

Gravity Field Retrieval from Next Generation Gravity Missions: Near-Real Time Retrieval Strategy

Anna Purkhauser and Roland Pail

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Content

Motivation

GRACE vs. NGGM: Differences, concepts, drawbacks and advantages

NGGM NRT approach

Results

Conclusion

Motivation

Goal

Recover gravity field variations as detailed as possible with the shortest possible temporal resolution.

Why?

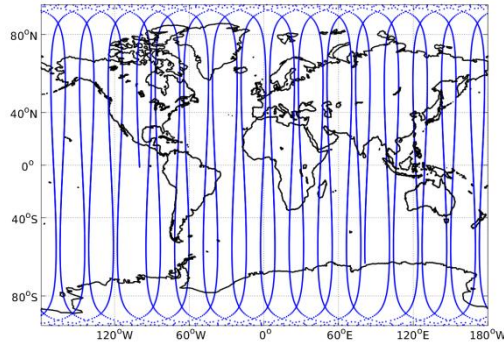
Applications with shorter temporal resolution: atmosphere, hydrology (e.g. water management, flood monitoring and detection), solid Earth (e.g. earth quake monitoring).

Problem

Increase in temporal resolution results in

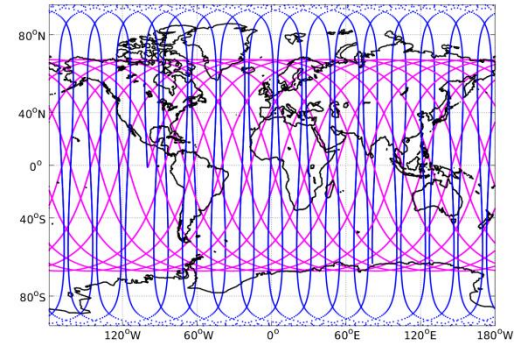
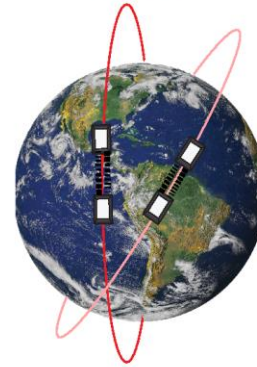
- Less observations per time span.
- Reduced redundancy in the parameter estimation process.

GRACE-like



1 pair of satellites
Polar orbit
Sparse groundtrack

NGGM



2 pairs of satellites
Polar and inclined orbit
Denser groundtrack

GRACE-like

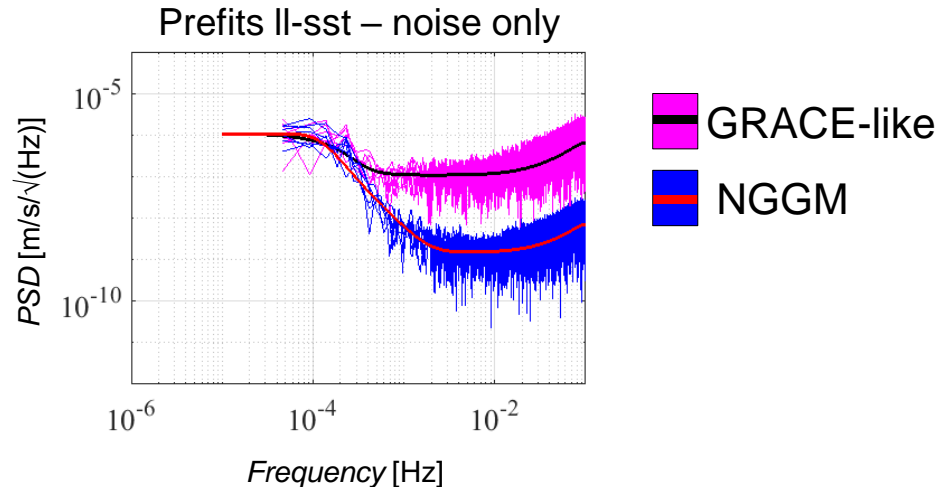
Il-sst tracking: K-Band ranging

Accelerometer: $3^{-11} \text{ m/s}^2/\sqrt{\text{Hz}}$ error level

NGGM

Il-sst tracking: Laser

Accelerometer: $1^{-11} \text{ m/s}^2/\sqrt{\text{Hz}}$ error level in MBW



GRACE-like

Only HIS, AO dealiasing

Daily Snapshots

(Kurtenbach et al. 2012)

