On the co-estimation of static and monthly gravity field solutions from GRACE Follow-On data

Martin Lasser, Ulrich Meyer, Daniel Arnold and Adrian Jäggi
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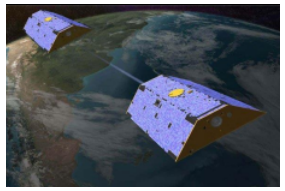
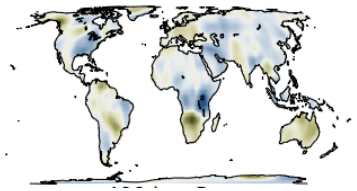
Starting Point
Monthly gravity fields - parametrisation





Force models

Gravity field	AIUB-GRACE03S static
Astronomic bodies	JPL DE421 (all planets)
Mean pole	Linear
Solid Earth tides	IERS2010
Solid Earth pole tides	IERS2010
Ocean tides	FES2014b (+ admittances from TUG)
Ocean pole tides	Desai
Atmospheric tides	AOD RL06
Atmospheric & oeanic dealiasing	AOD RL06
Relativistic effects	IERS2010

Basic parametrisation

- initial conditions 2x[6]
- accelerometer bias 2x[3]
- accelerometer scaling 2x[3]

parameters per arc 24

Additional parameters

- 15 min PCA per satellite in
  - radial 2x[96]
  - along-track 2x[96]
  - cross-track 2x[96]

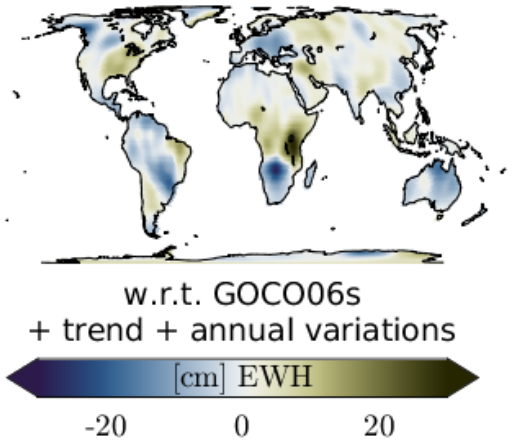
parameters per arc 576

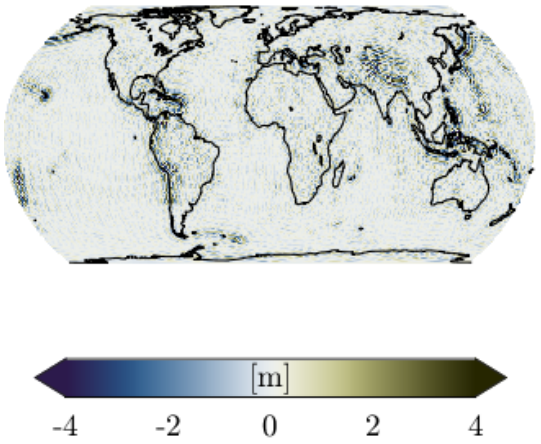
in daily arcs (30 days):
18000 ‹orbit› parameters
+ 9405 gravity field d/o=2..96

Starting Point
Gravity field resolution

Resolution

- A priori gravity field: d/o=160 (+ other gravitational forces)
- Monthly estimation: d/o= 96





Research Question
Test scenario

Does the a priori chosen gravity field influence our monthly solutions or can we do better by co-estimating monthly solutions (up to d/o=96) together with a static component (d/o=97..160)?

Test scenario

- 51 months of GRACE Follow-On (Jun 2018 – Oct 2022).
- A priori gravity field model: *AIUB-GRACE03S static* or *GOCO06s.*
- With and without noise modelling from post-fit residuals.

1 apr: AIUB
2 apr: GOCO06s
3 apr: AIUB + emp
4 apr: GOCO06s + emp
5 stat co-est + emp
6 stat co-est + emp full

