Advanced processing strategies for a future GFZ GRACE/GRACE-FO Level-2 data release

SUPPLEMENTARY MATERIAL

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GFZ Helmholtz Centre Potsdam

TU berlin

NEROGRAV
New Refined Observations of Climate Change from Spaceborne Gravity Missions

Improving and better understanding

- Background models
  - Stochastic modeling of ocean tide (OT) models
    Sulzbach et al. (2023) https://doi.org/10.5880/nerograv.2023.003
    Hauk et al. (2023) https://doi.org/10.1029/2023EA003098
  - Stochastic modeling of non-tidal atmospheric and oceanic de-aliasing (AOD) models
    Shihora et al. (2022), https://doi.org/10.5880/GFZ.1.3.2022.003
    Shihora et al. (2023), https://doi.org/10.5880/nerograv.2023.004
    Wilms et al., poster presentation, EGU24-16530

Improving and better understanding

- Background models
  - Stochastic modeling of ocean tide (OT) models
  - Stochastic modeling of non-tidal atmospheric and oceanic de-aliasing (AOD) models
- Sensor data
  - Stochastic modeling of GPS data
  - Stochastic modeling of ACC, MWI, and LRI data

    Murböck et al. (2023)

    https://www.mdpi.com/2072-4292/15/3/563

    https://doi.org/10.5880/nerograv.2023.001

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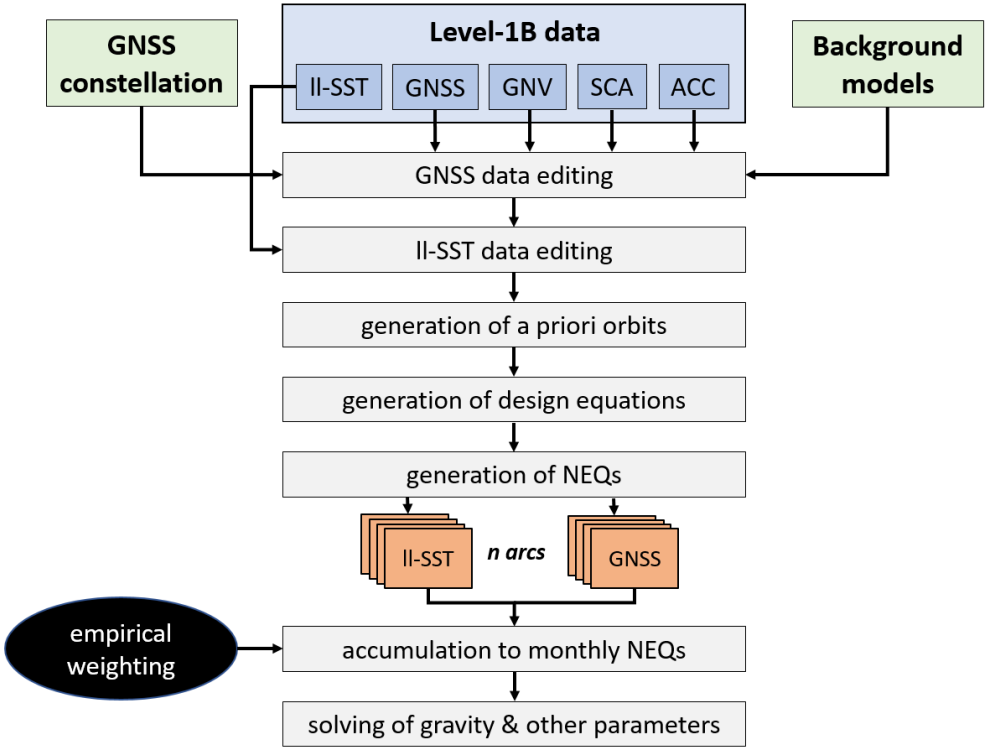
  - Stochastic modeling of ACC, MWI, and LRI data
- Processing strategies
  - Optimization of relative weighting

