On recovering GRACE/GFO Accelerometer data

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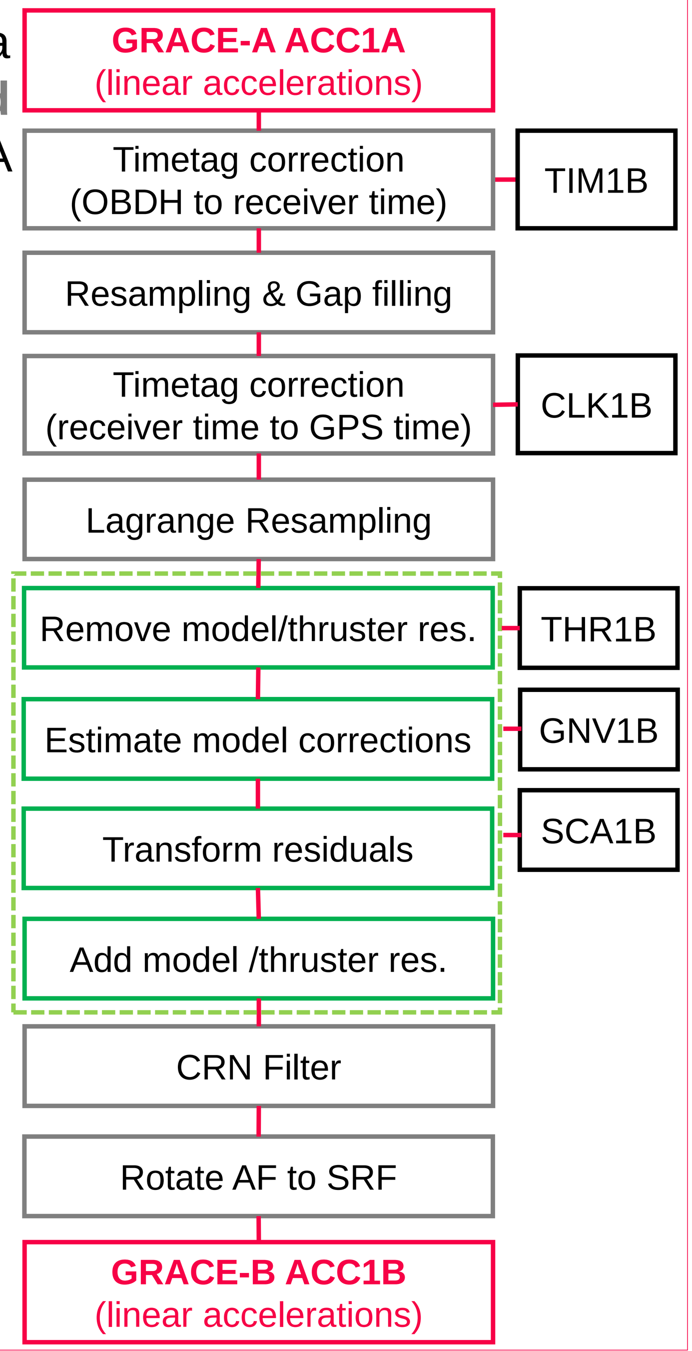
Introduction

- At the end of the GRACE mission, the accelerometer on-board GRACE-B was switched off due to the reduced battery capacity and its measurements were replaced by synthetic data. Coincidentally, after one month in orbit, the GFO-B accelerometer data also degraded which raised the demand for synthetic data in the current mission as well.
- In an approach introduced by Bandikova et al.[1] the synthetic data was derived from the GRACE-A ACC, by applying time and attitude corrections and GRACE-B thruster responses. To improve upon the existing approach, we recover the GRACE-B data by implementing the state-of-the-art non-gravitational force models and applying additional force model corrections.
- The recovered data improves the gravity field solutions in the final months of the GRACE mission. Furthermore, in case of a severe problem on GFO-B accelerometer, the synthetic data can improve the real measurements through sensor fusion.

