

GRACE-FO processing at IfE/LUH

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COST-G Team Meeting 2021

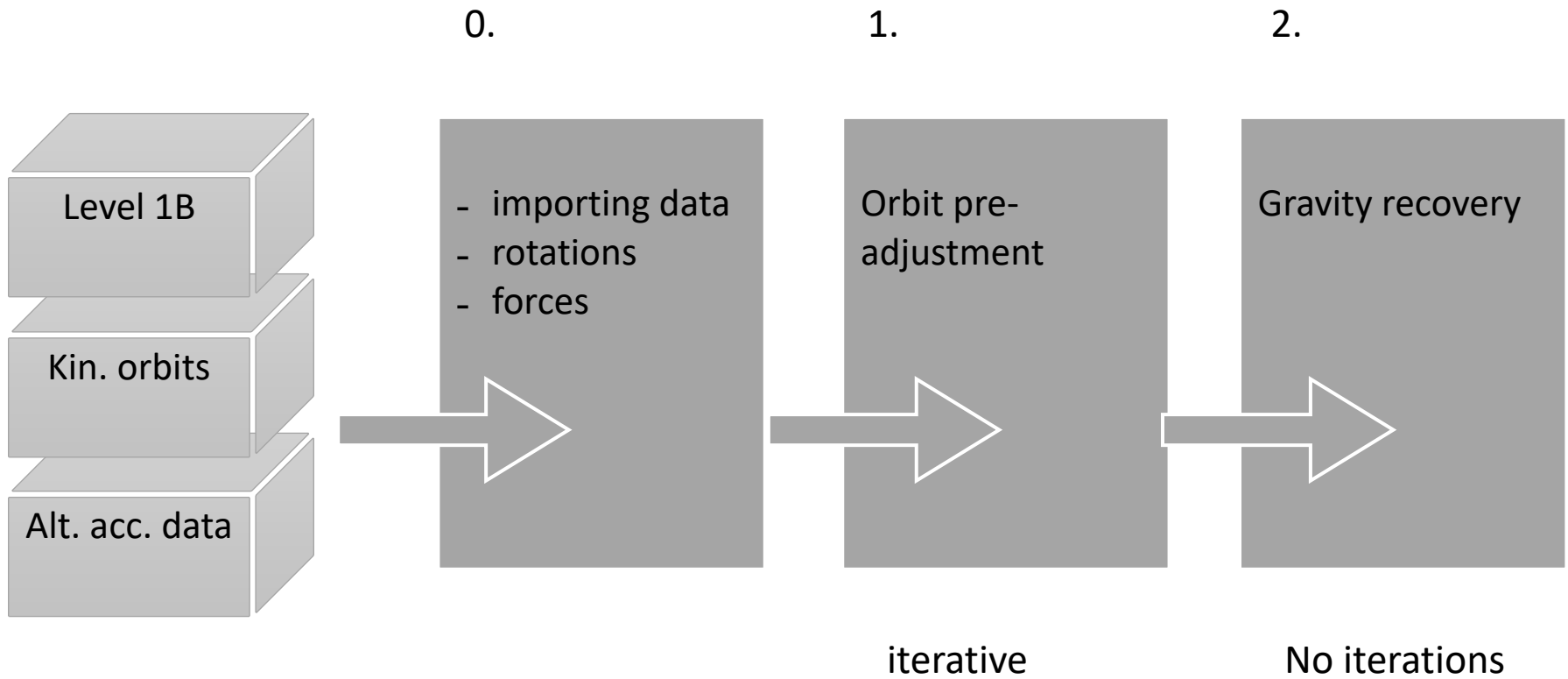
January 11-15, 2021

Online

Gravity field recovery at IfE

- GRACE-SIGMA: software package for gravity field recovery from GRACE and GRACE-FO sensor data
- Generalized dynamic orbit determination (variational equations approach)
- Initially all-MATLAB software [Naeimi et al., 2018]
- Several parts of the software converted to C/C++
- Mostly vectorized and parallelized
- Computation time one solution: app. 3.5 h (18 cores, 128 GB)