Set-up
Design-matrix

pre-eliminated on arc-wise level

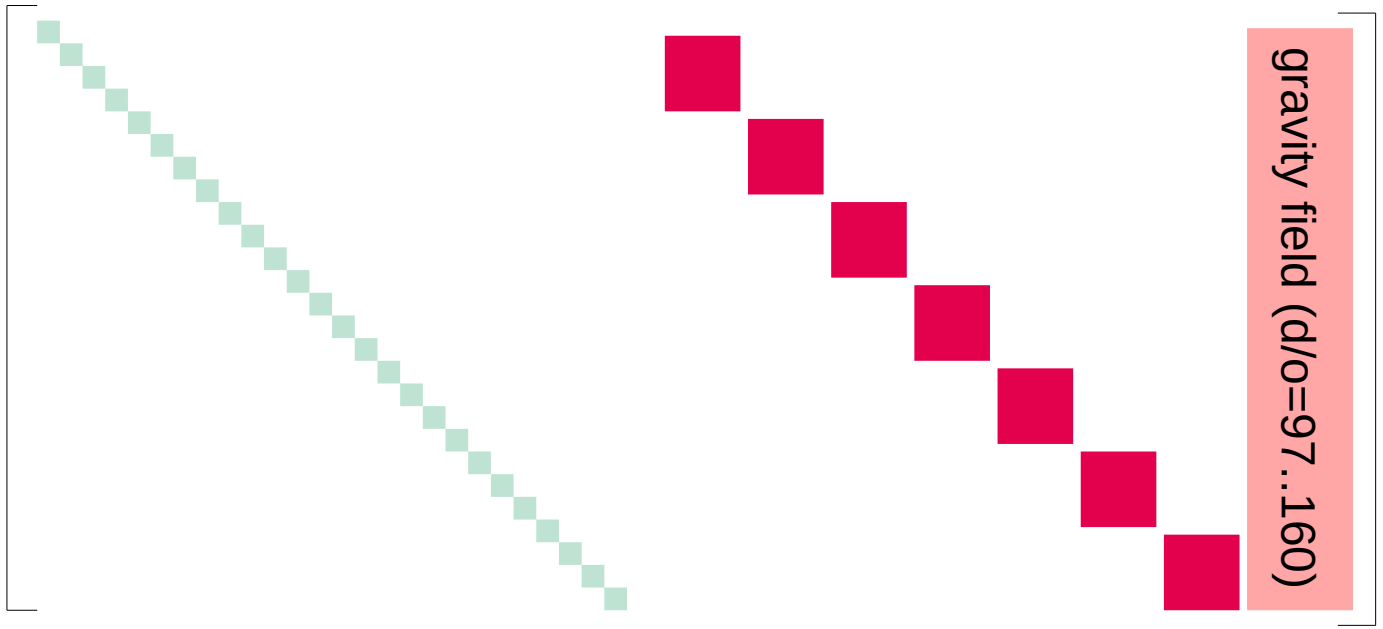
pre-eliminated on monthly level and back-substituted

arc-wise orbit parameters (600 per arc)

monthly gravity fields (d/o=2..96)

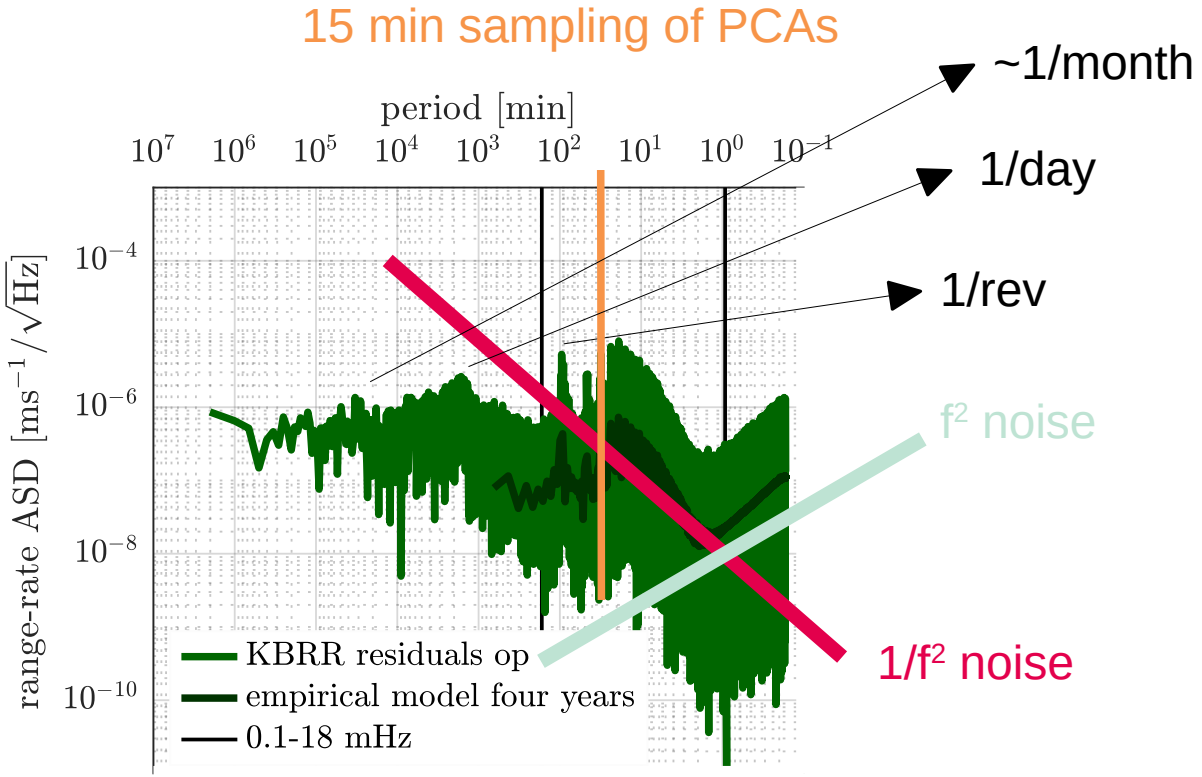
observations (Jun 2018 – Oct 2022)

