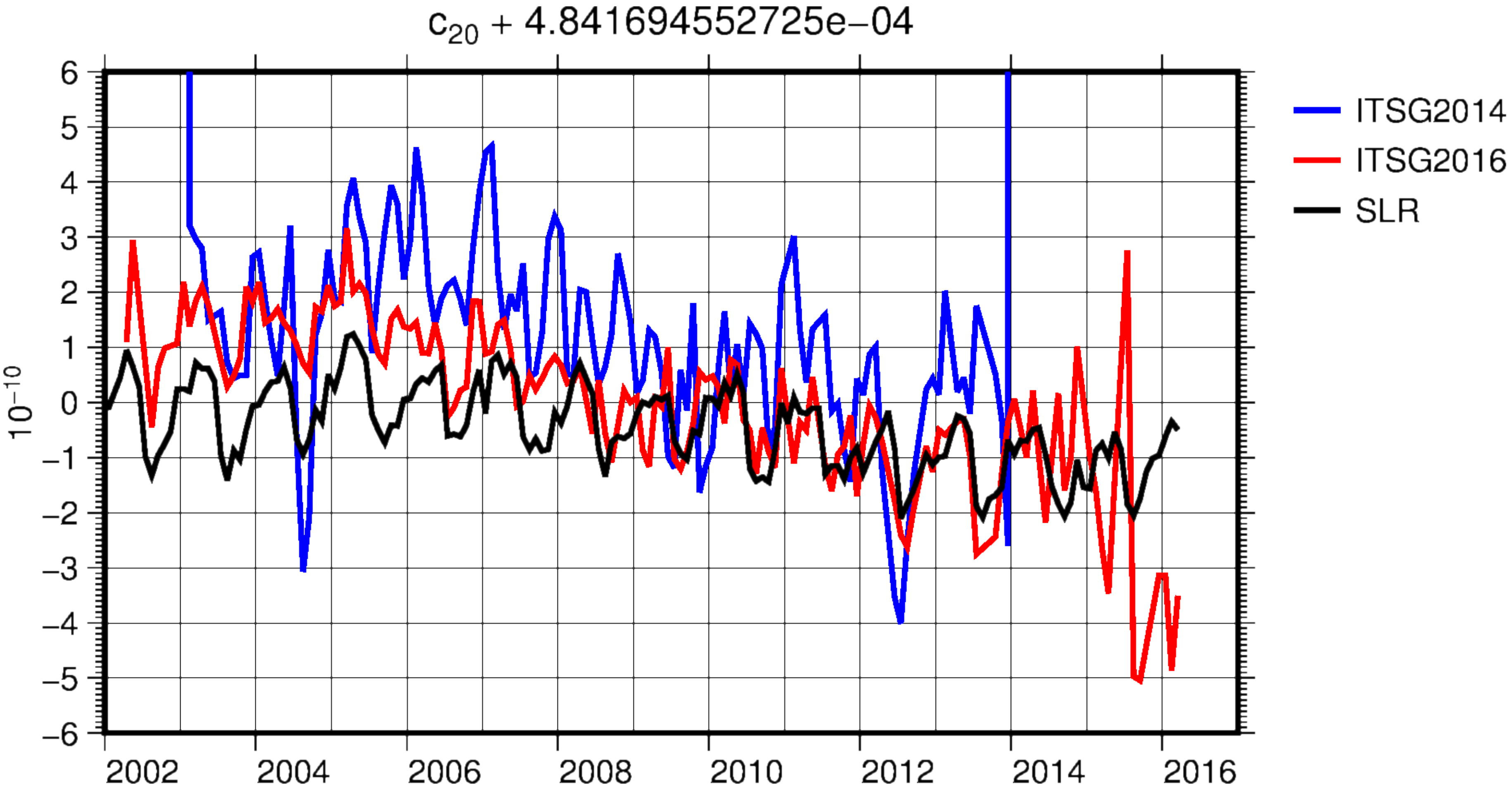
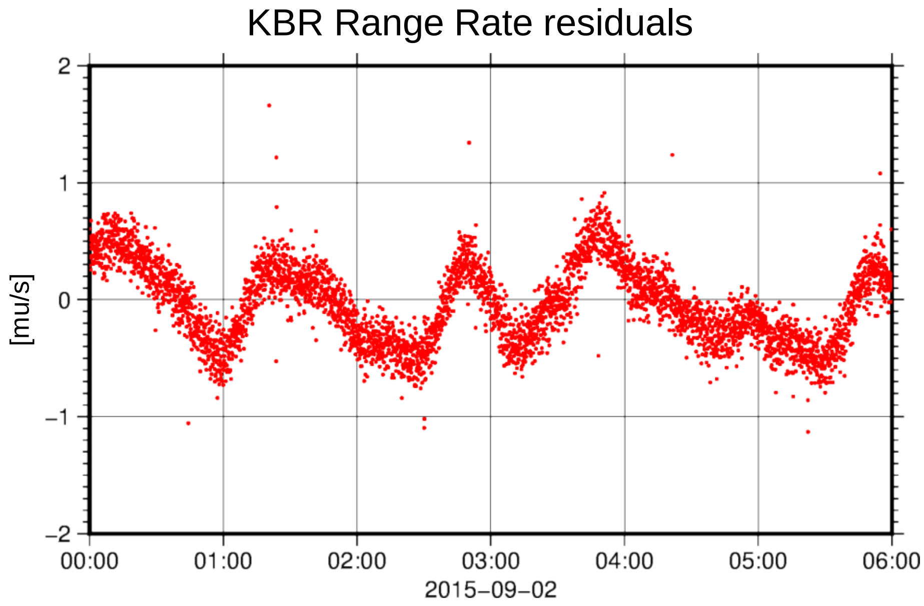


Noise modeling – covariance function

- **Empirical covariance function:** decorrelation of KBR range-rate data
- **Robust covariance estimator:** guarantees outlier-resistant covariance estimation



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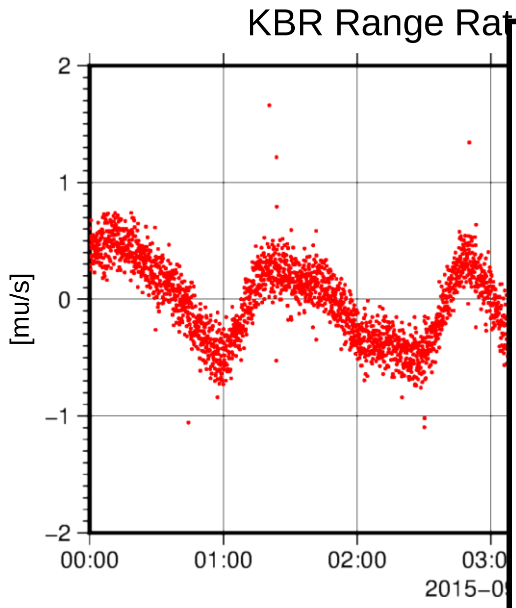
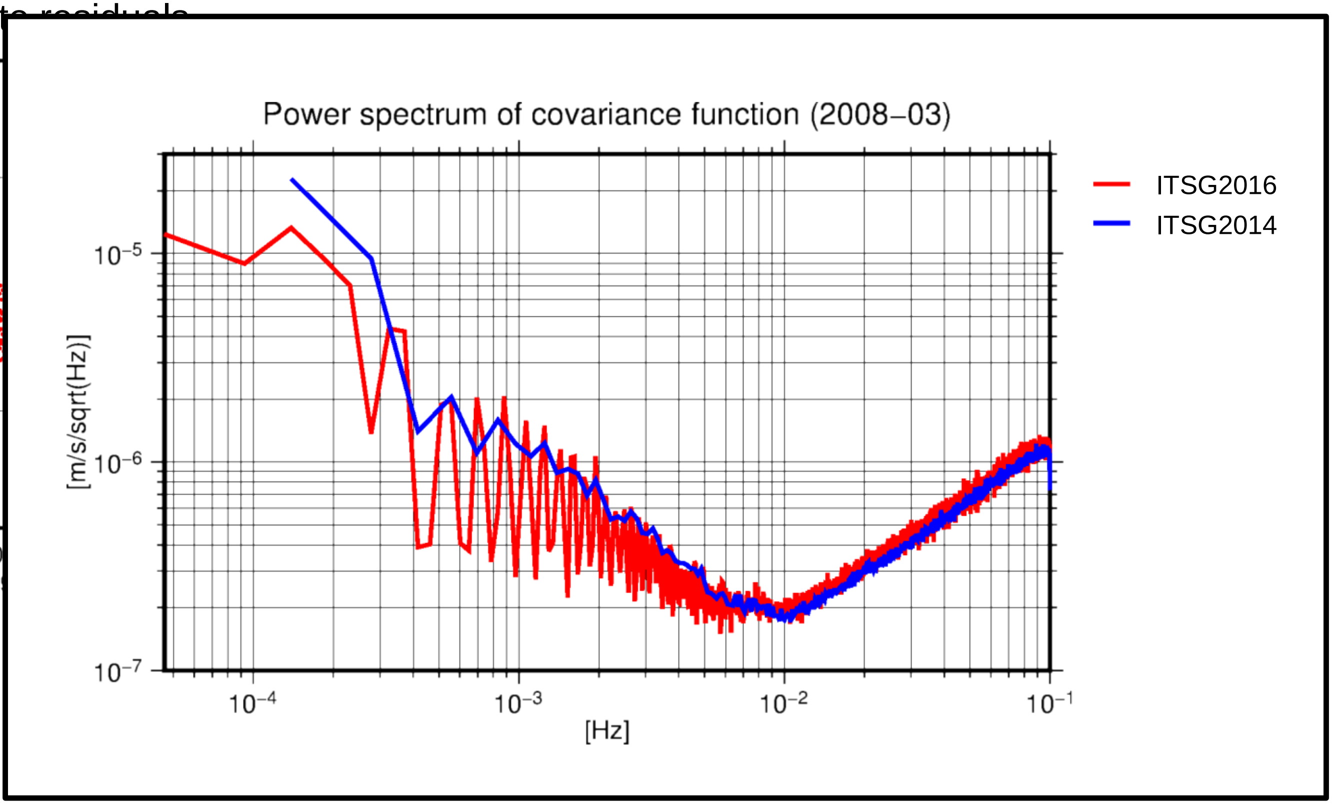
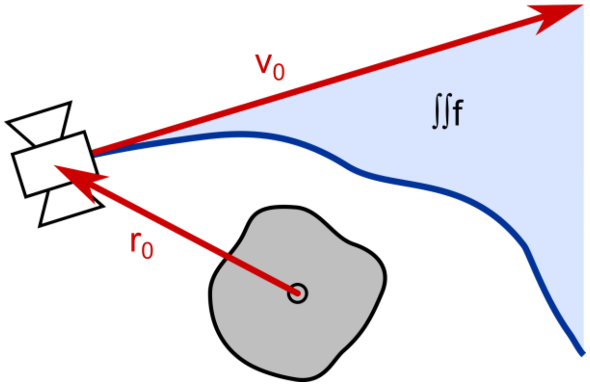