Overview



Force modeling

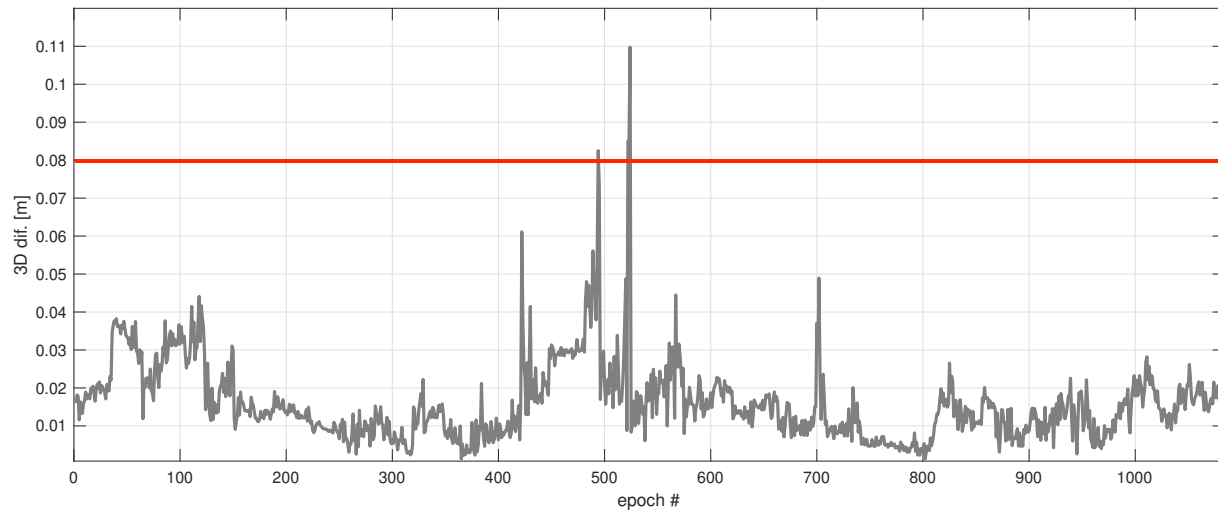
Effect	Model	Reference
Gravity field	GOCO06s (d/o: 300)	Kvas et al., 2020
Third bodies	Moon, Sun, Planets, Ephemerides: DE431	Folkner et al., 2014
Solid Earth tides	IERS Conventions 2010	Petit a. Luzum, 2010
Ocean tides	FES2014b	Carrere et al., 2015
Solid Earth pole tides	IERS Conventions 2010	Petit a. Luzum, 2010
Ocean pole tides	IERS Conventions 2010	Petit a. Luzum, 2010
Relativistic	IERS Conventions 2010	Petit a. Luzum, 2010
Non-tidal	AOD1B RL06	Dobslaw et al., 2017
Atmospheric tides	AOD1B RL06	Dobslaw et al., 2017
Non-gravitational	ACT1B (GRACE C) TU Graz accelerometer data (GRACE D)	JPL, 2018 Behzadpour, 2020

Observations

- K-band range rates (5 s)
- LRI range rates in following releases
- Kinematic AIUB orbits as pseudo-observations (30 s)

Orbit screening

- Kinematic positions are compared to GNV1B orbit
- Epochs with 3D-difference >8 cm not considered in estimation



Weights

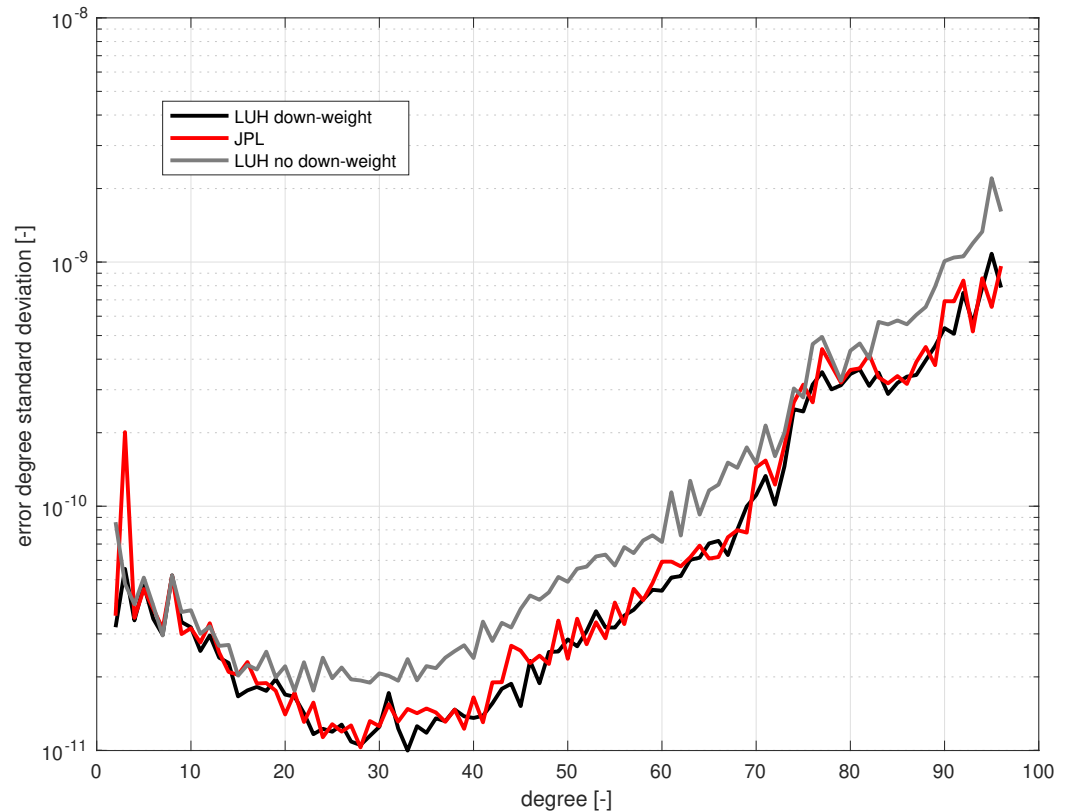
- KBRR:

$$\sigma_{\text{KBRR}} = 2\text{E-}07 \text{ m/s (fixed)}$$

- Kinematic positions:

σ_{Orbit} = diagonal elements of the orbit
covariance matrix (down-weighted by a factor 5)