Methodology

- We derive the synthetic ACC during the level1-A data processing. This approach includes **Level-1A standard steps** [2] as well as **recovery steps** from GRACE-A ACC data:
  1) Removing force models from GRACE-A ACC.
  2) Estimate model corrections and obtain ACC residuals:
     - **Aerodynamic force model scale,**
     - **Thermal radiation pressure model scale.**
  3) Transfering the ACC residuals to GRACE-B by applying time and attitude corrections,
  4) Adding force models, corrections and thruster responses of GRACE-B.



Force type	Reference
Aerodynamic force	
- Time-variable drag and lift coefficients	Krauss [3], Moe and Moe [4]
- Temperature and density	Bruinsma [5]
Solar radiation pressure	Montenbruck et al. [6]
Albedo	Rodríguez-Solano et al. [7]

Table1.: Non-gravitational force models.

Impact of drag model and corrections

- The evaluation of our approach is done for the month when both satellite have measurments.
- To study the impact of the force model, we removed thruster events.

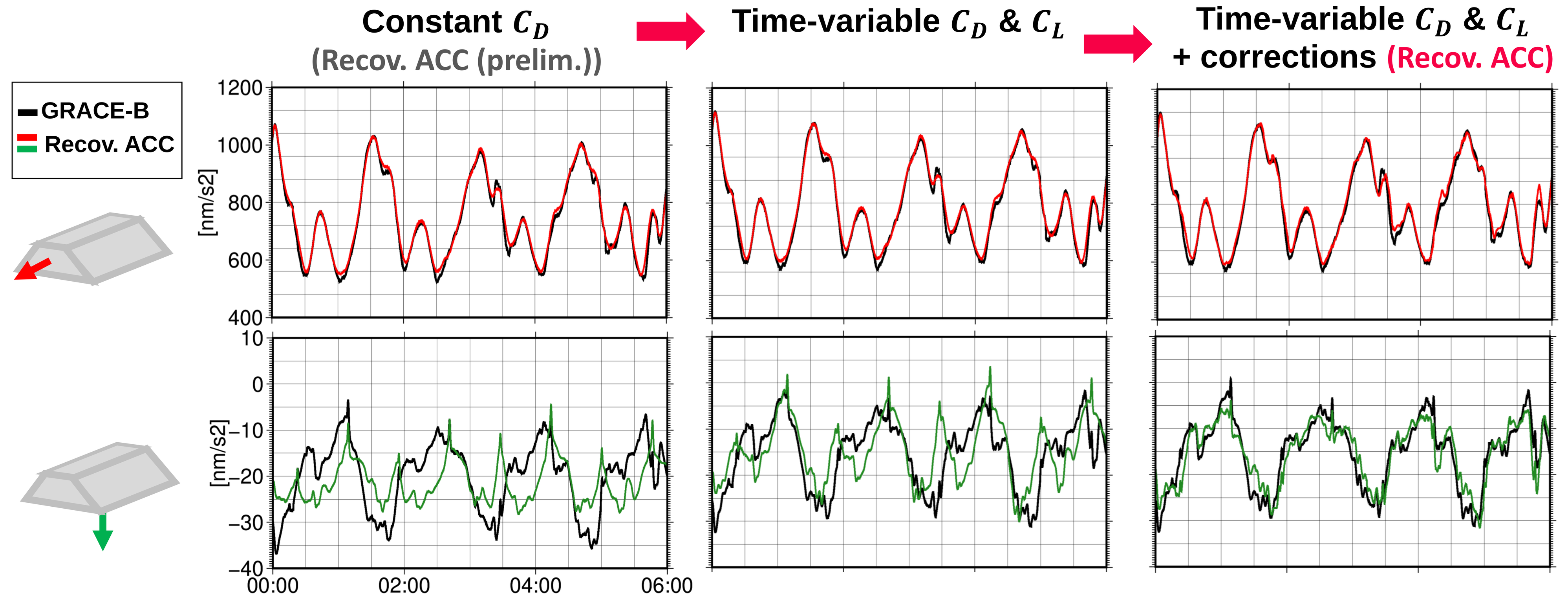


Fig.1: Comparison of the recov. ACC1B with the original GRACE-B (thruster responses are removed) for 2015-03-07 in along-track and radial directions.