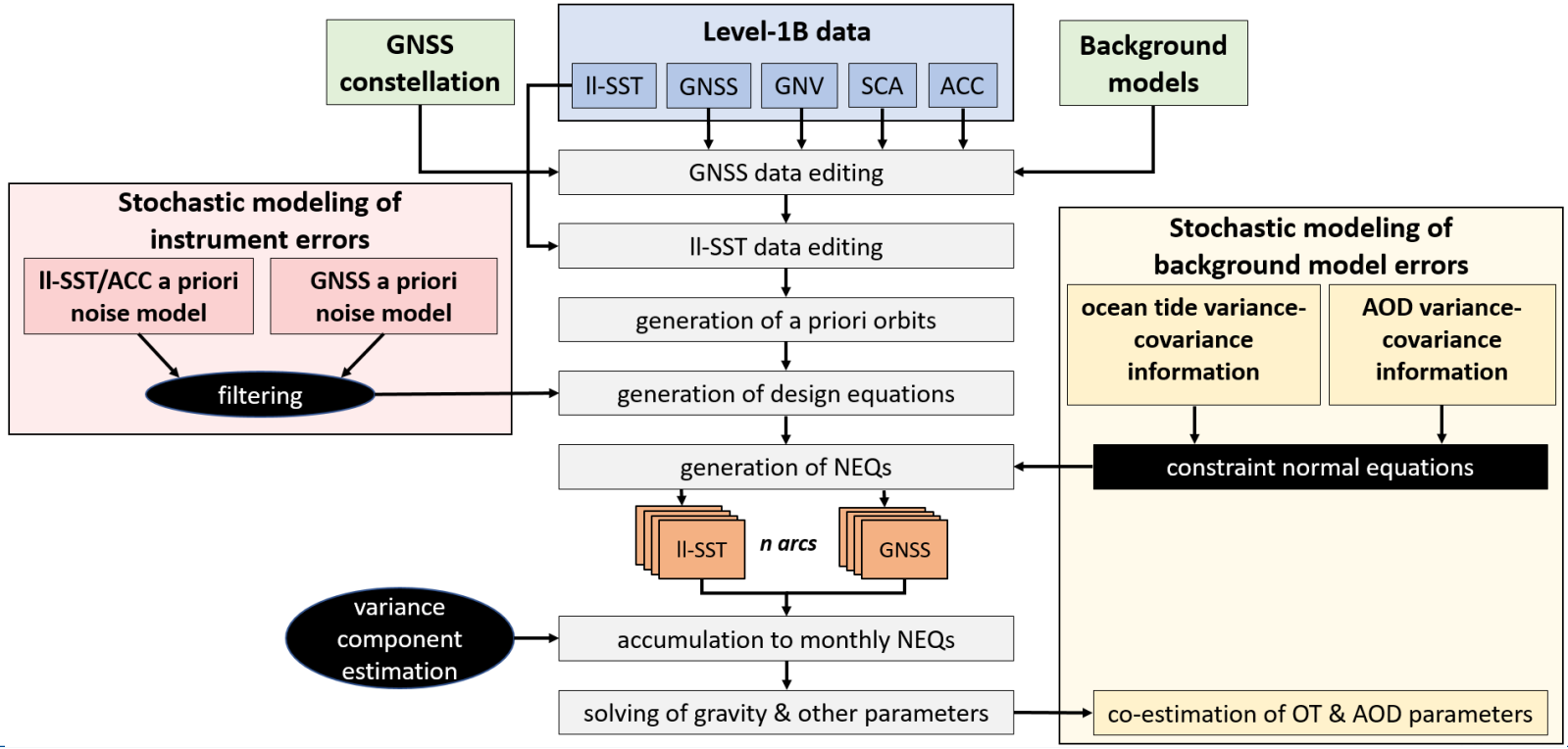
Increasing

the **resolution**, **accuracy**, and **long-term consistency** of mass transport series from satellite gravimetry