GPS down-weighting



Parameters

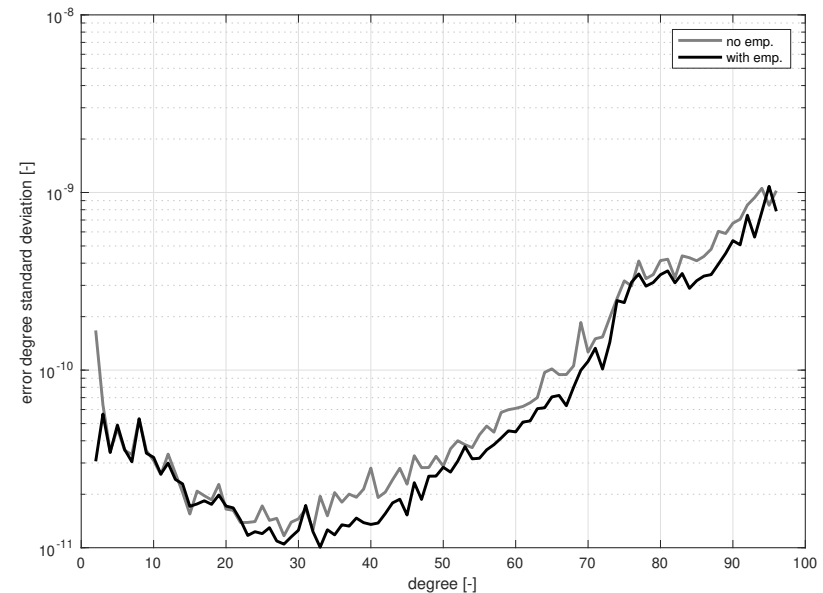
- Per 3h-arc:
 - Initial state
 - Accelerometer biases
 - Empirical parameters [Kim, 2000]

- Per monthly solution:
 - Full scale matrix [Klinger a. Mayer-Gürr, 2016]
 - Gravity potential (d/o: 96)

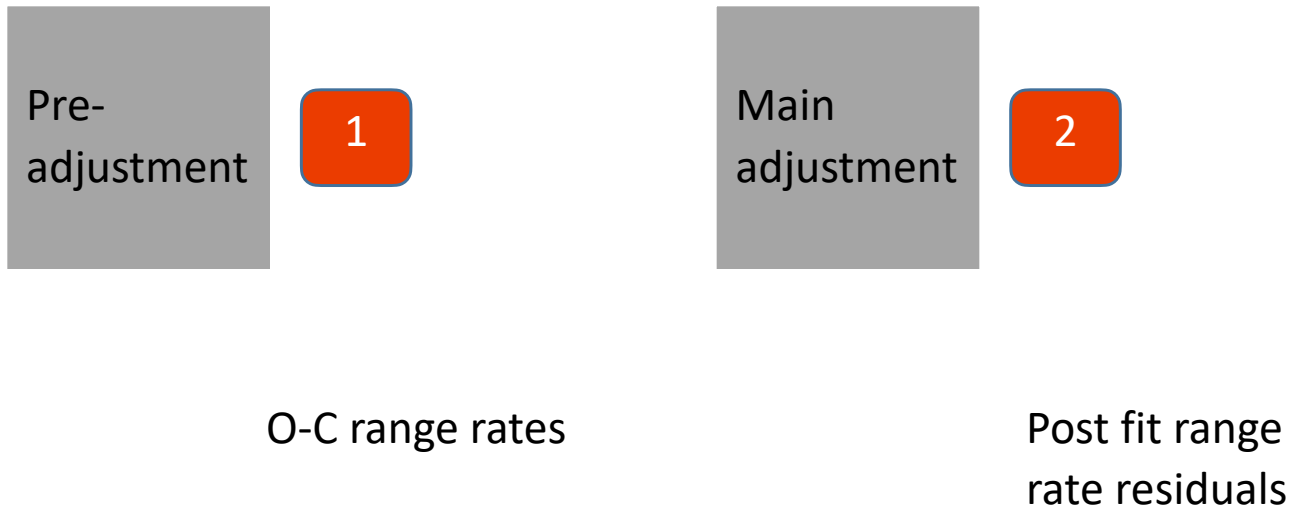
Empiricals

$$\dot{\rho}_o - \dot{\rho}_c = A + Bt + (E + Ft) \cos u + (G + Ht) \sin u$$

- Bias A: 90 min
- Bias rate B: 90 min
- Periodic bias E,F: 3 h
- Periodic bias rate G,H: 3 h