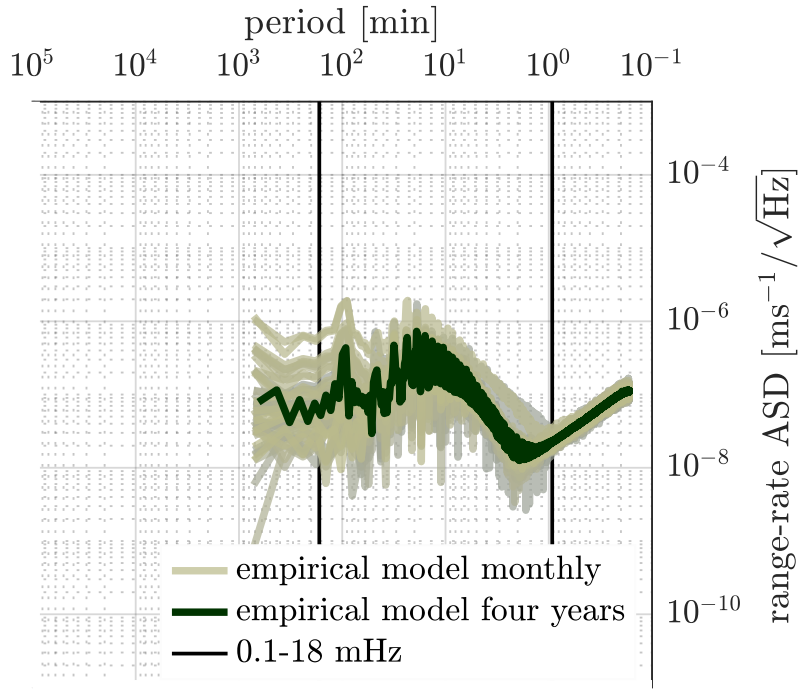
$A =$



Noise Model

Based on post-fit residuals

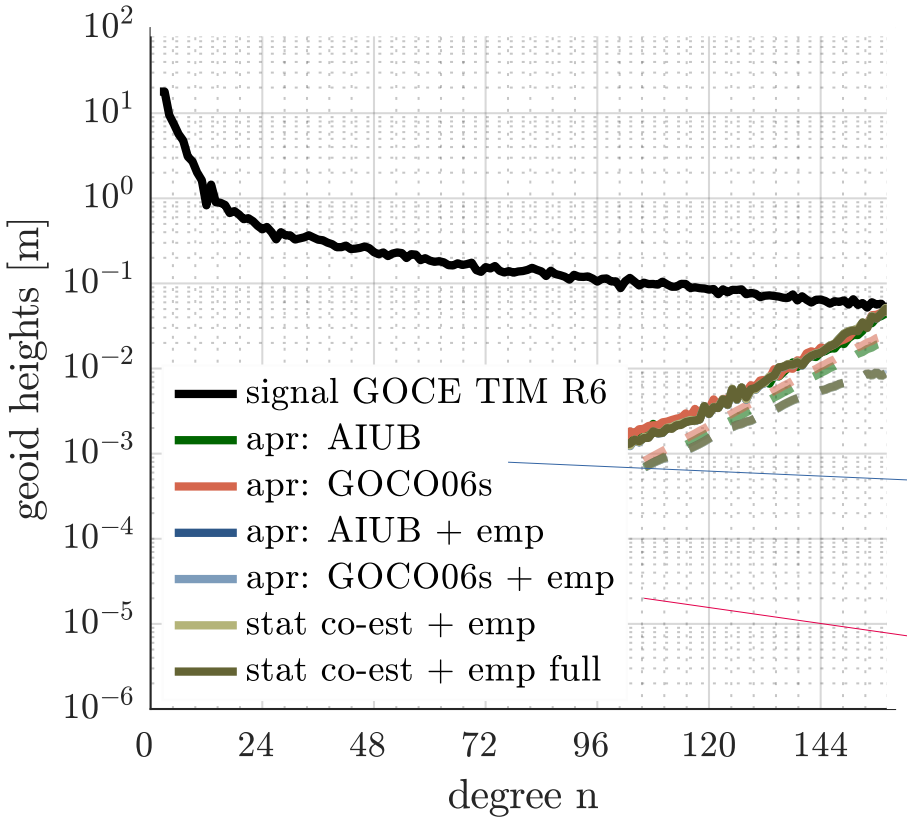




Auto covariance function → covariance matrix → weight matrix

Results

Static gravity field



- Very similar for all tests.
- Two groups
  - w/ and
  - w/o empirical noise modelling

RMS = 74.56 µm
RMS = 74.98 µm

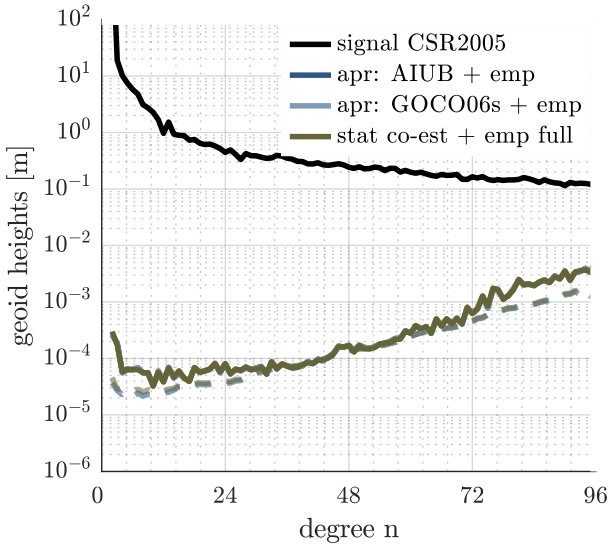