Short-arc approach

A priori spatial and temporal correlation patterns can be derived from geophysical models

Kalman filter and smoother estimation procedure

Weighted mean between GRACE observations and prediction

NGGM

Full AOHis, Self-dealiasing

Short/daily solutions

(Purkhauser et al. 2019)

Short-arc approach

Sliding window on NEQ level

Self-dealiasing with Wiese approach

Reduced latency

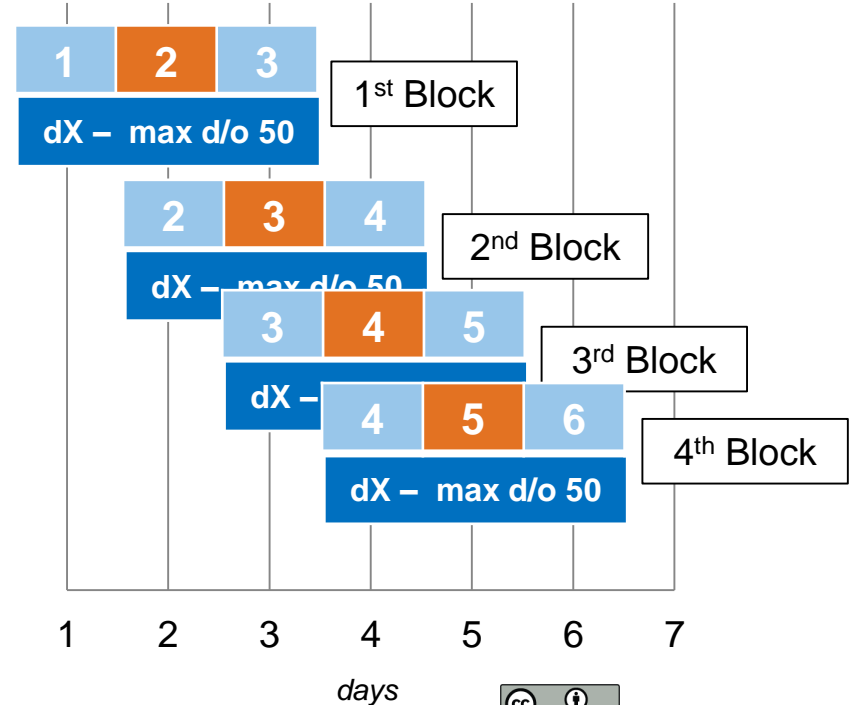
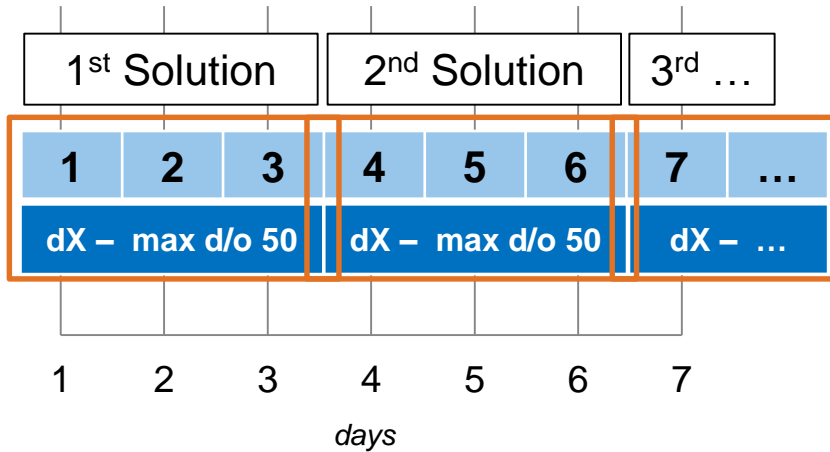
Temporal resolution acc. to application