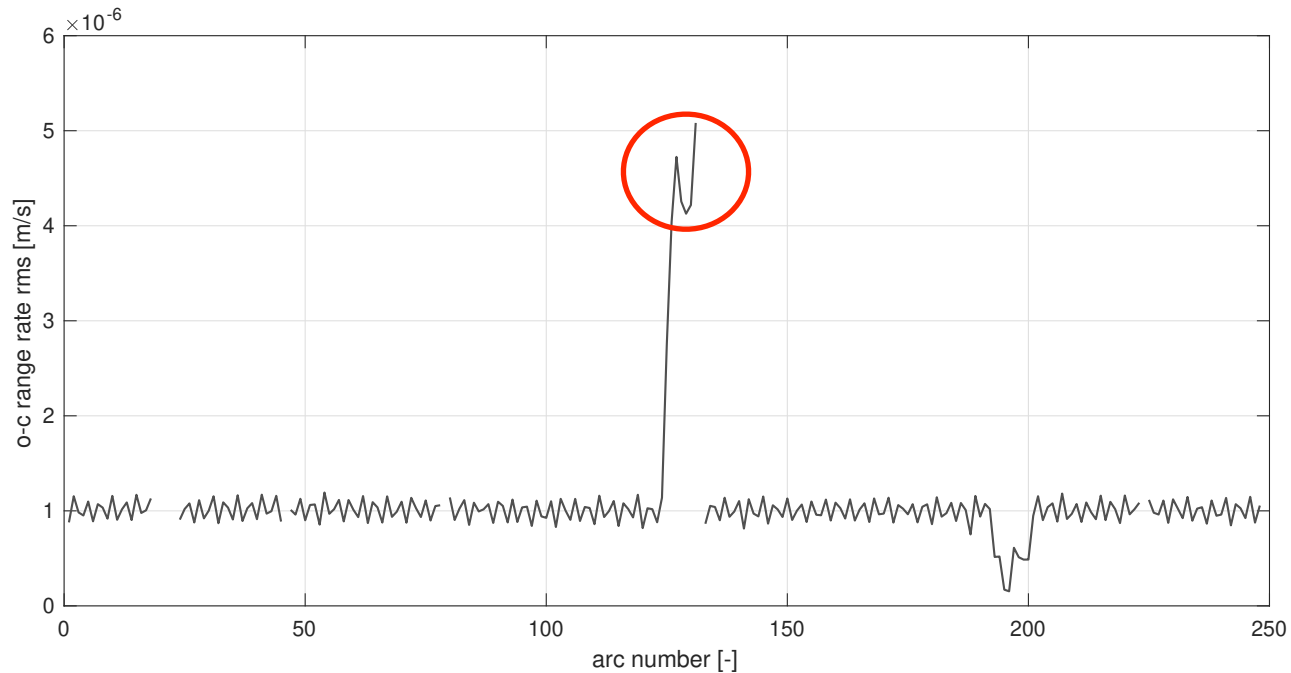


Screening / Outlier detection



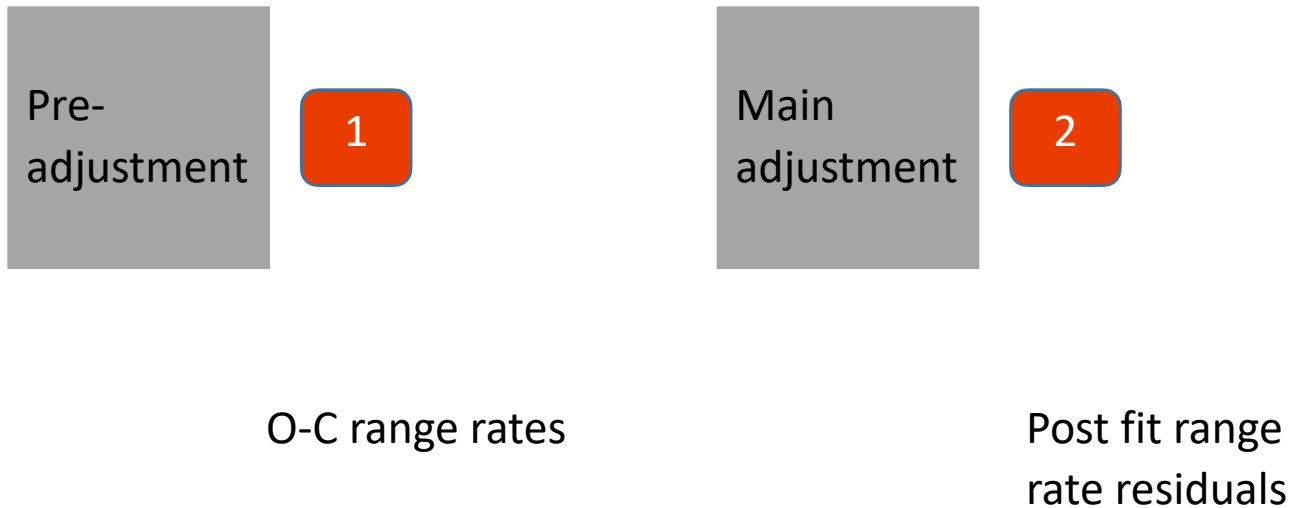
Screening

1



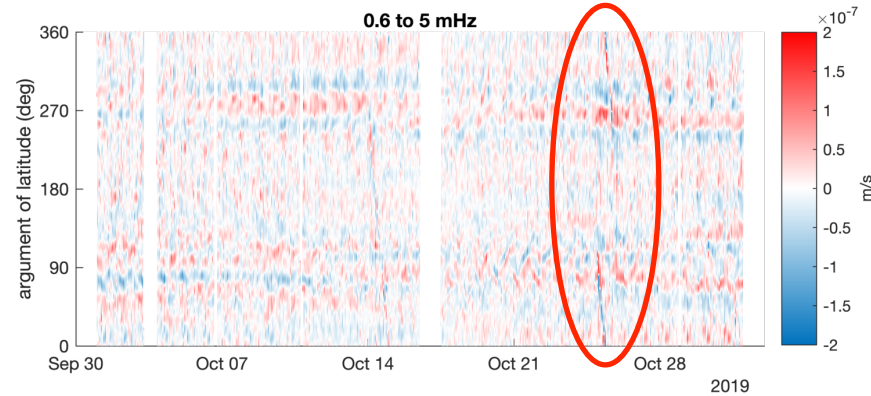
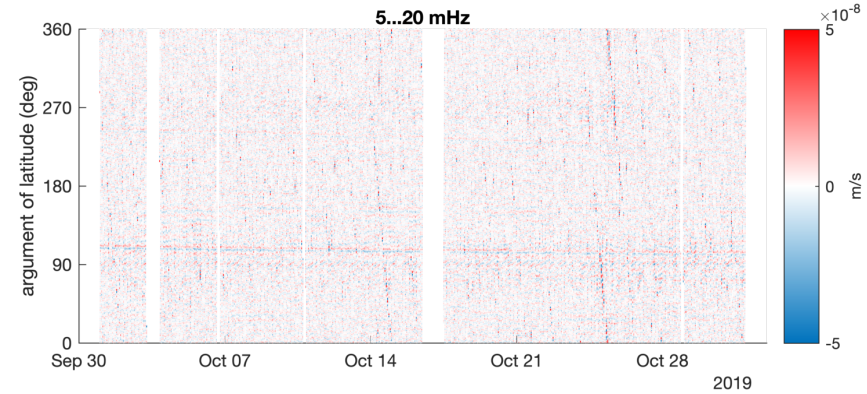