RMS = 72.69 µm
RMS = 72.64 µm
RMS = 72.78 µm
RMS = 72.45 µm

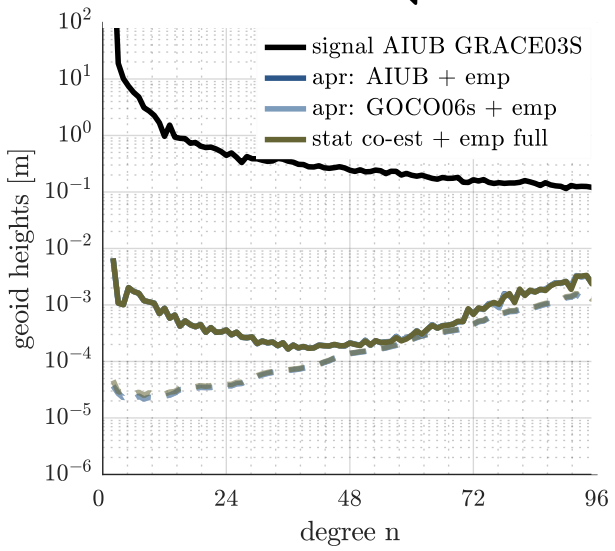
Results

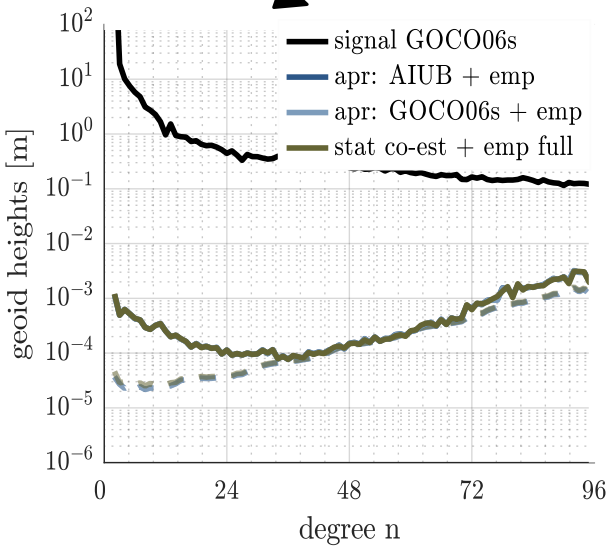
Time-variable gravity field

- Reference to CSR and a priori gravity fields
- differences negligible

1 apr: AIUB
2 apr: GOCO06s
3 apr: AIUB + emp
4 apr: GOCO06s + emp
5 stat co-est + emp
6 stat co-est + emp full