3-, 5-, 7- ... day solutions

Standard Processing



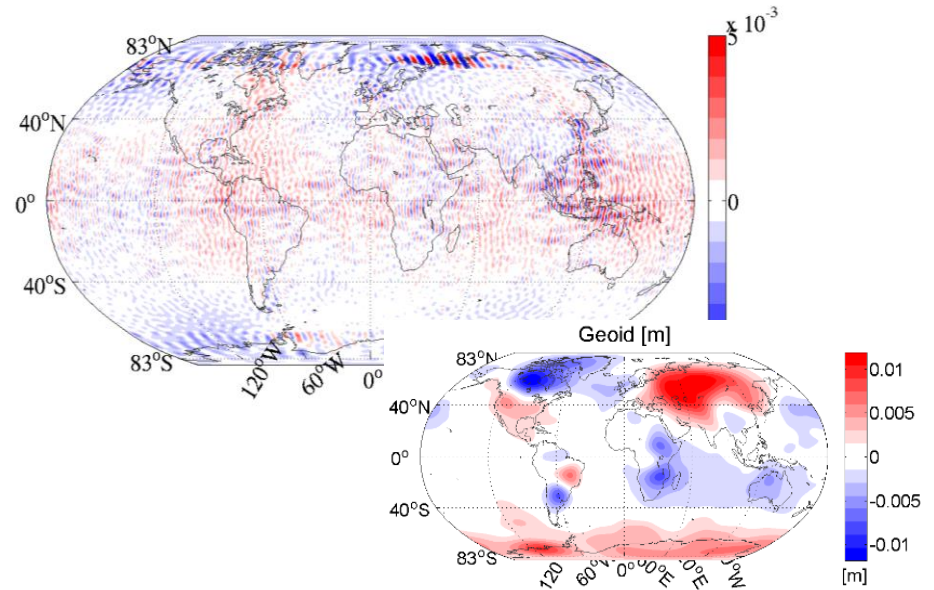
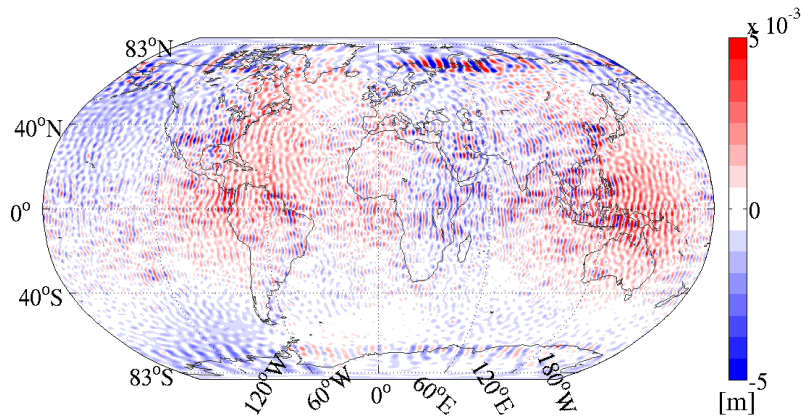
NRT Processing