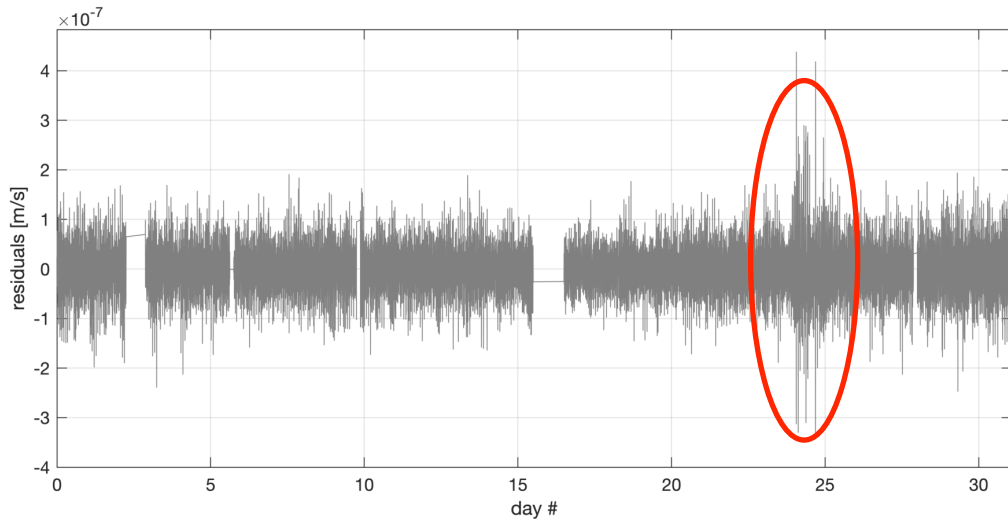
○ Arcs will not be considered in main adjustment

Screening / Outlier detection



Screening

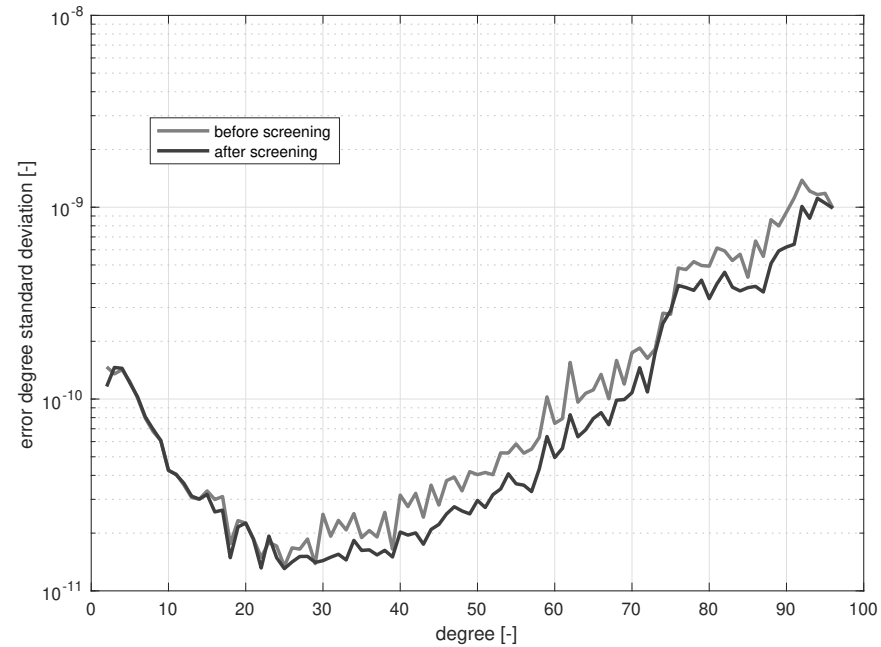
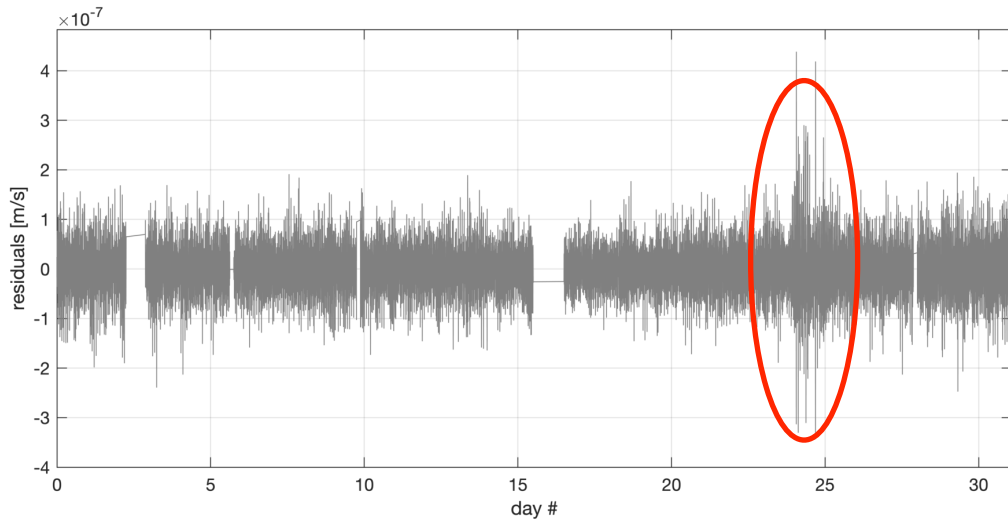
2