Current processing scheme of GFZ RL06



Enhanced processing scheme of GFZ RL07p



Monthly GRACE-FO KBR/LRI solutions

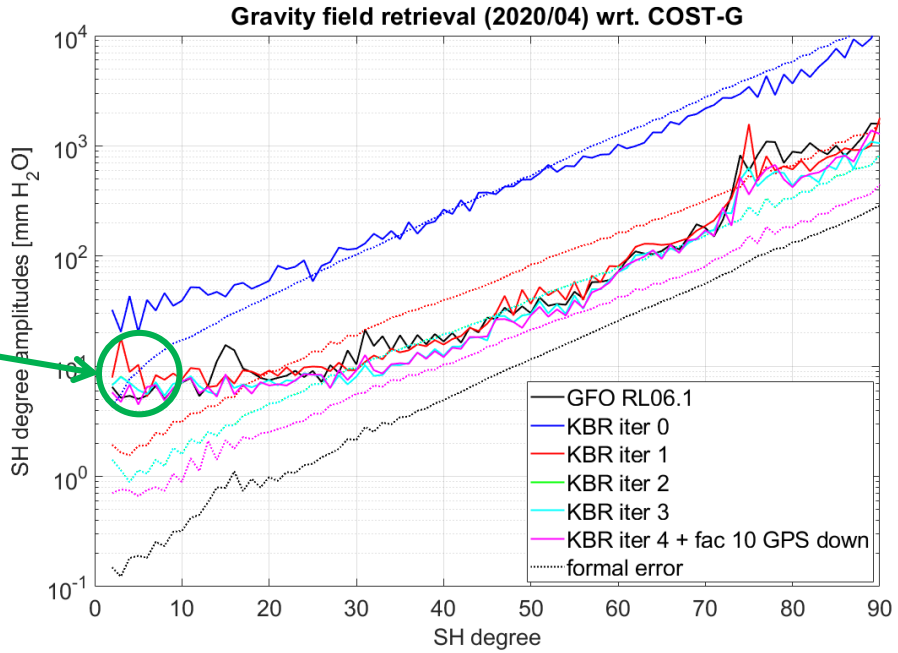
- Three test years: 2019 – 2021
- Results in terms of residuals relative to a GRACE/GRACE-FO COST-G climatology
- Solutions

	Stochastic modelling of instrument data	Stochastic modelling of background models	Relative weighting with VCE
RL06.1	✗	✗	✗
RL07p V1	✓	✗	✓
RL07p	✓	✓	✓