Orbit integration

Elliptical reference orbit replaces linear motions:

- Improved force model integration for dynamic orbit computation (Encke’s method)
- Reduced processing artifacts in adjusted SST observations and residuals



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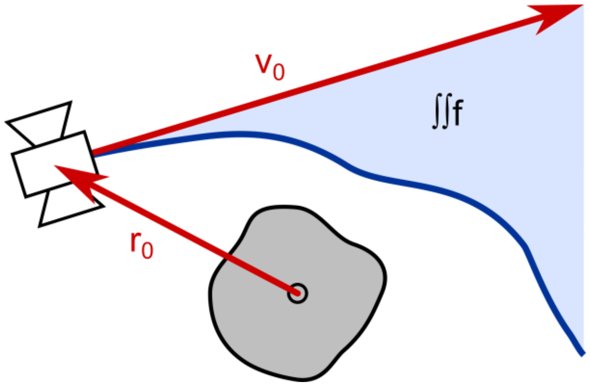

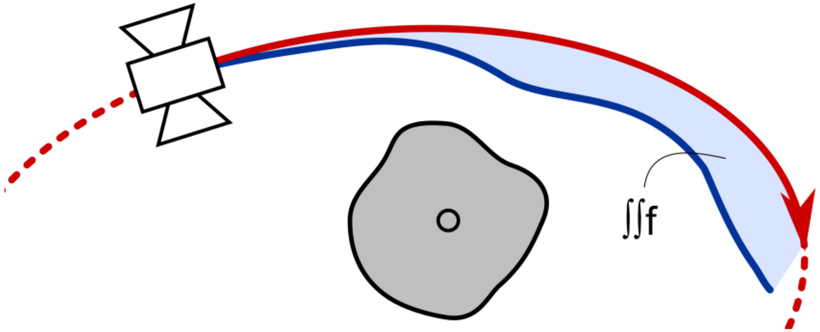

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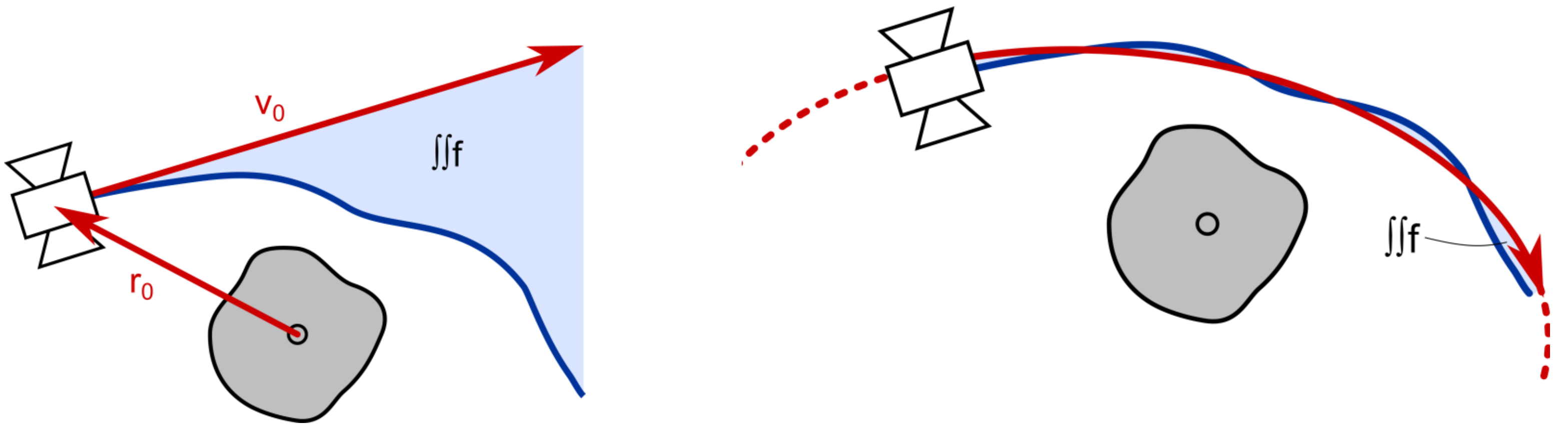

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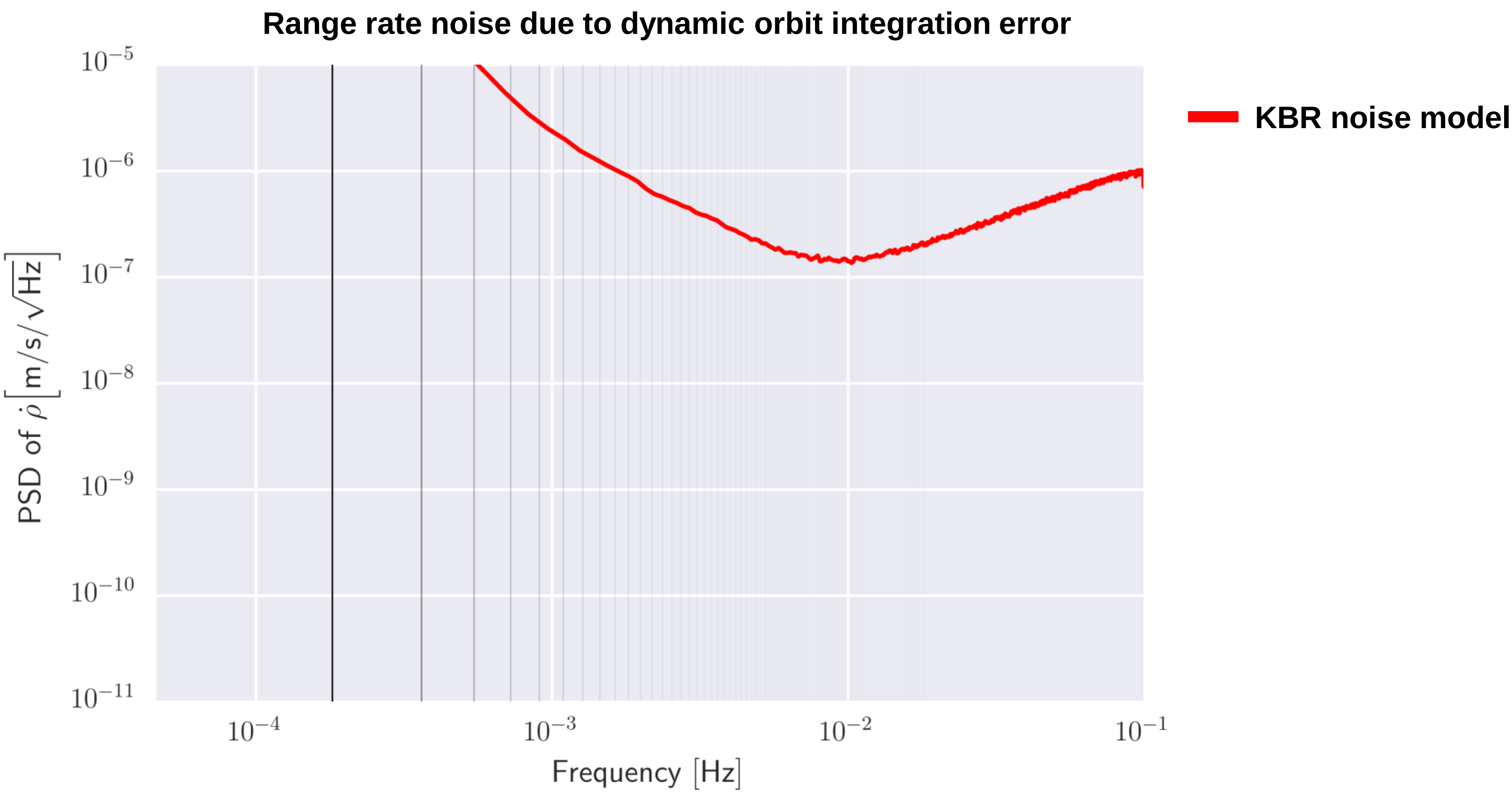

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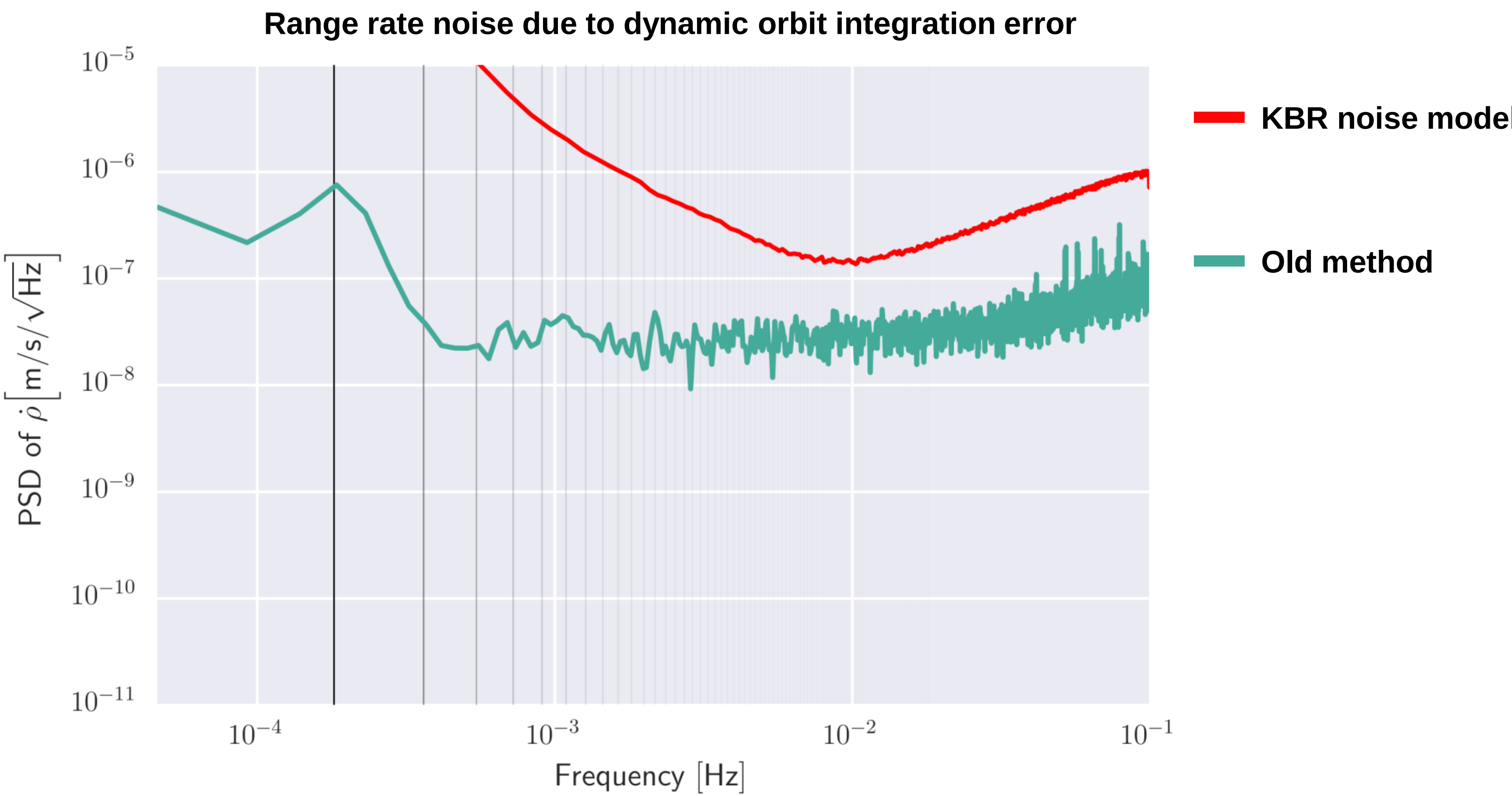