- Remove suspicious epochs
- Recompute solution

Screening

2



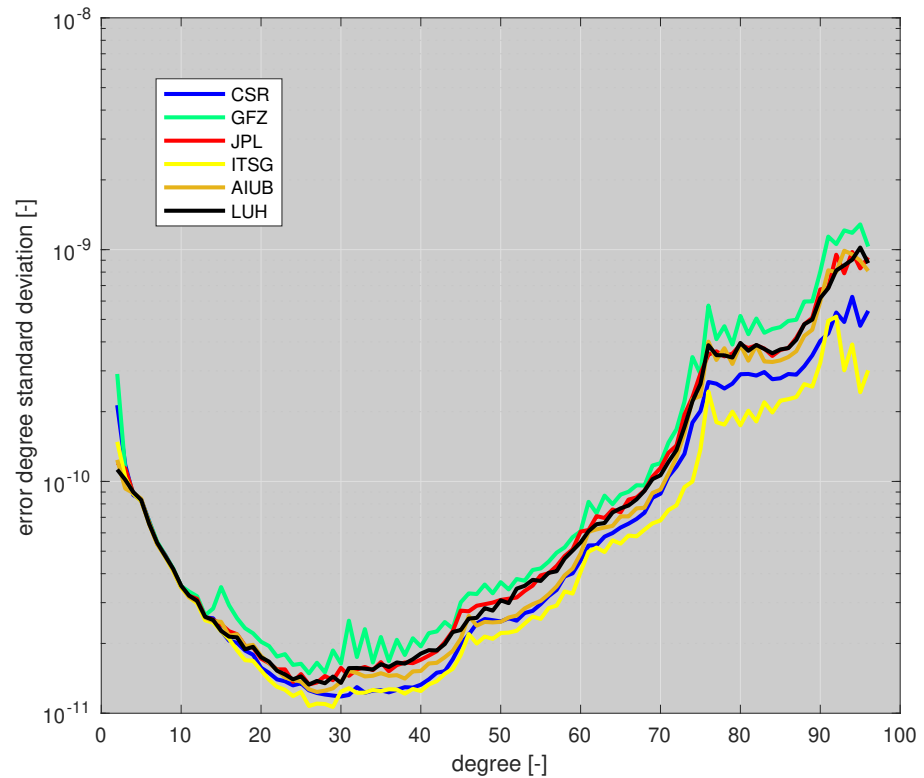
- Remove suspicious epochs
- Recompute solution

Evaluation

- Spectral noise
- Spatial noise
- Signal content
- Coefficients C20 C30

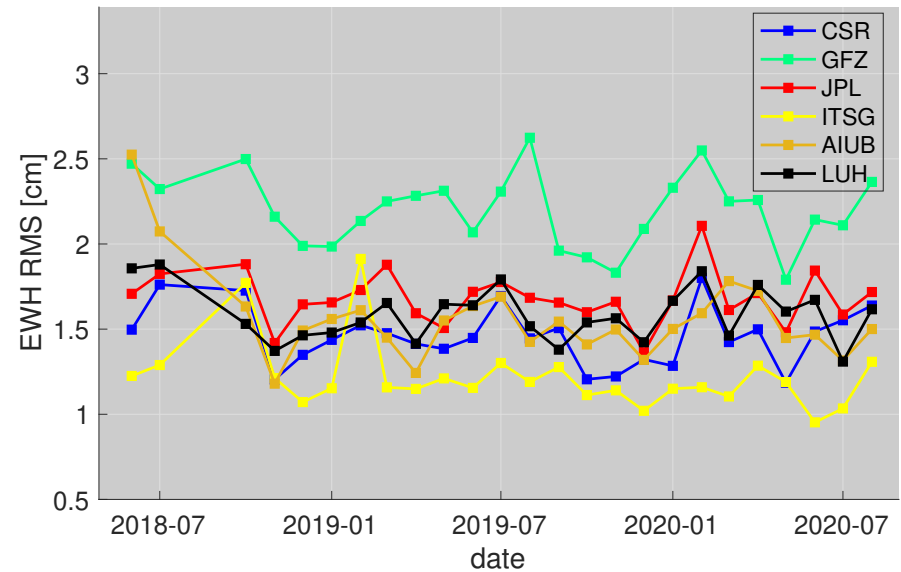
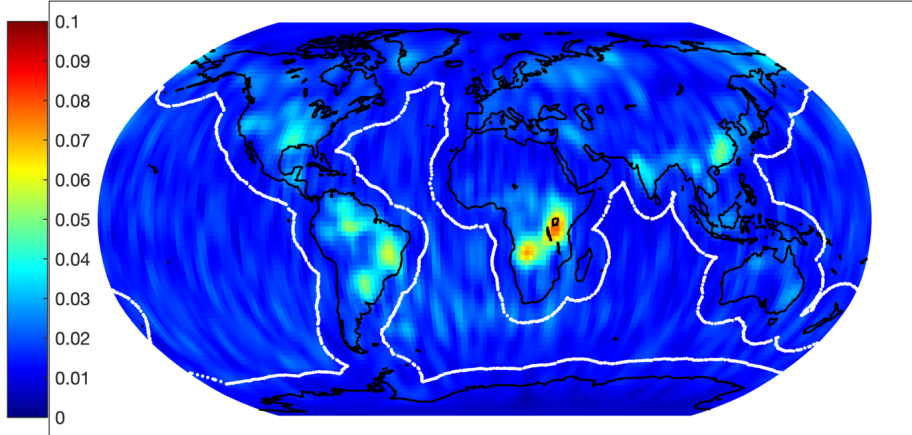
Spectral noise