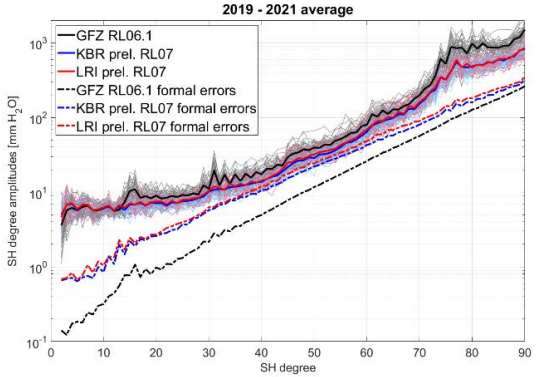
Currently not for AOD parameters

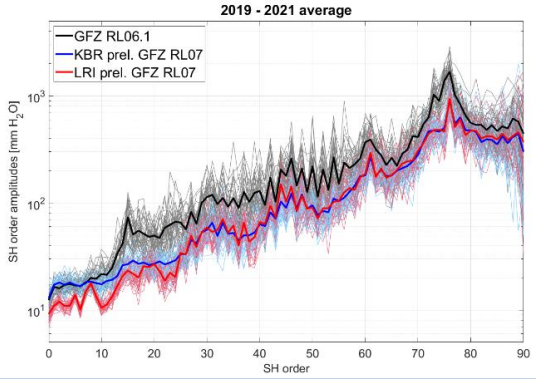
Remarks on VCE: KBR solutions

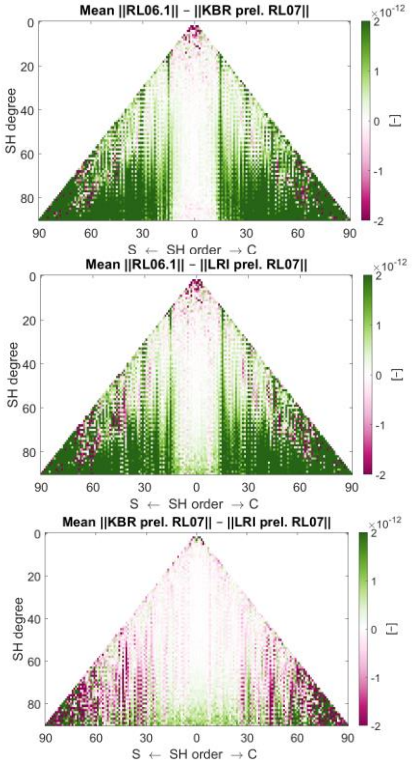
- Convergence reached already after two iterations
- Additional empirical down-weighting of GPS leads to further slight improvements and particularly seems to stabilize the very low degree harmonics:
  - ➢ Currently applied: factor of 10
  - ➢ Ocean wRMS (cm EWH):
    'KBR iter 3': 3.76
    'KBR iter 4 + fac 10 GPS down': 3.52