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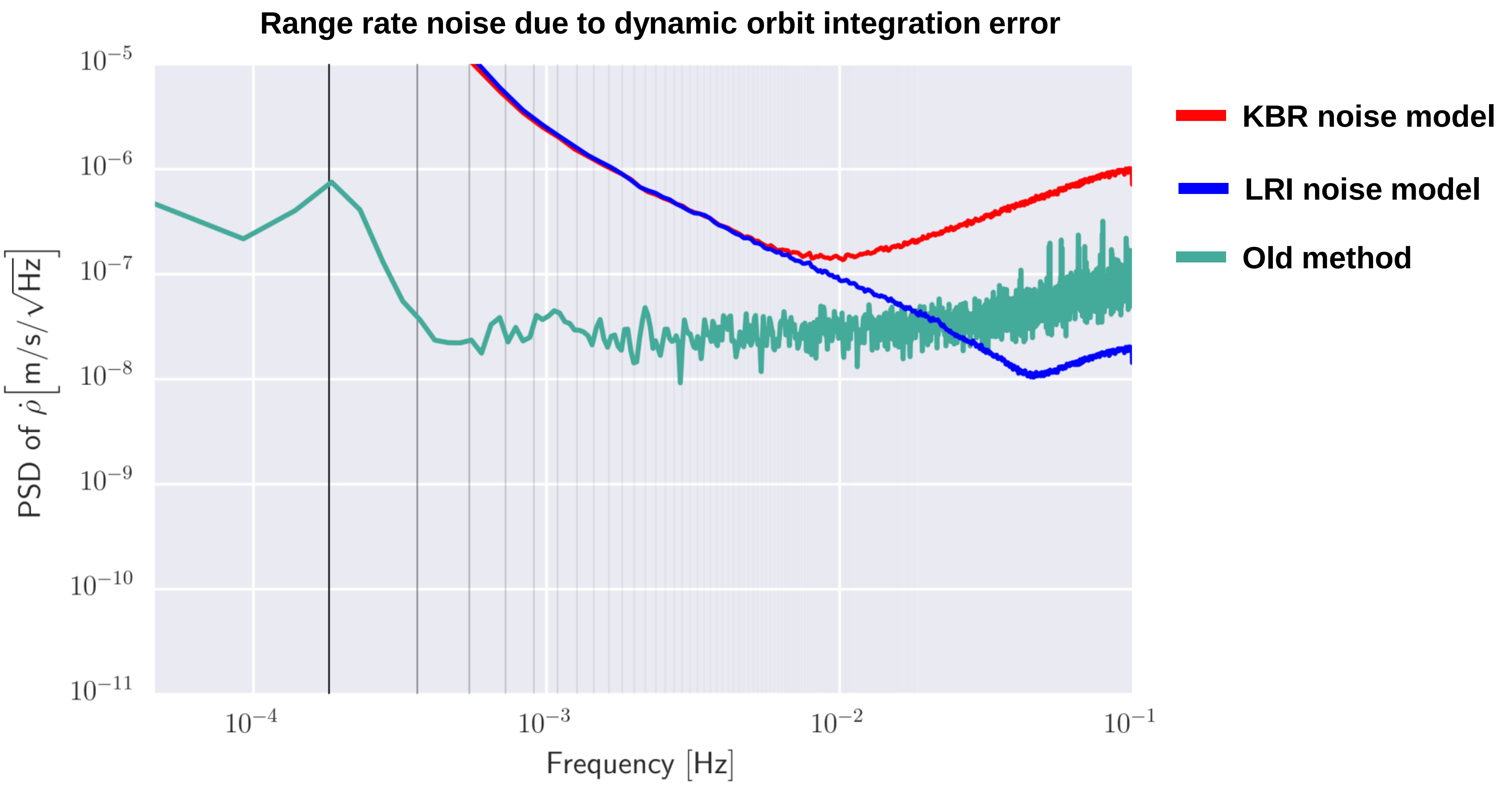

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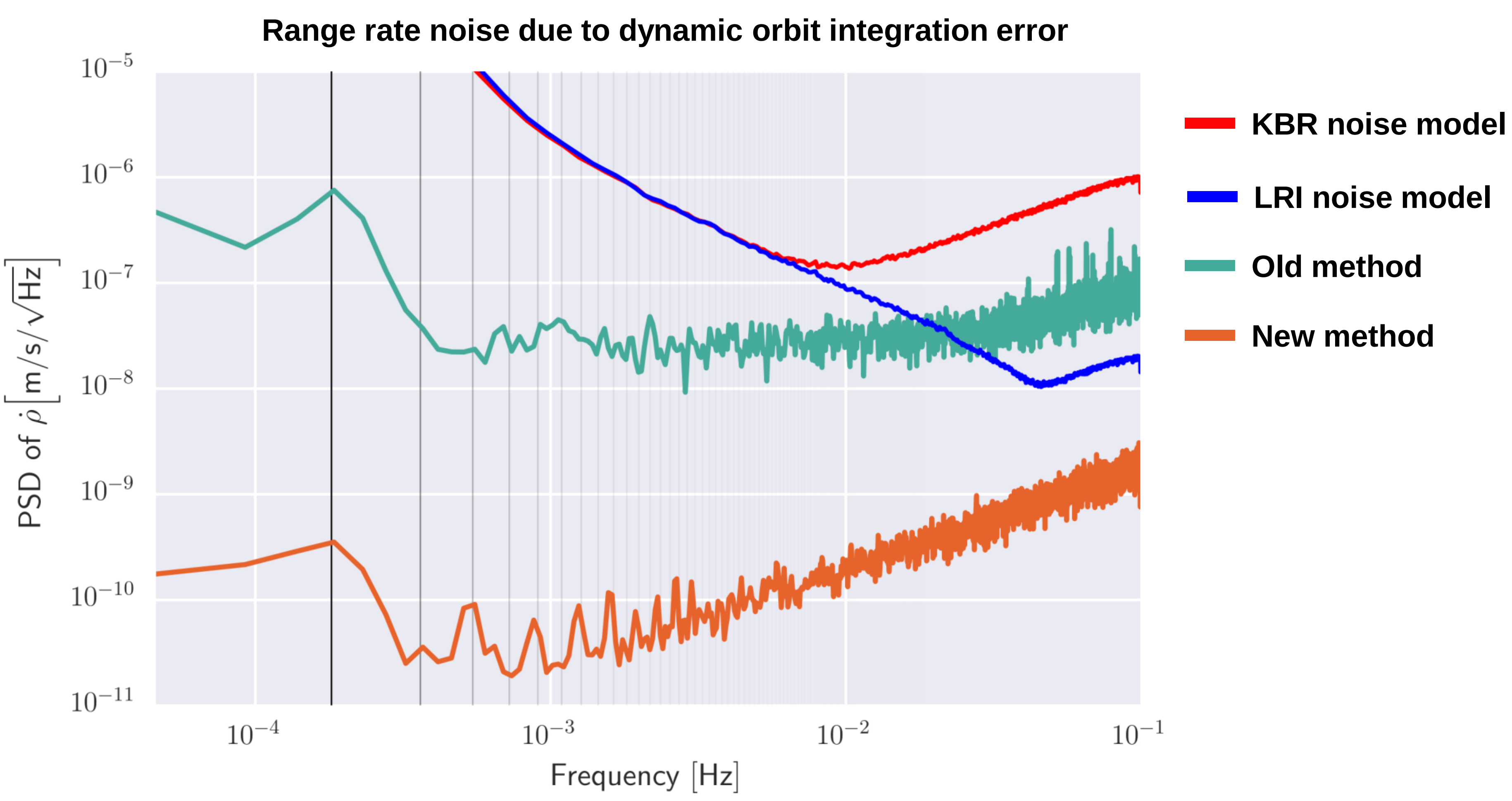