- w.r.t. mean solution of all centers
- C20 zero tide
- 2018/06 - 2020/08



Noise over the oceans

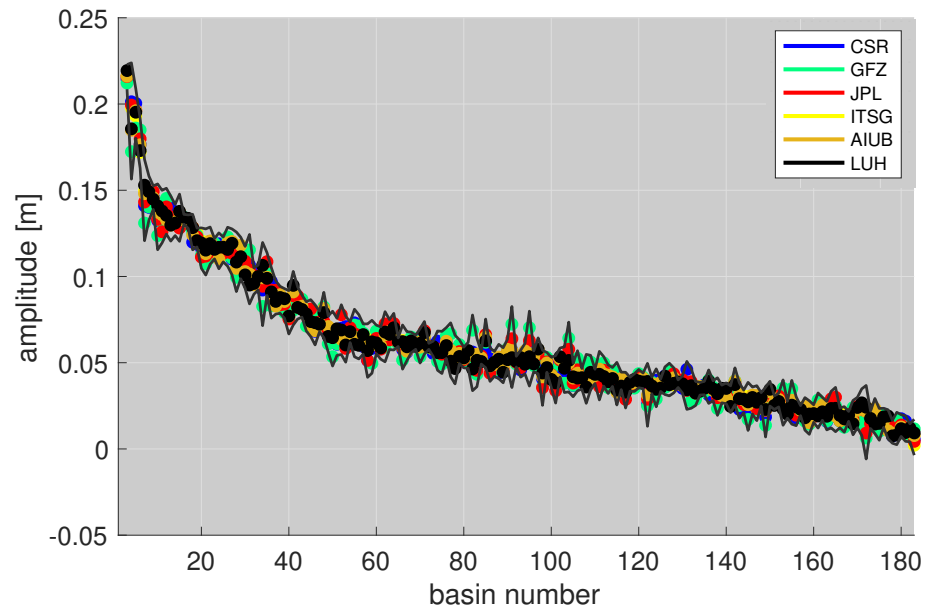
LUH



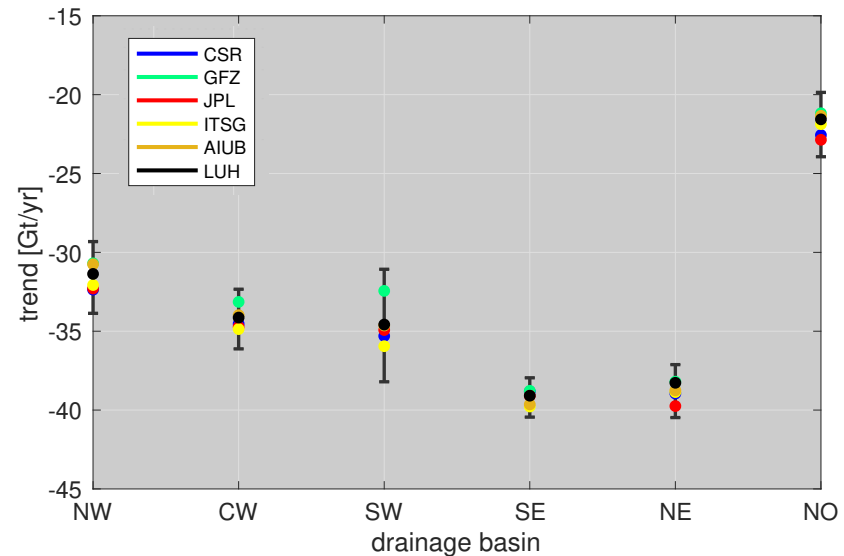
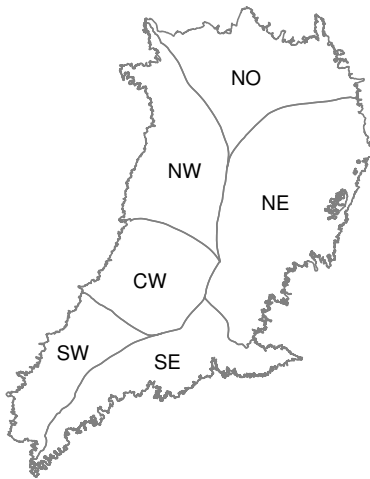
- 2018/06 - 2020/08
- EWH w.r.t. mean solution of all centers
- C20 and C30 replaced with SLR
- Gaussian filter (400 km)
- Climatology model subtracted
- (bias, trend, annual, semi-annual signal)