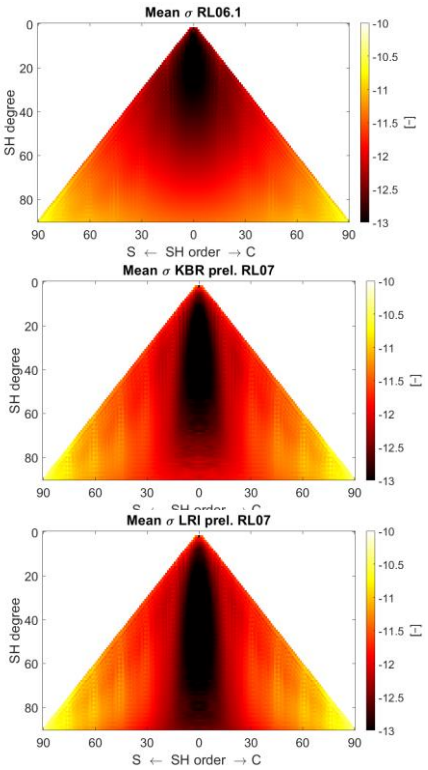


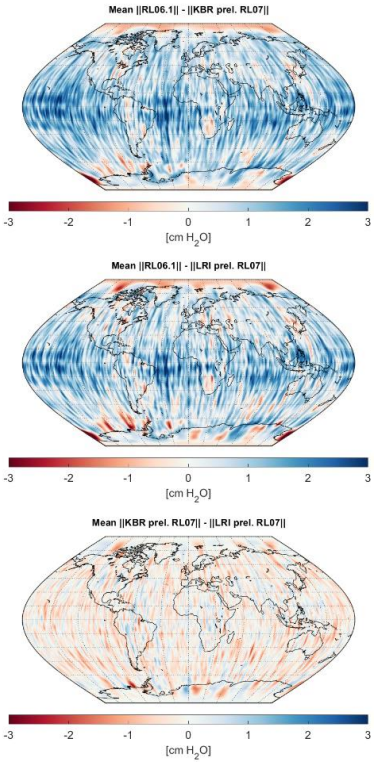
Results: KBR - LRI





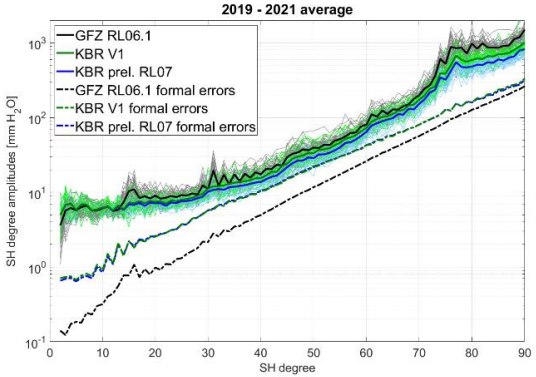


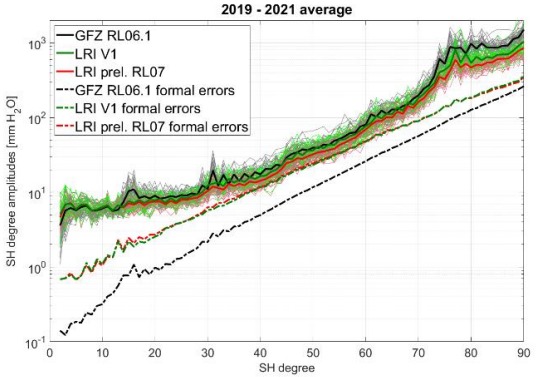


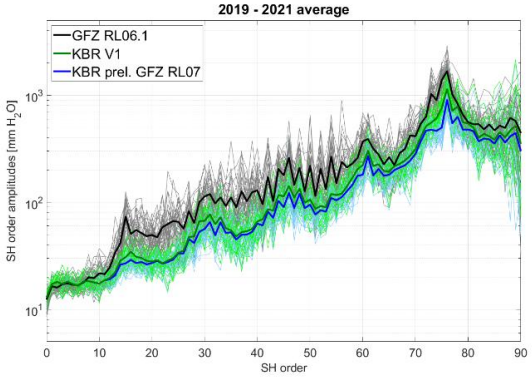


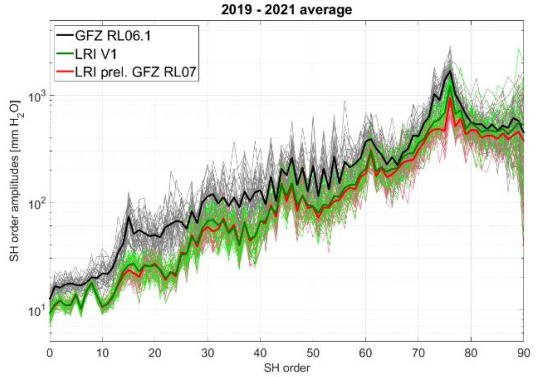
Results: OT- and AOD-VCM impact

- V1: OTVCM and AODVCM not included



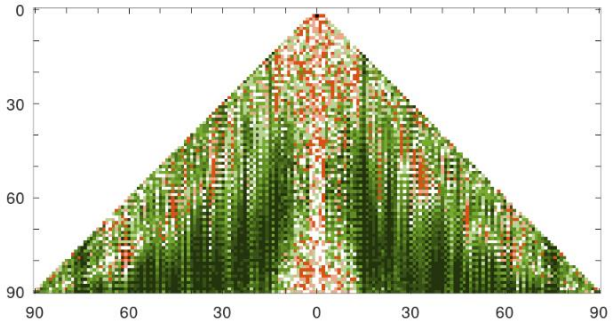




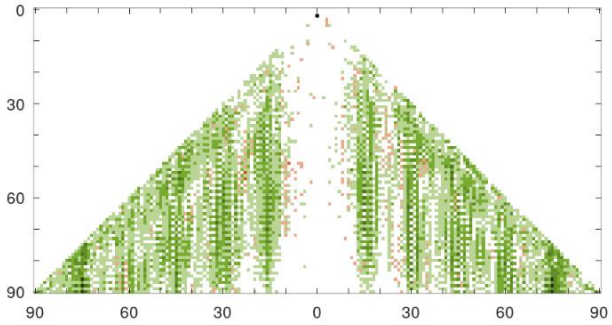


Results: residual rms change (1)