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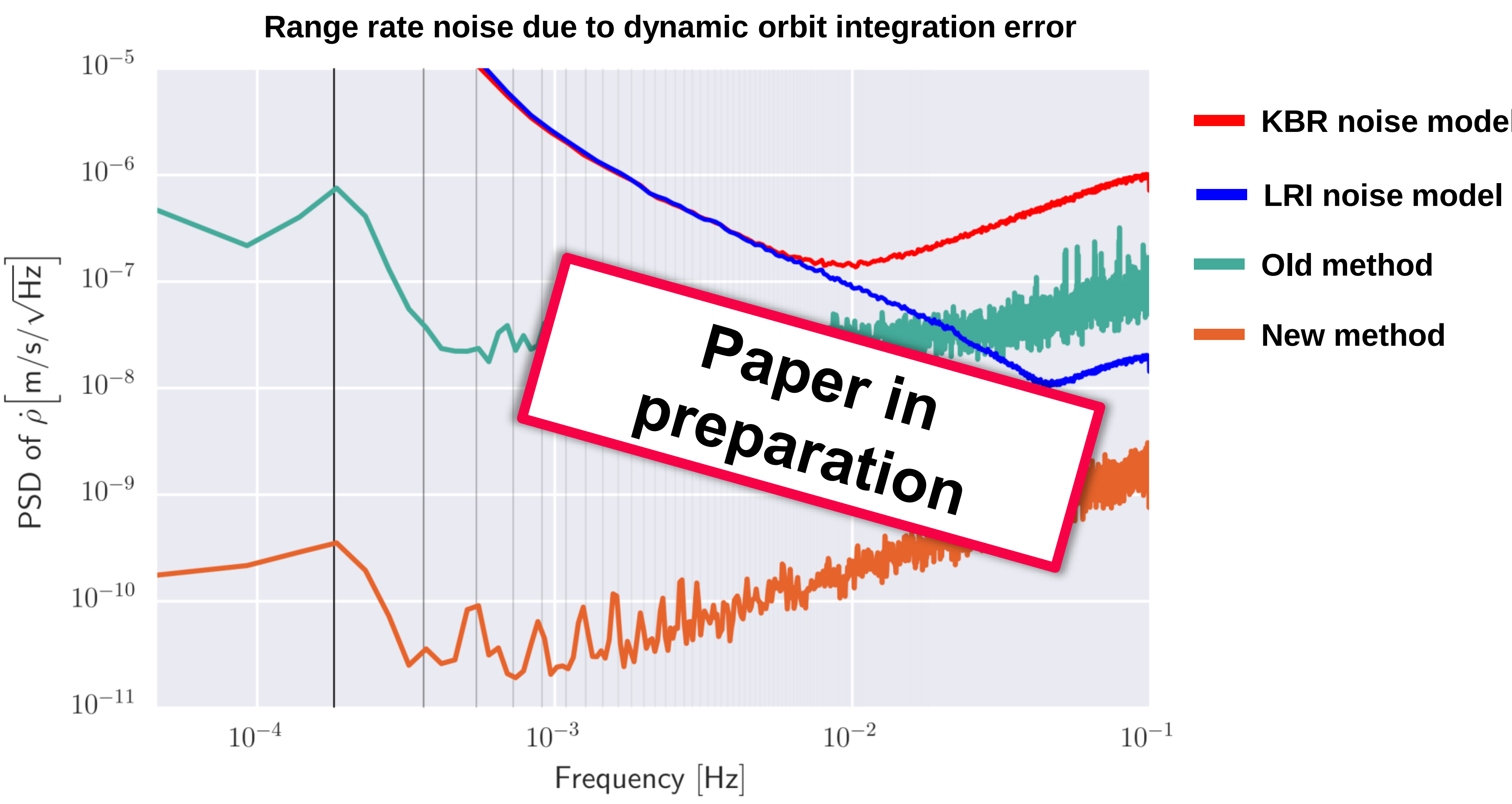
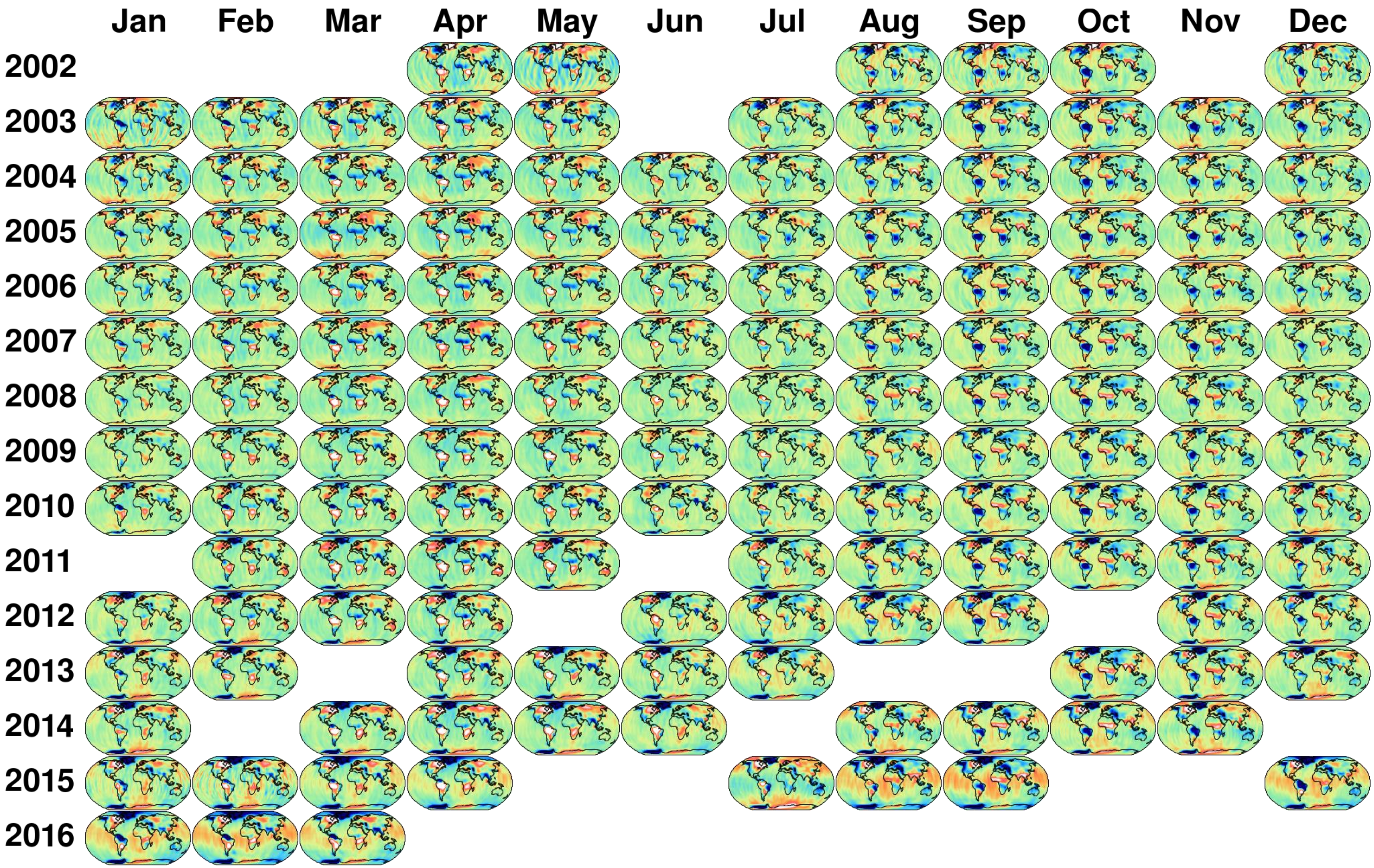