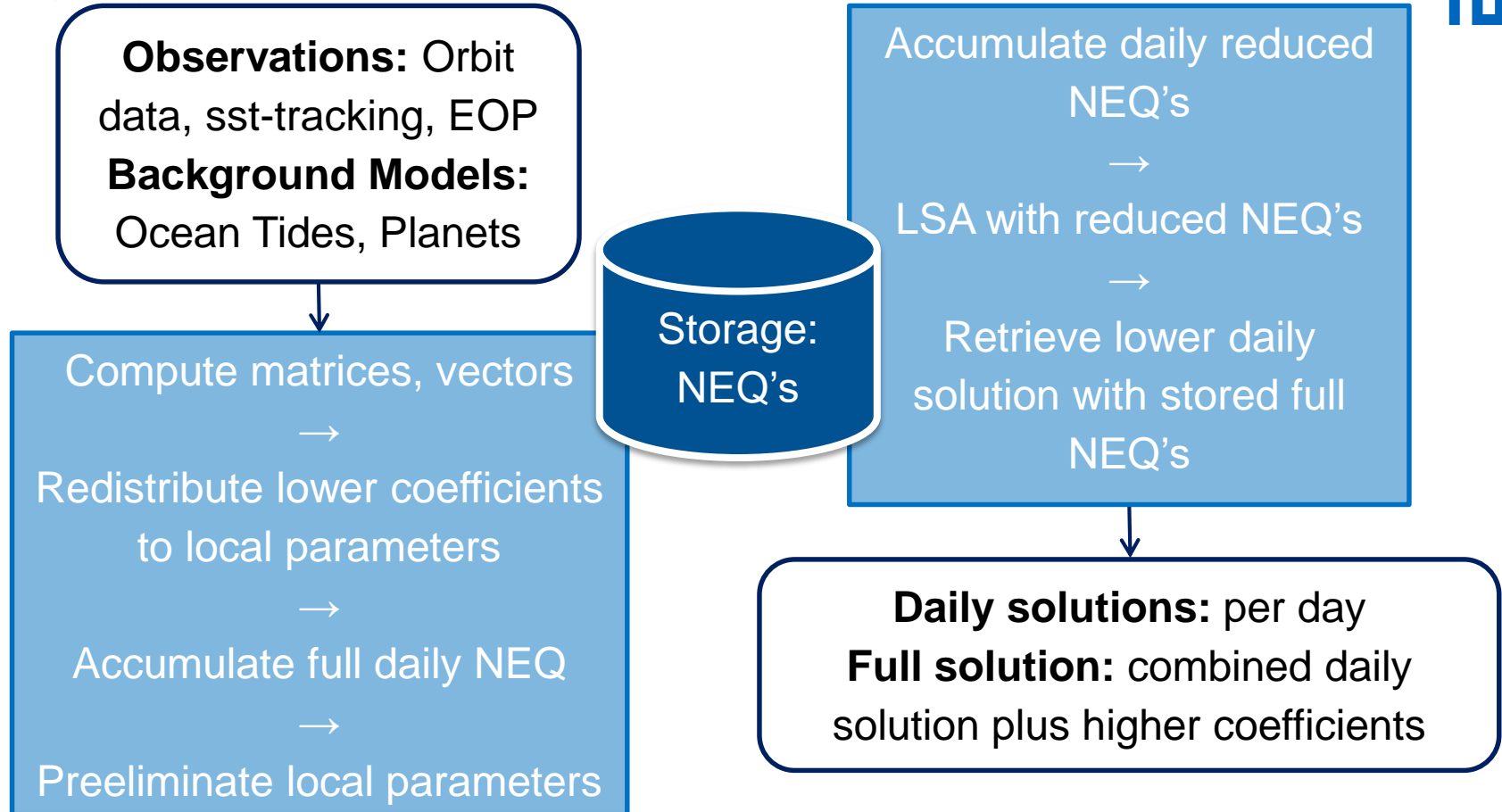
Standard Processing



NRT Processing



Scheme



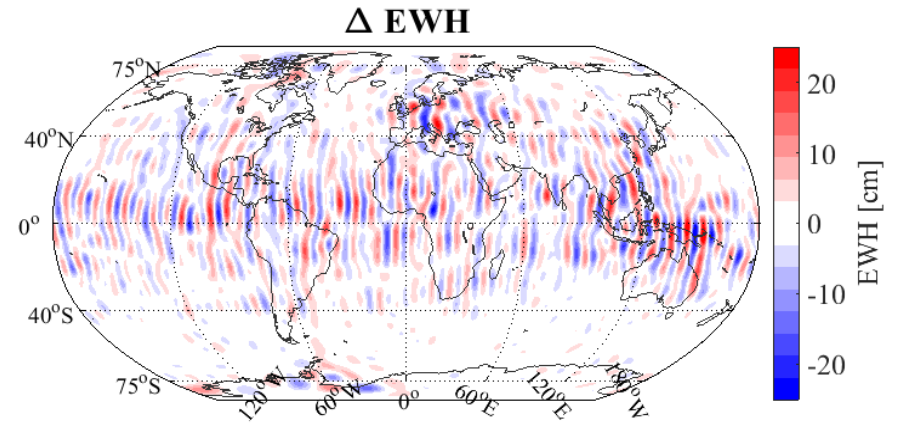
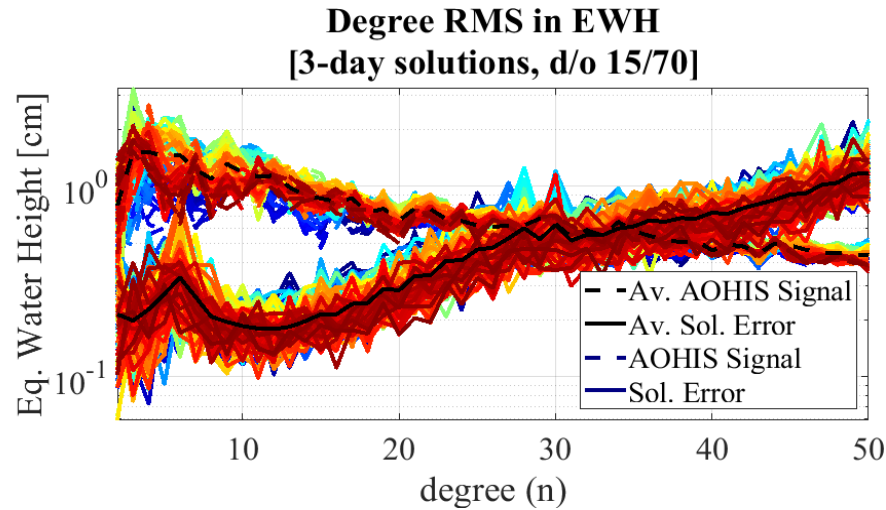
Simulation environment

model	“true” world	simulated world
Static gravity field model	GOCO05s	GOCO05s
Time varying GF model	ESA AOHIS	-