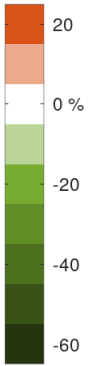
- V1: OTVCM and AODVCM not included



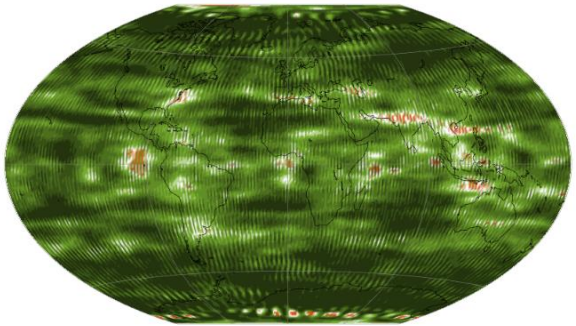
RL07p / RL06.1 - 1

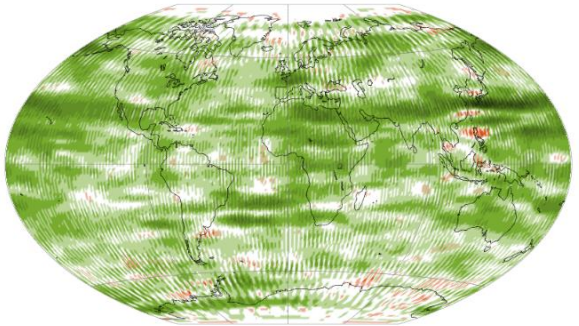


RL07p / RL07p V1 - 1



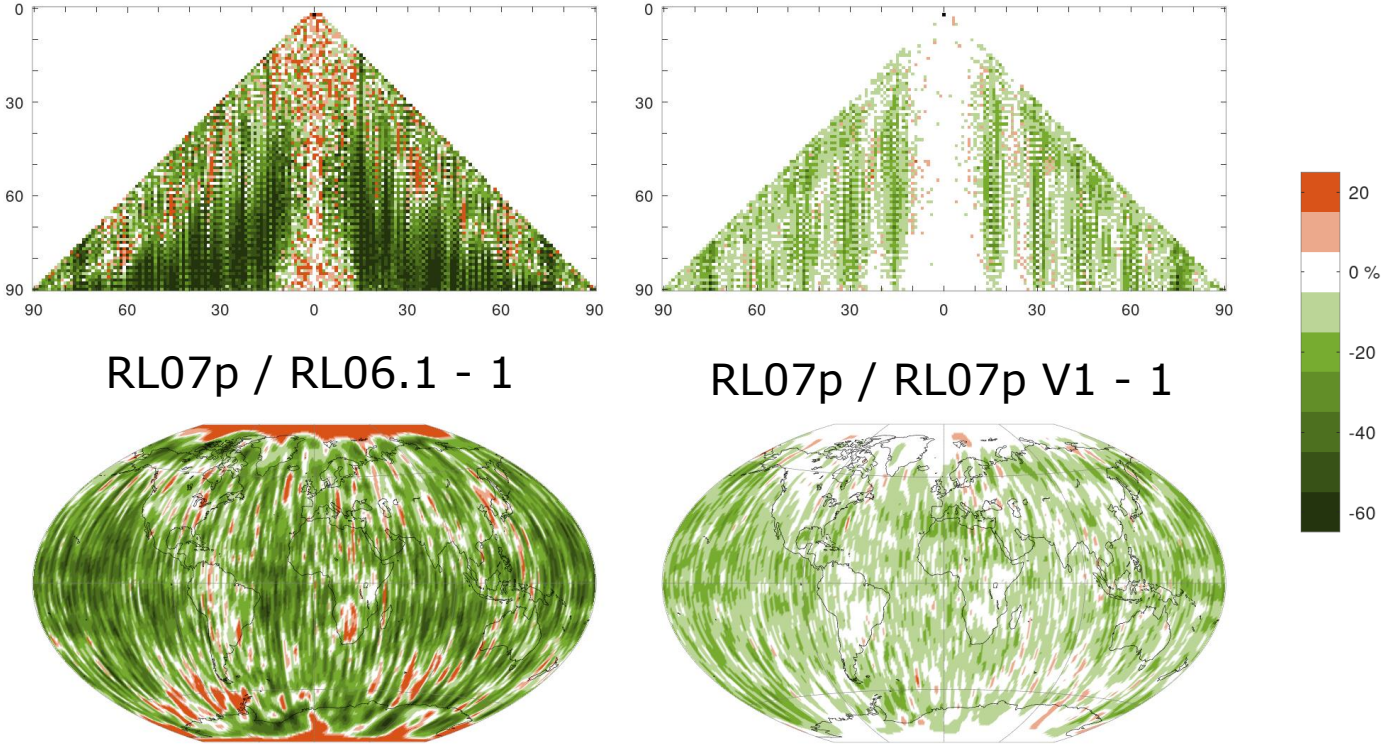
unfiltered surface mass densities



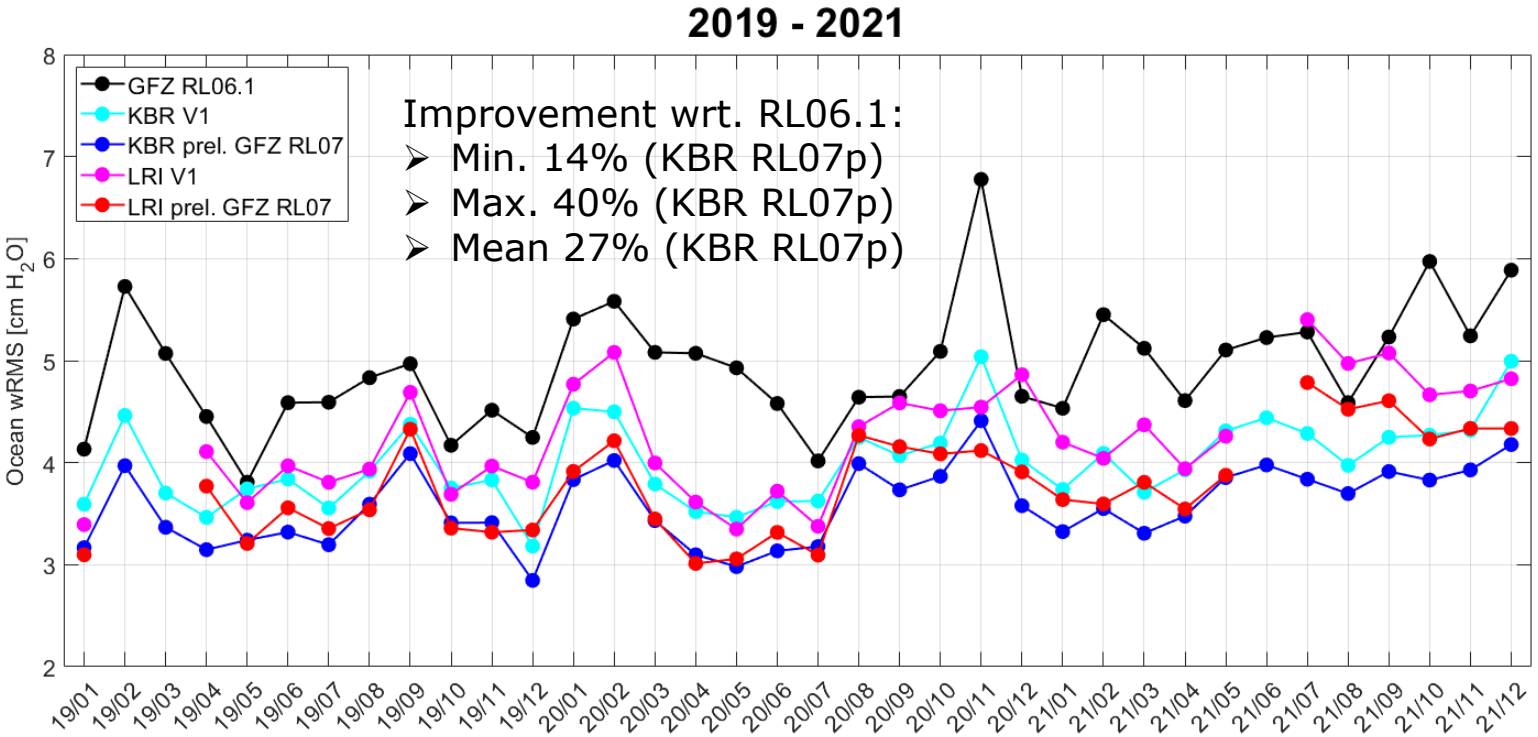


Results: residual rms change (2)

- V1: OTVCM and AODVCM not included



Results: ocean wrms



Main Conclusions

- Consistent long-term solutions
- More realistic formal errors
- Improved medium and high degrees
- Reduced noise by up to 40 % for small wavelengths

Outlook

- Including temporal correlations to the AOD VCM assessment
- Using kinematic orbits instead of GPS code and phase observations
- Further improving relative weighting