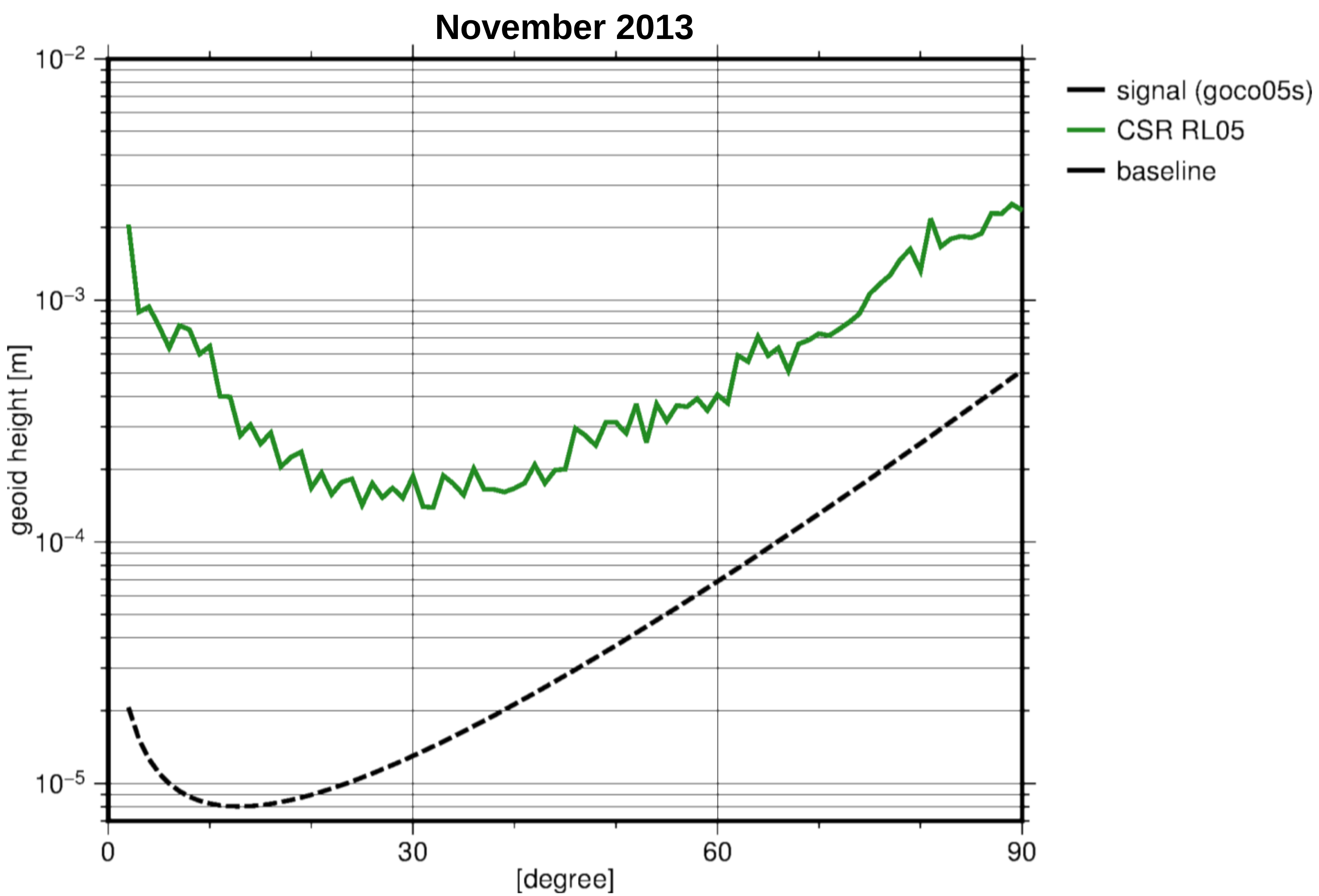
Unconstrained monthly solutions

ITSG-Grace2016 Monthly Solutions



ITSG-Grace2016 Monthly Solutions

Unconstrained monthly solutions: degree 90 comparison



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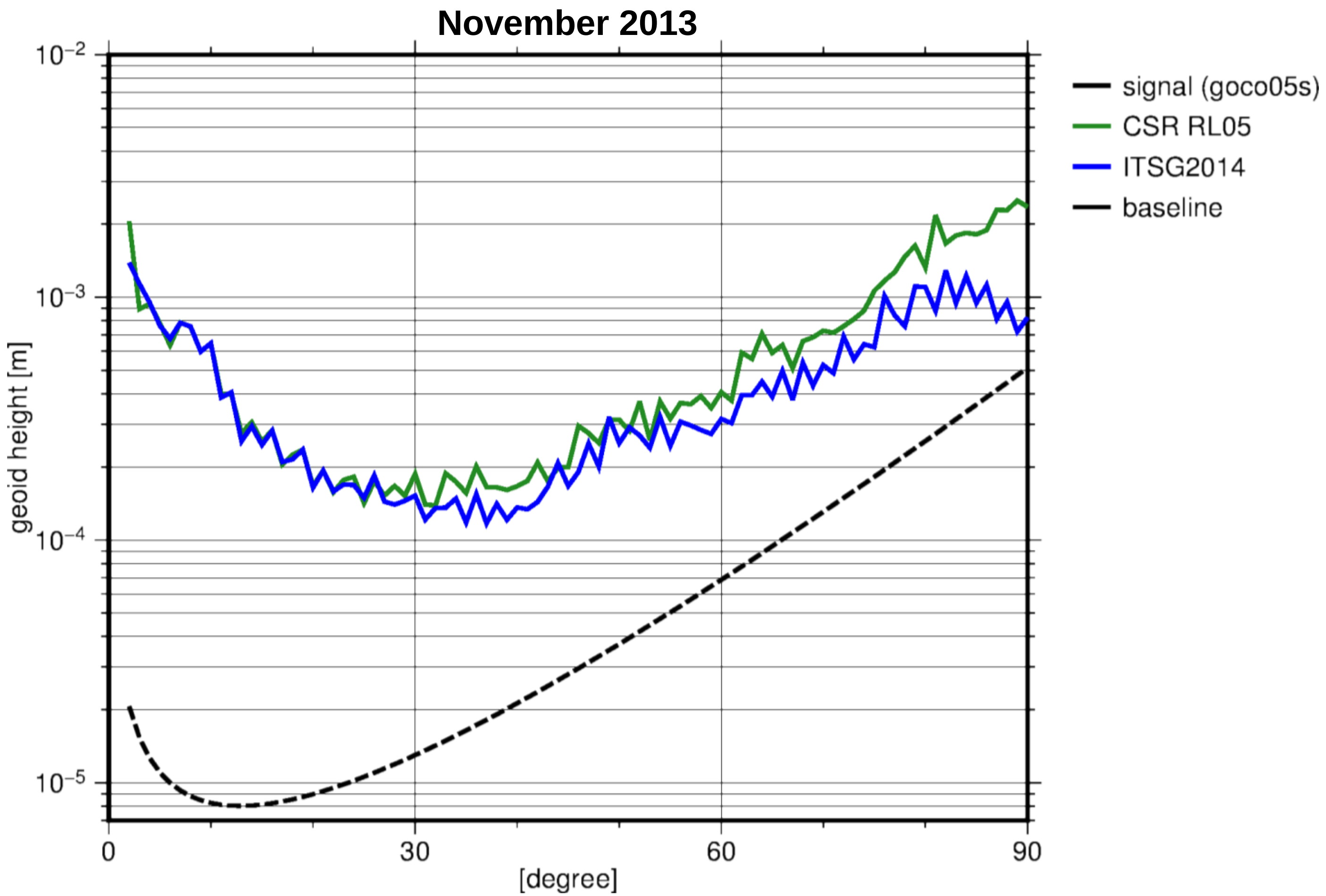

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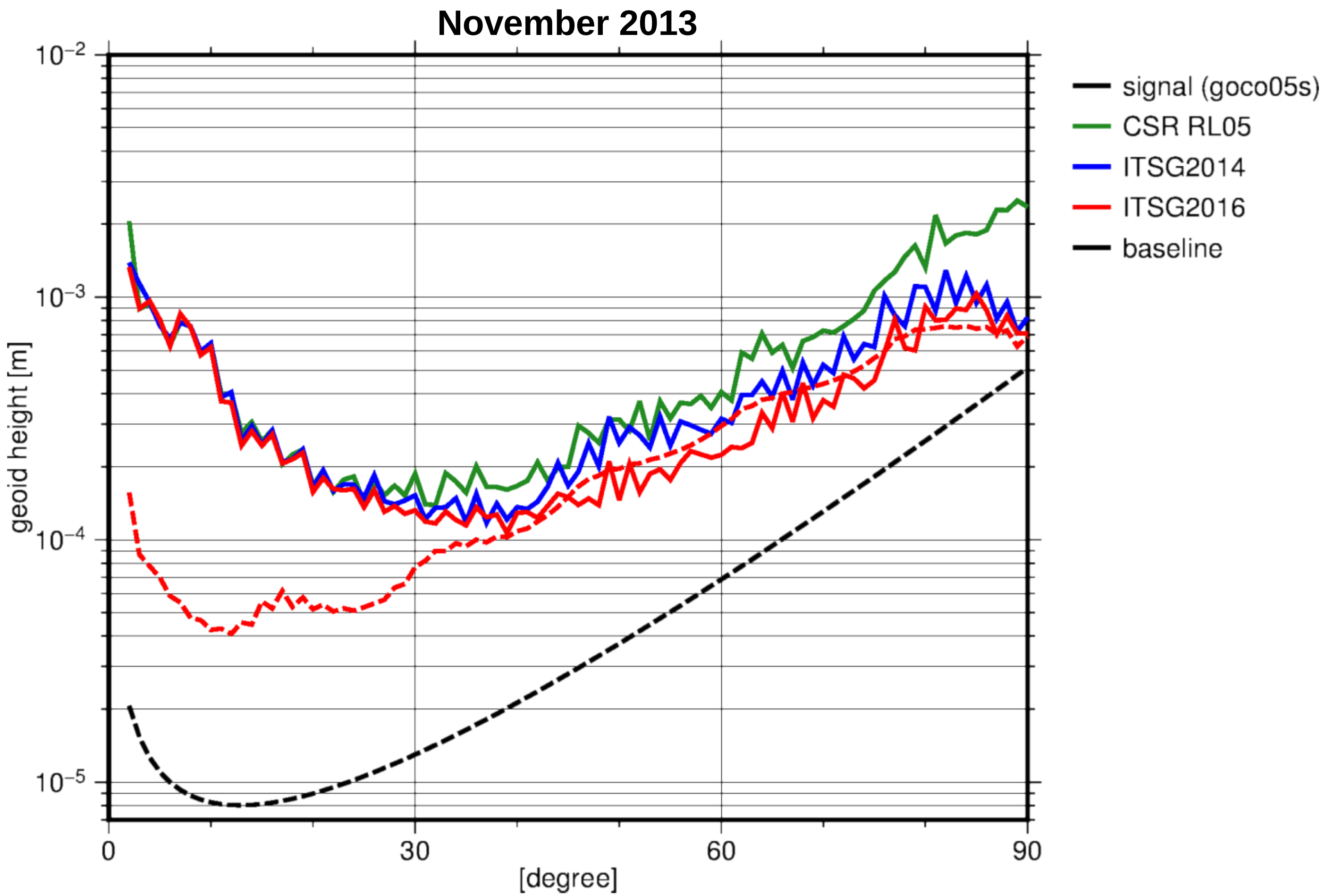

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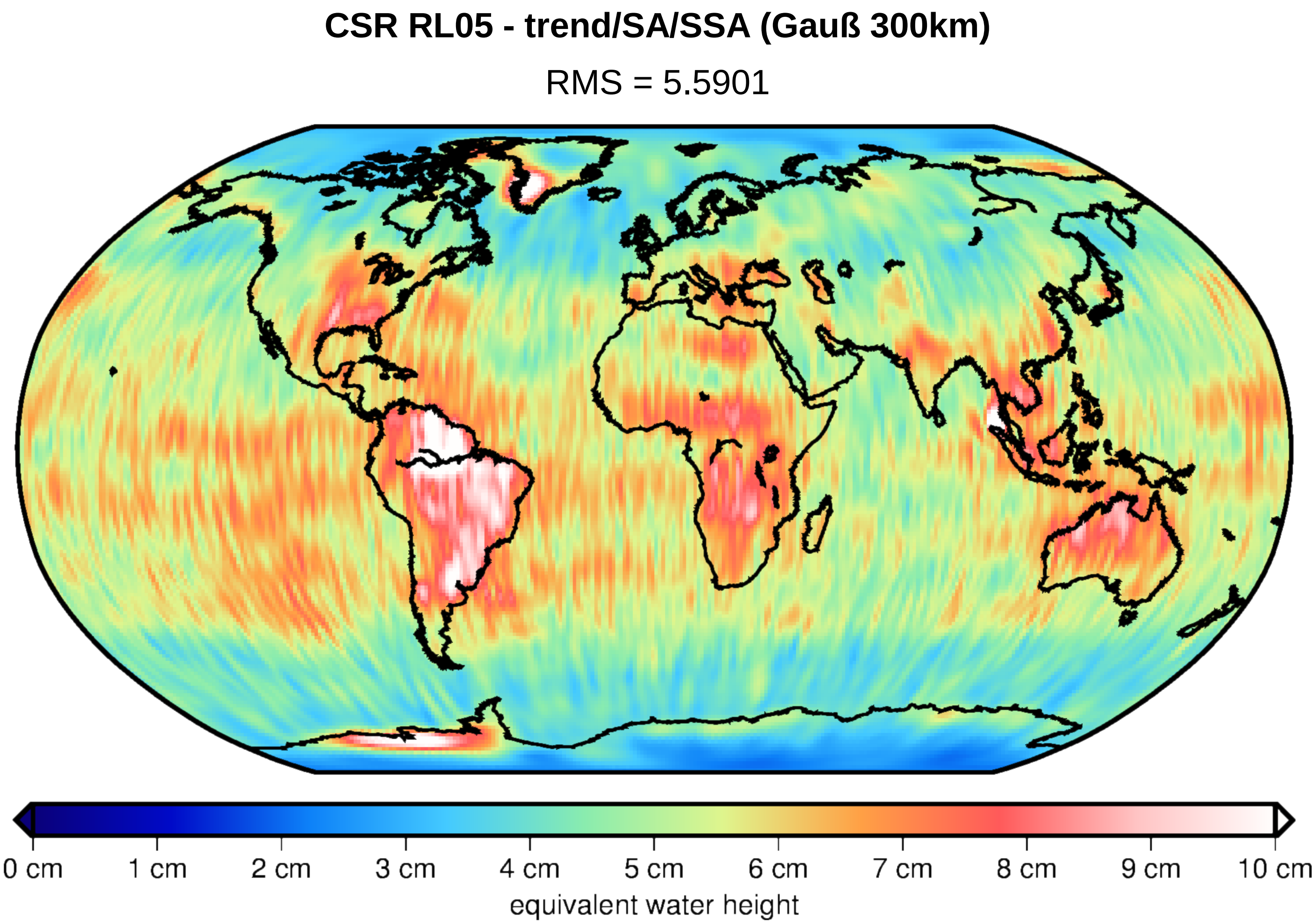
Temporal RMS