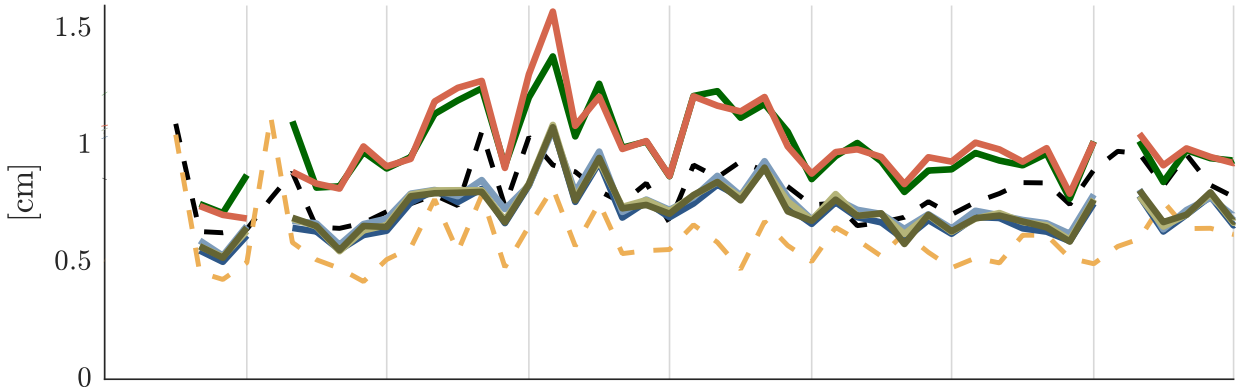


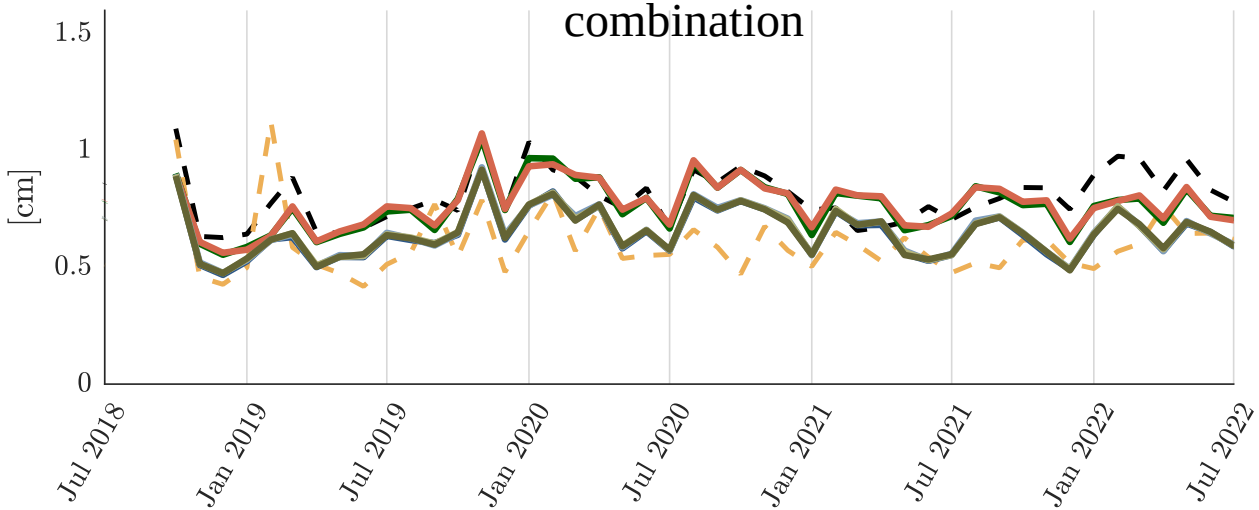




Results – Noise evaluation

Combining time-variable gravity field solutions to provide
for a product of improved quality, robustness and reliability





CSR
TUG
apr: AIUB
apr: GOCO06s
apr: AIUB + emp
apr: GOCO06s + emp
stat co-est + emp
stat co-est + emp full

difference

w/o emp: 4.65%

w/ emp: 3.96%

CSR
TUG
apr: AIUB
apr: GOCO06s
apr: AIUB + emp
apr: GOCO06s + emp
stat co-est + emp
stat co-est + emp full

difference

w/o emp: 1.41%

w/ emp: 1.07%

Conclusions

Summary

Co-estimating of a static gravity field solution from four years of GRACE Follow-On data

- With and without an empirical modelling

  → differences in all cases due to modelling strategy

- Co-estimated monthly gravity field solutions

  → no significant difference to be found

  → for now not worth the time and effort

Thank you for your attention

Contact

Martin Lasser
martin.lasser@unibe.ch

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