River basin amplitudes

- 2018/06 - 2020/08
- EWH w.r.t. mean solution of all centers
- C20 and C30 replaced with SLR
- Gaussian filter (400 km)
- Fit of climatology model
- (bias, trend, **annual**, semi-annual signal)

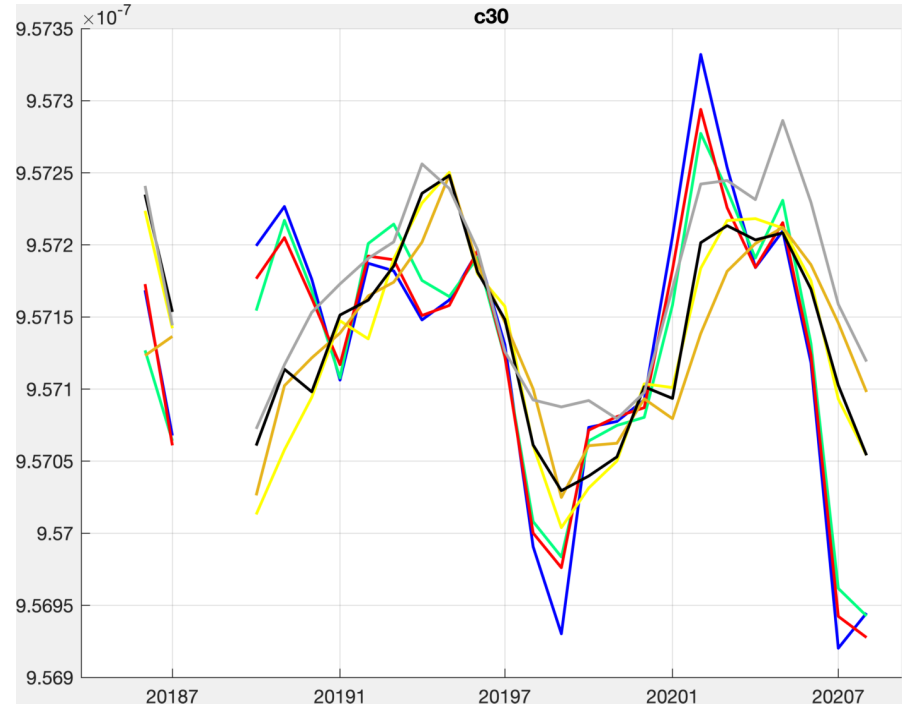
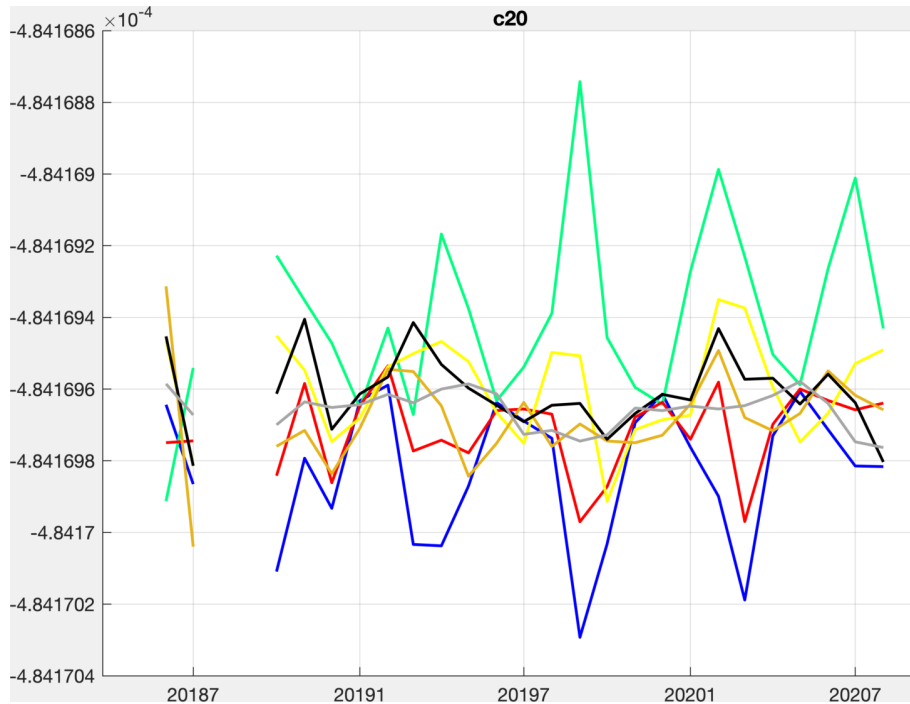
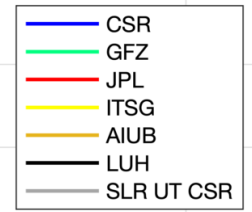


Greenland mass trends



- 2018/06 - 2020/08
- EWH w.r.t. mean solution of all centers
- C20 and C30 replaced with SLR
- Gaussian filter (400 km)
- Fit of climatology model
- (bias, **trend**, annual, semi-annual signal)
- GIA, degree 1, .. not considered

Coefficients C20, C30



LUH-GRACE-FO-2020 solutions

- Solutions are computed operationally
- Available a few days after all needed GRACE-FO products are online (L1B, kinematic orbits, alt. acc)
- Solutions can be found on ICGEM and LUH data repo:
 - http://icgem.gfz-potsdam.de/series/03_GRACE_other/LUH/LUH-GRACE-FO-2020
 - <https://data.uni-hannover.de/dataset/luh-grace-fo-2020>

References

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