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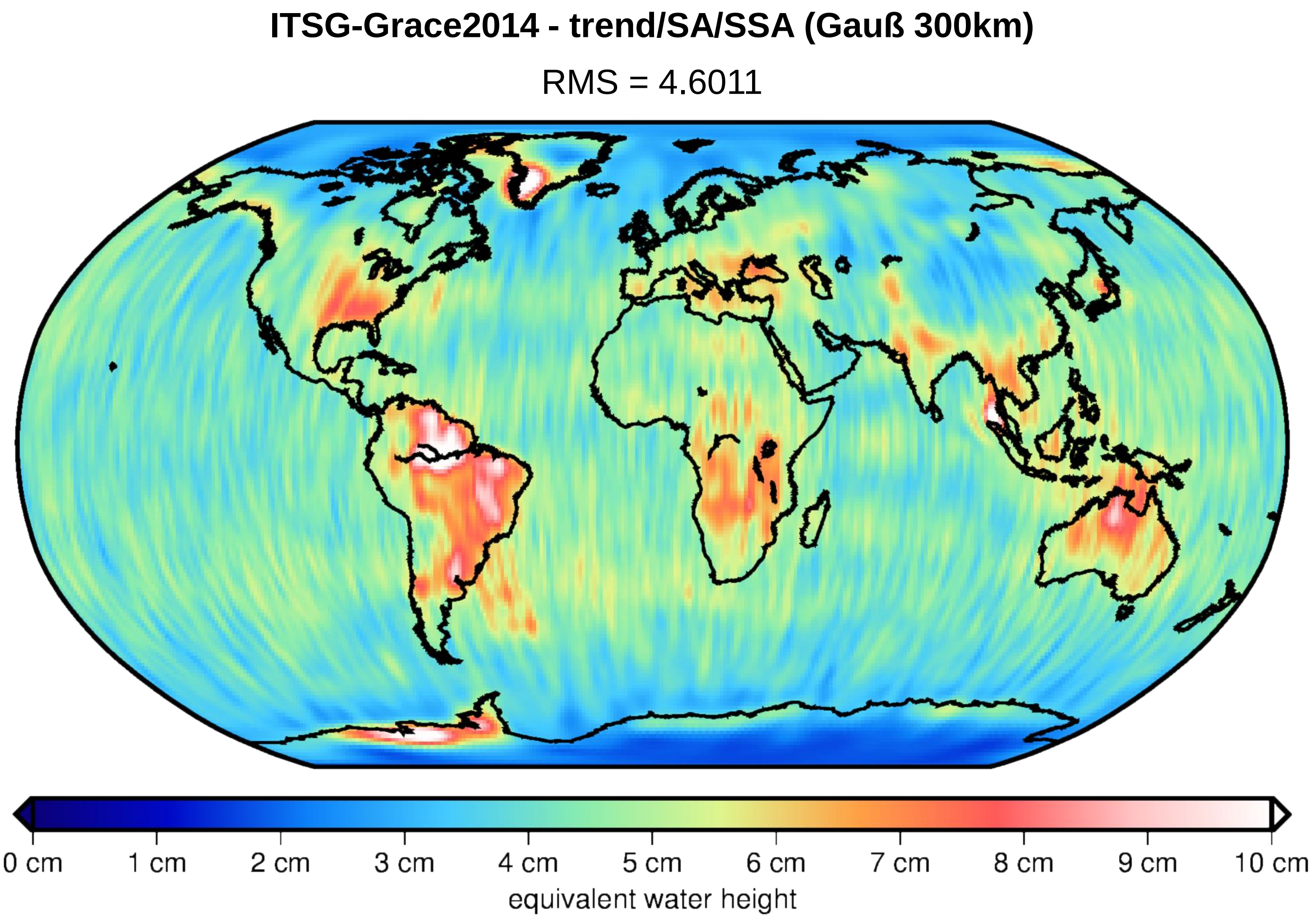

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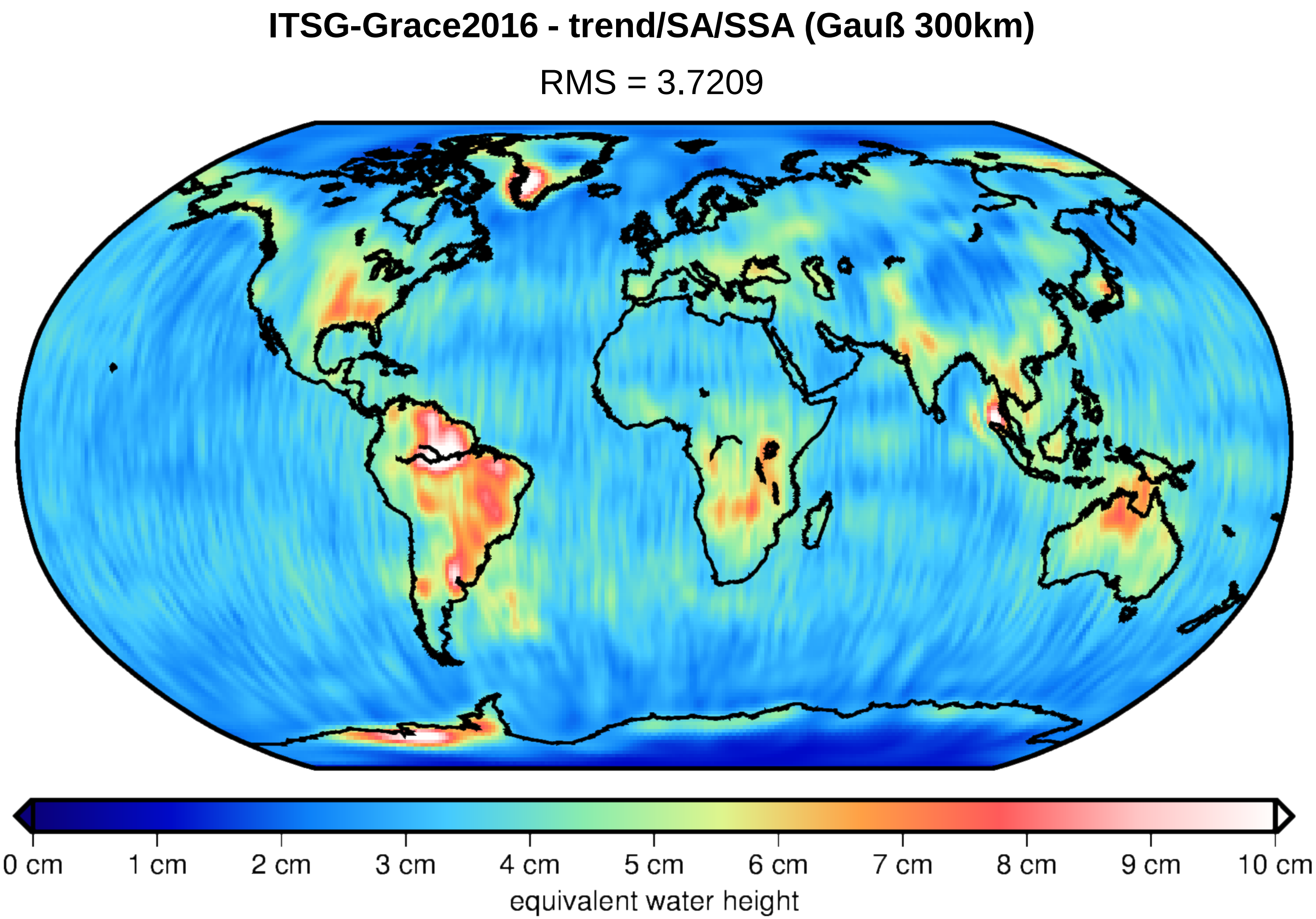
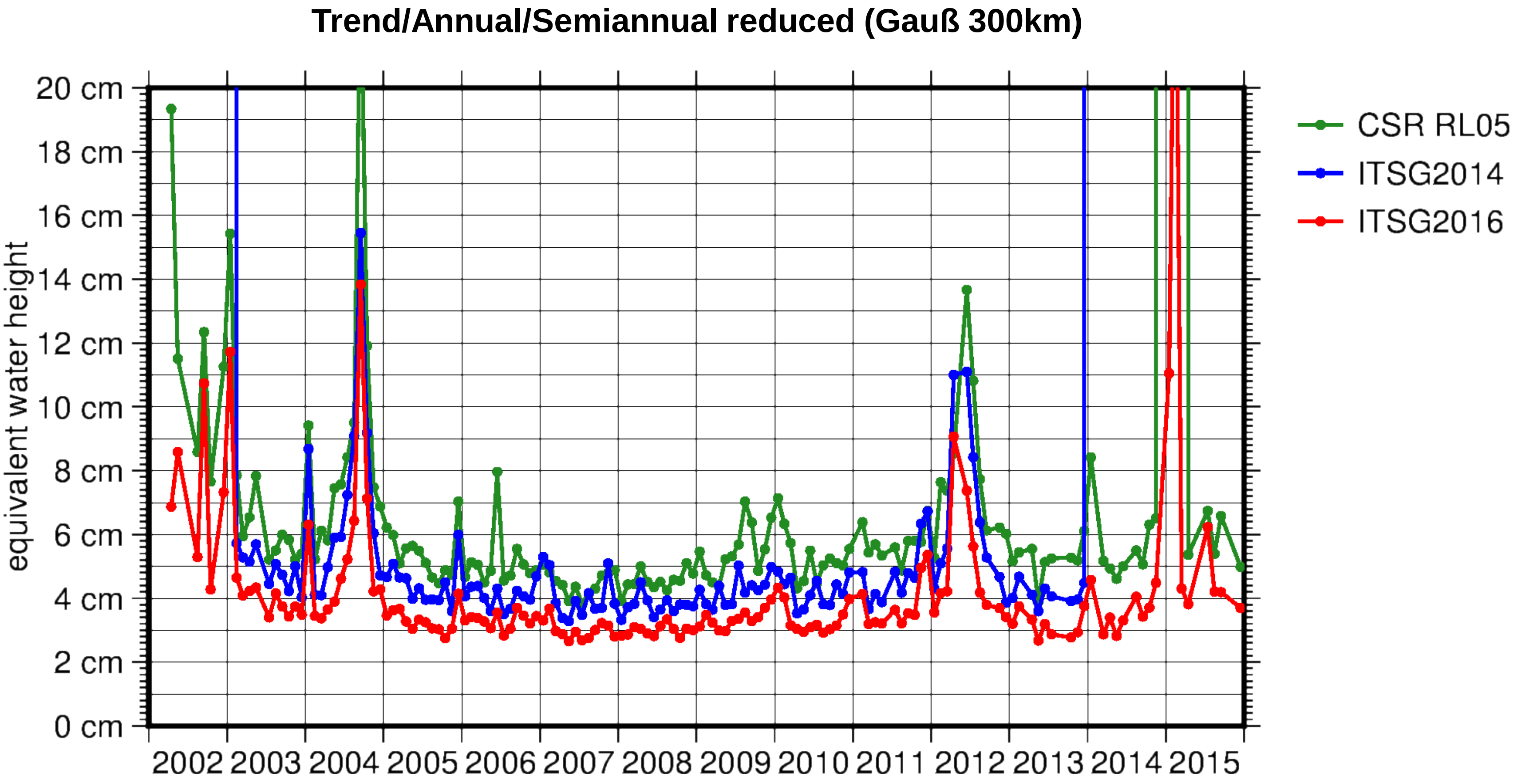