Ocean tide model	EOT08a	GOT4.7

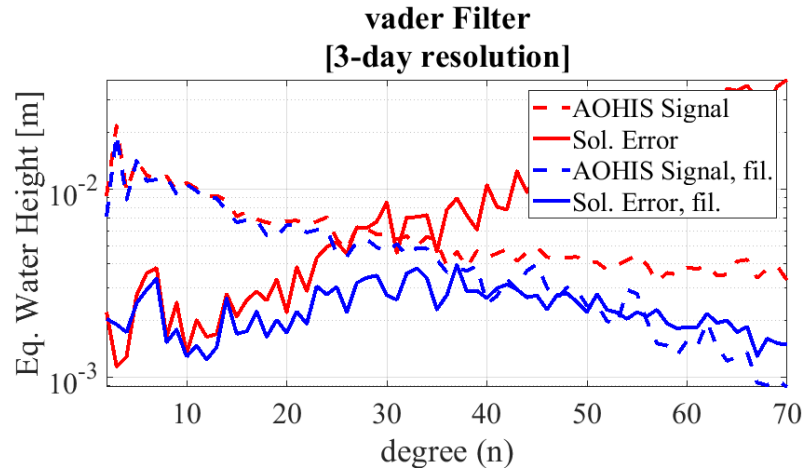
noise

Laser interferometer	Noise model
Accelerometer	Noise model
Orbit	White noise, 1 cm

3-day solution



Post-Processing with VADER filter



time variable decorrelation (VADER) filter
(Horvath et al. 2018)