Variability over the Oceans



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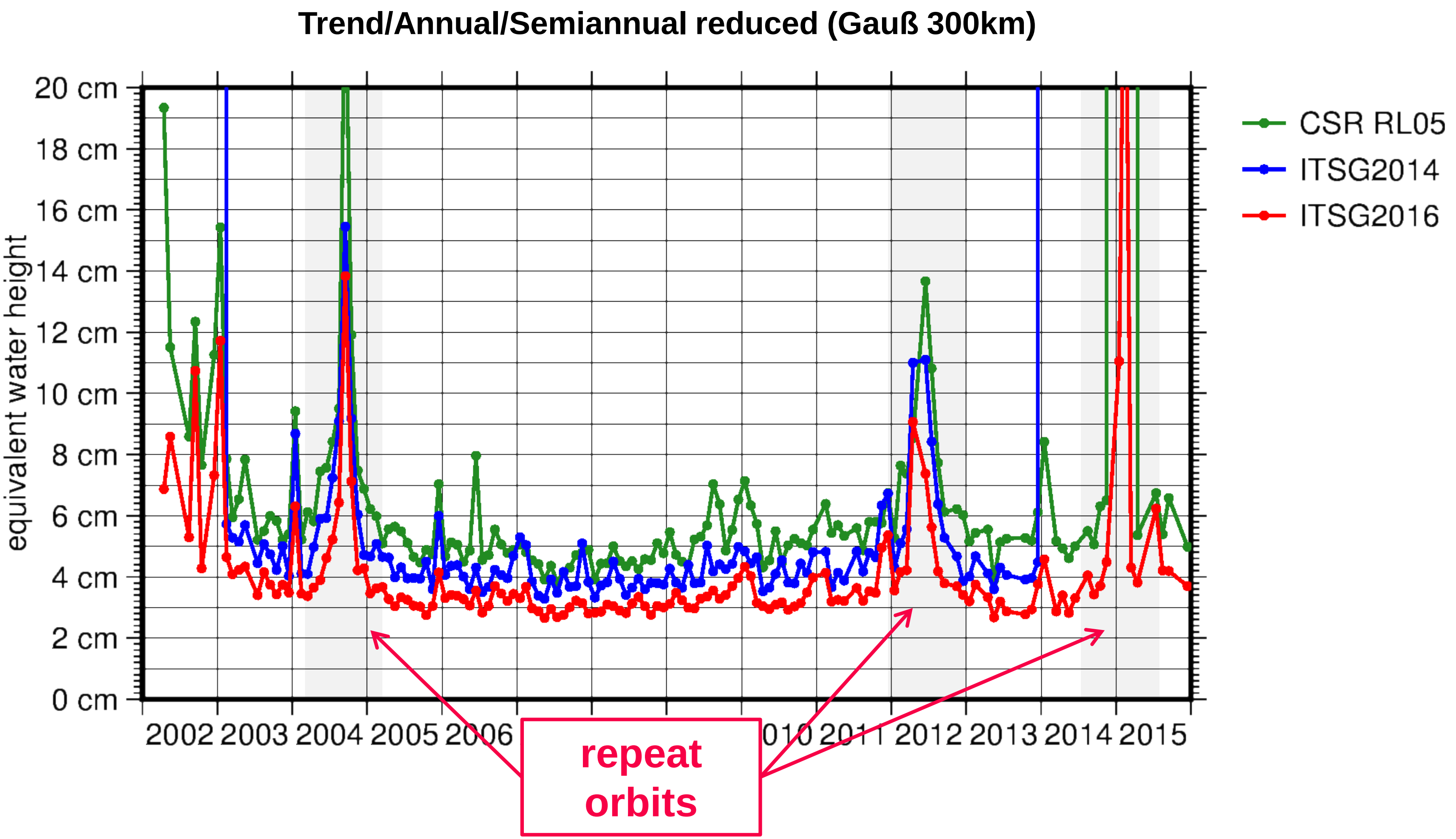

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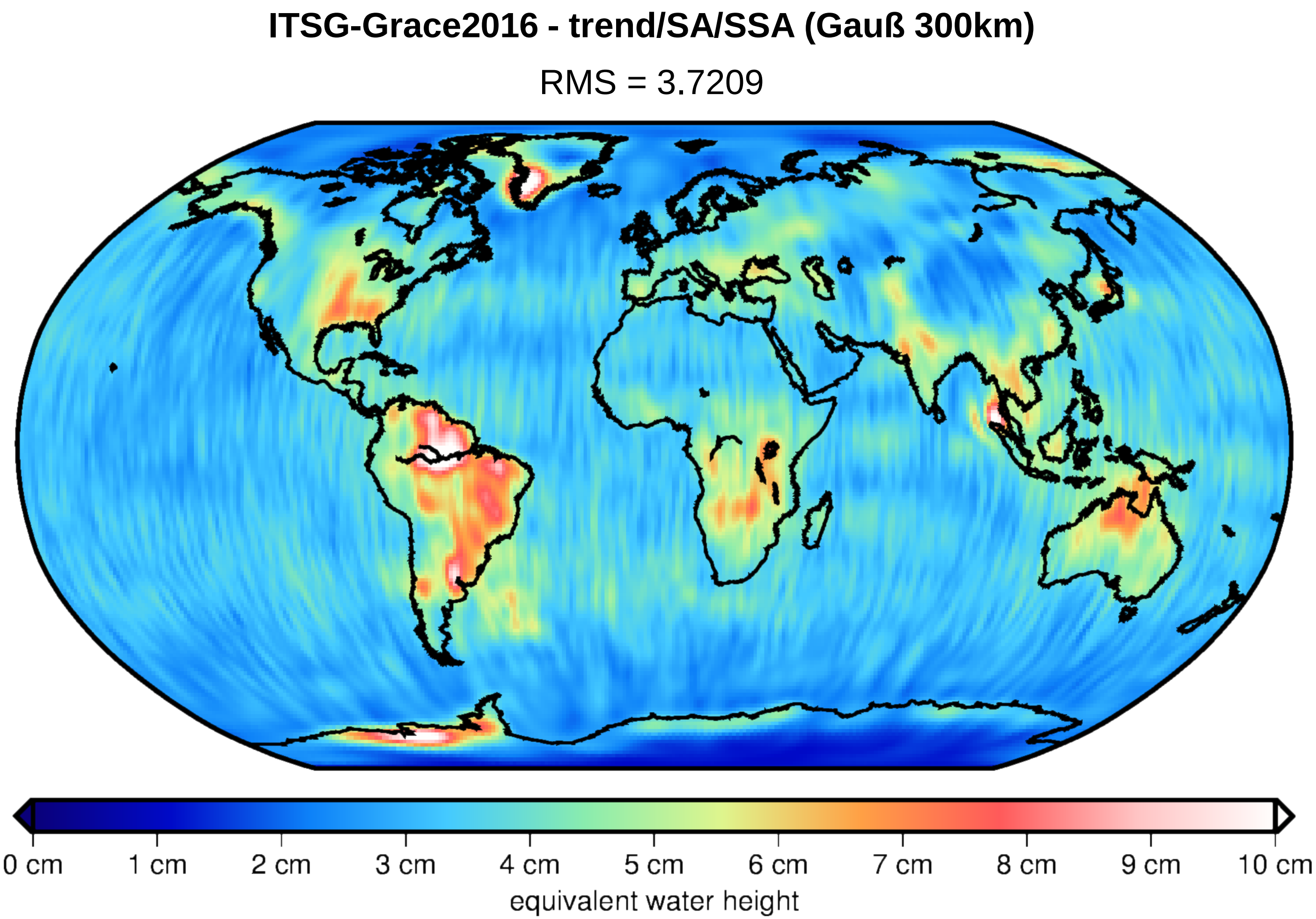
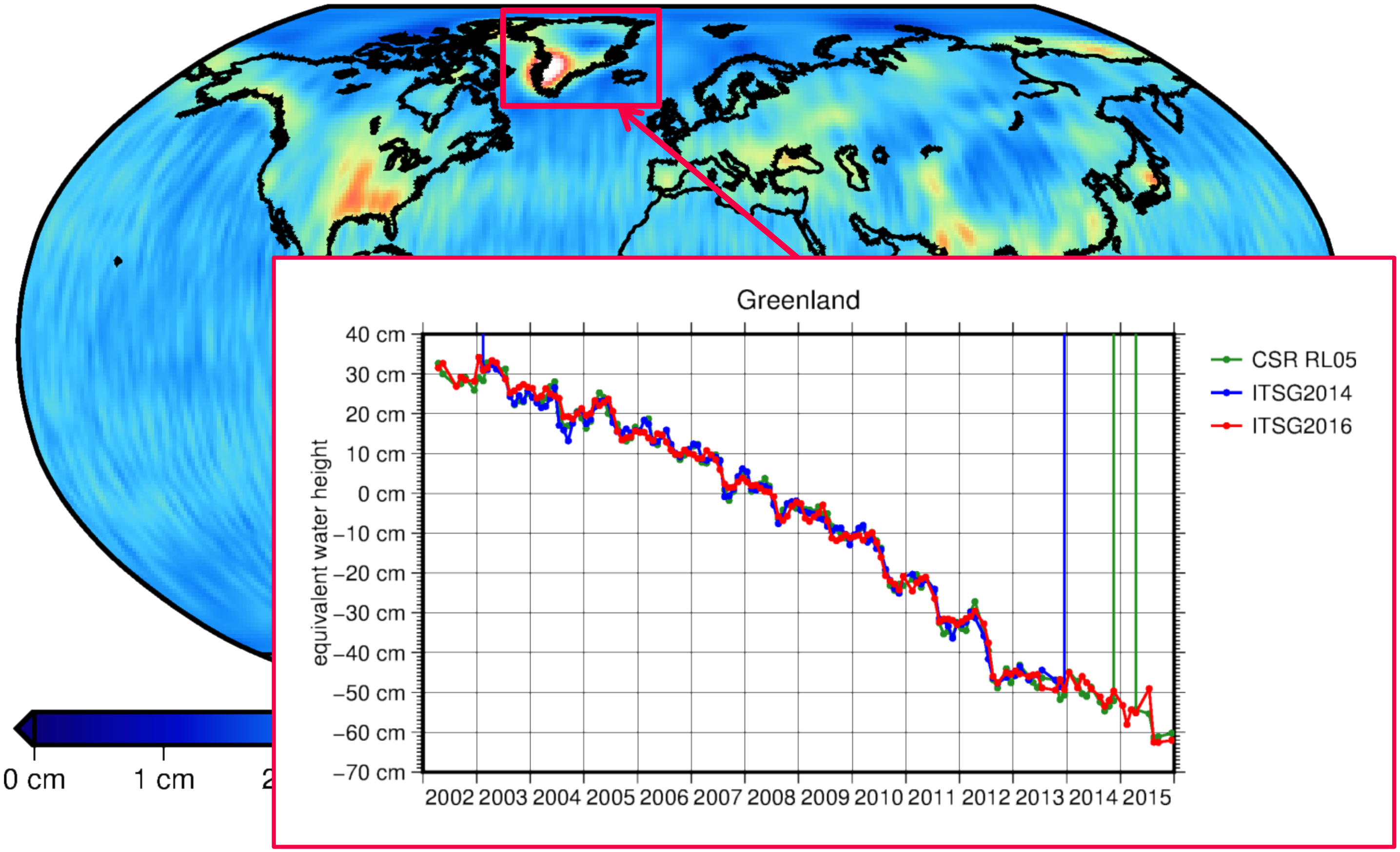


Comparison of signals

ITSG-Grace2016 - trend/SA/SSA (Gauß 300km)

RMS = 3.7209



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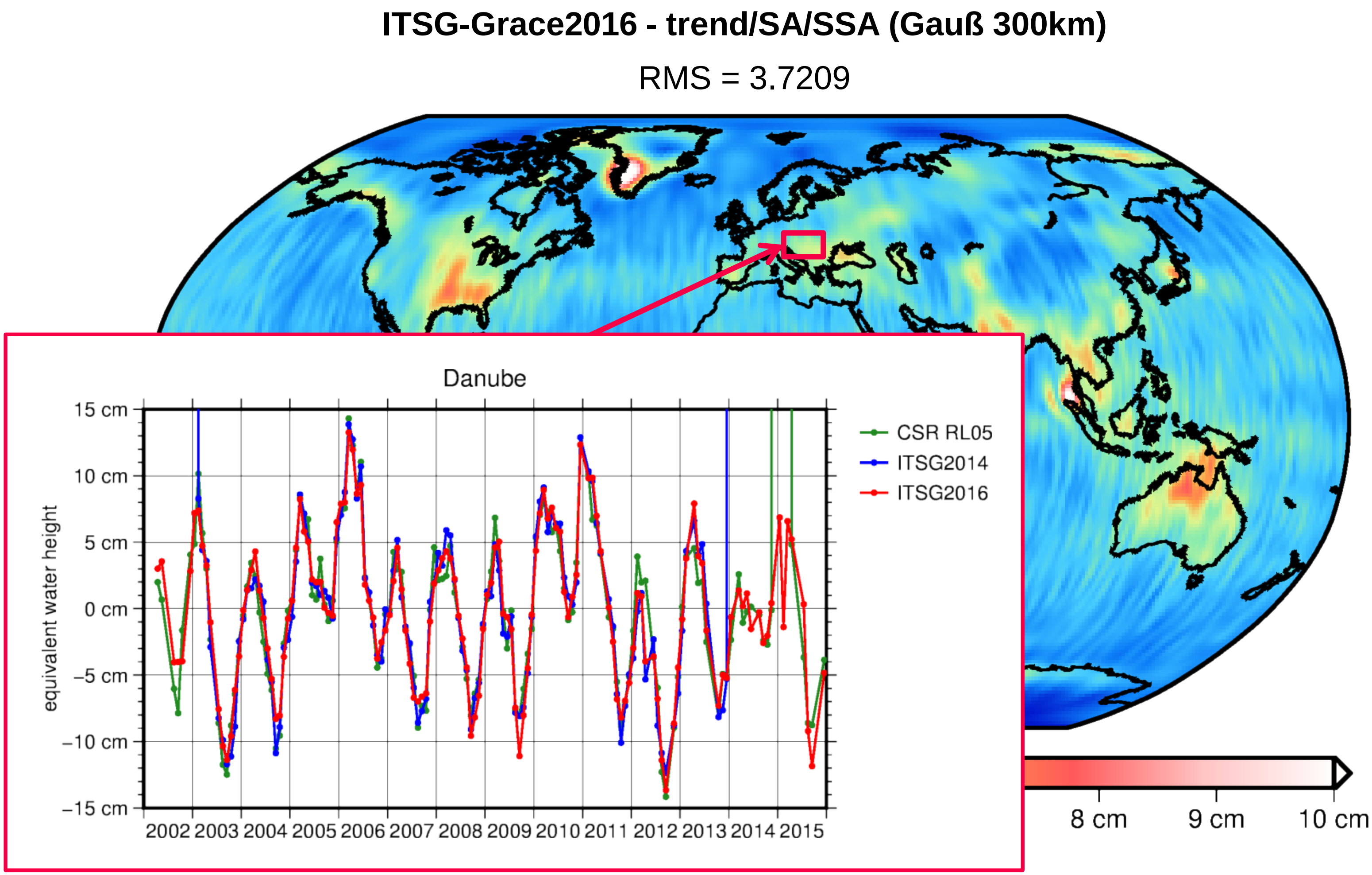

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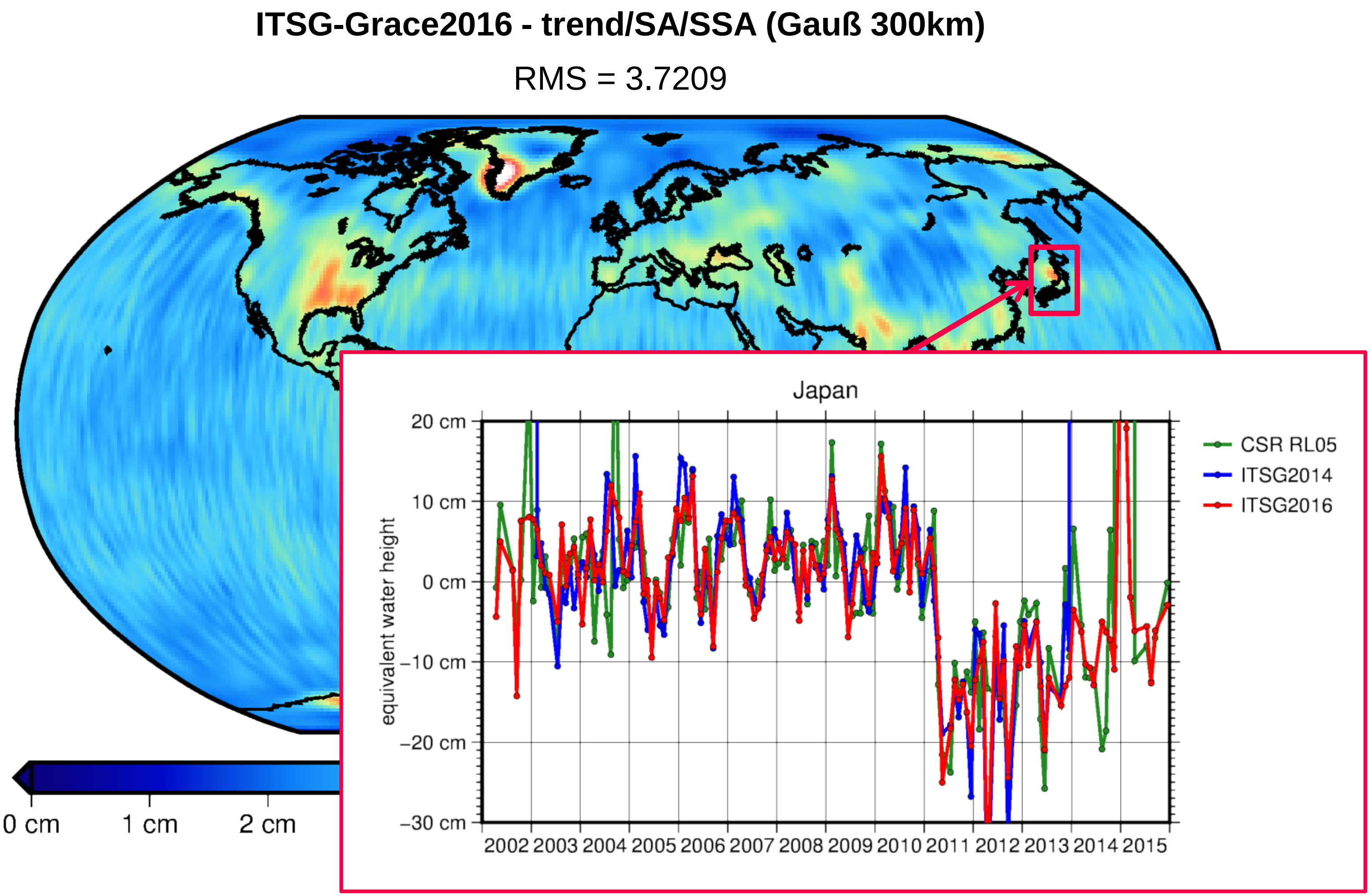

Conclusions

ITSG-Grace2014 vs. ITSG-Grace2016:

- Improved processing and updated models contribute to overall accuracy of monthly gravity field solutions
- Noise reduction w.r.t. ITSG-Grace2014 on the order of
  - 20% for n=15-25
  - 40% for n=25-40
  - 25% for n=40-90
- Fully-populated scale factor matrix significantly improves C20 coefficient

ITSG-Grace2016

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- Full normal equations in SINEX format are published

Daily Kalman smoothed solutions:

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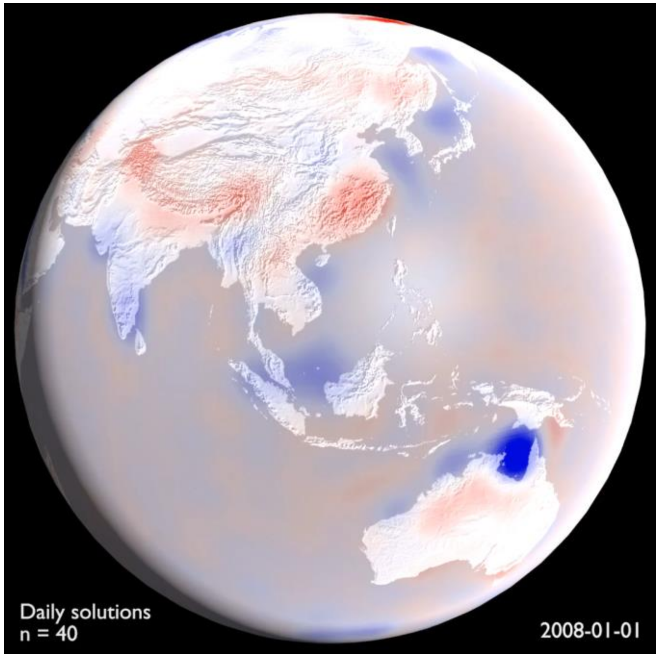

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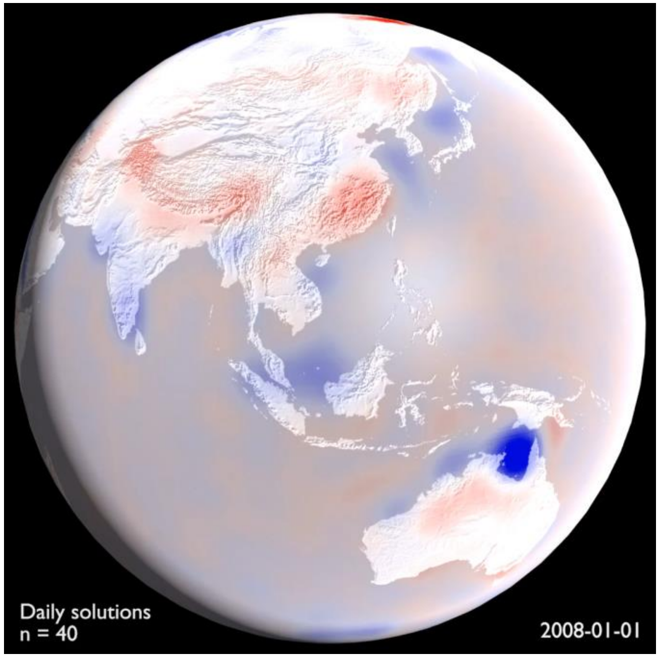

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ITSG-Grace2016 Release available at:

ifg.tugraz.at/ITSG-Grace2016

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HORIZON 2020