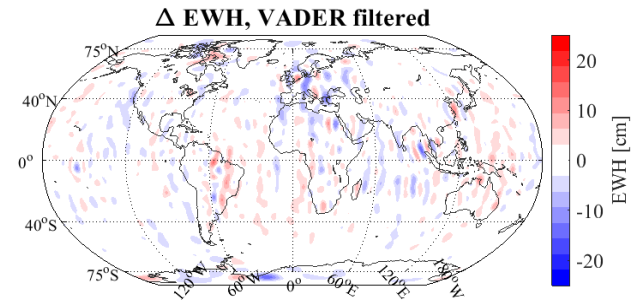
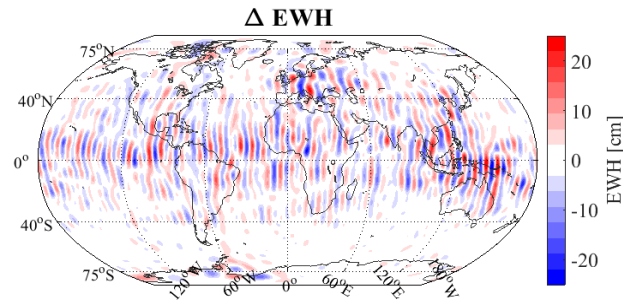
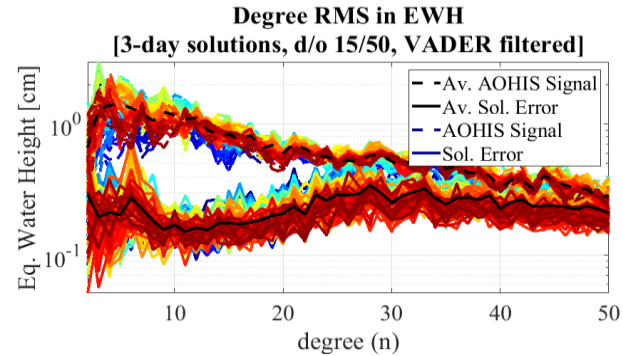
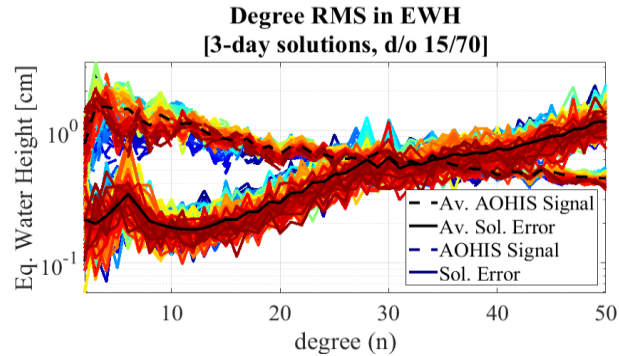
$$\hat{x}_{\alpha}^{VADER} = (N + \alpha M)^{-1} N \hat{x} \\ = W_{\alpha} \hat{x}$$

normal equation matrix N

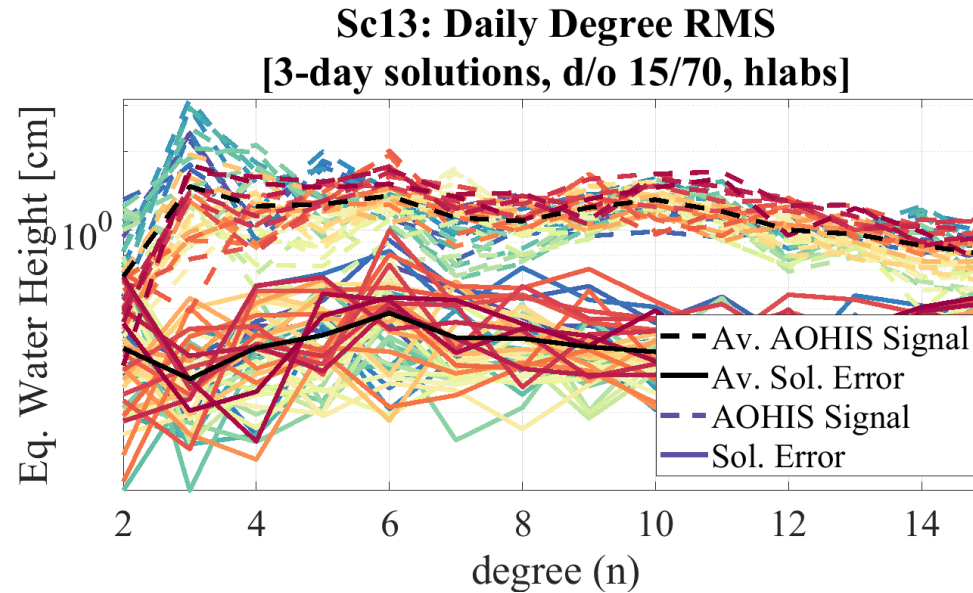
inverse signal variance matrix M

scaling factor α

3-day solution



Daily solutions



Conclusion

- Stable daily and short term solution possible
- Only possible with a NGGM constellation!
- Resolution sufficient?
 - Depends on application
 - Kalman filtering or other post-processing strategies are still a possibility for improvement if necessary