Comparision to the Level-1B data

- To evaluate the final Recov. ACC data with the GRACE-B data, real thruster responses are added back to Recov. ACC (prelim.) and Recov. ACC.
- The improvement both in frequency domain (<2mHz) and time domain in terms of RMS is more noticeable in radial direction.

Table 2.: RMS differences between the recov. ACC1B and the original GRACE-B data for November 2008 (altitude ~470 km) and March 2015 (altitude ~410 km).

Data (nm/s^2)		RMS 2008-11	RMS 2015-03
ACC Recov. (prelim.)	a_x	2.73	34.56
	a_y	6.24	46.94
	a_z	4.10	97.38
ACC Recov.	a_x	2.74	33.98
	a_y	6.21	46.97
	a_z	4.02	66.24

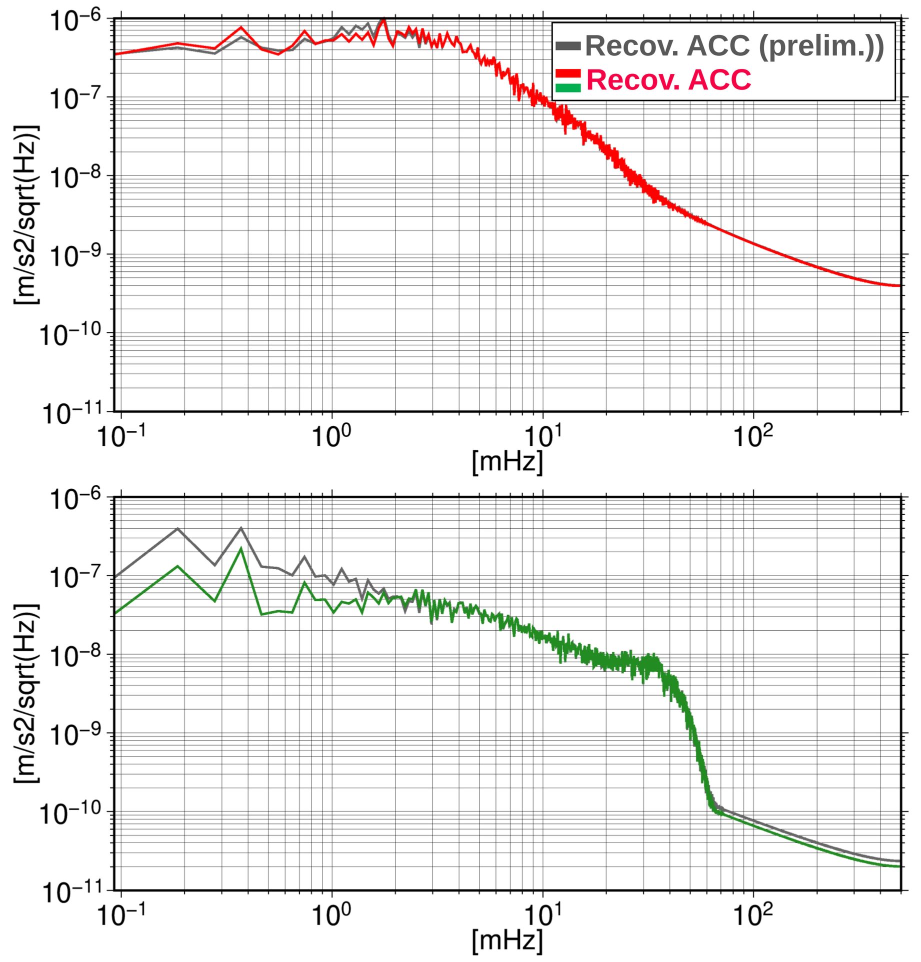


Fig.2: PSD of the difference of the recov. ACC1B relative to the original GRACE-B data in along-track and radial directions for 2015-03-07 in a 3h interval.

Gravity field recovery

- We recover the monthly gravity field solution based on the ITSG-Grace2018 processing standards [8] and compare the solution in terms of degree variances.

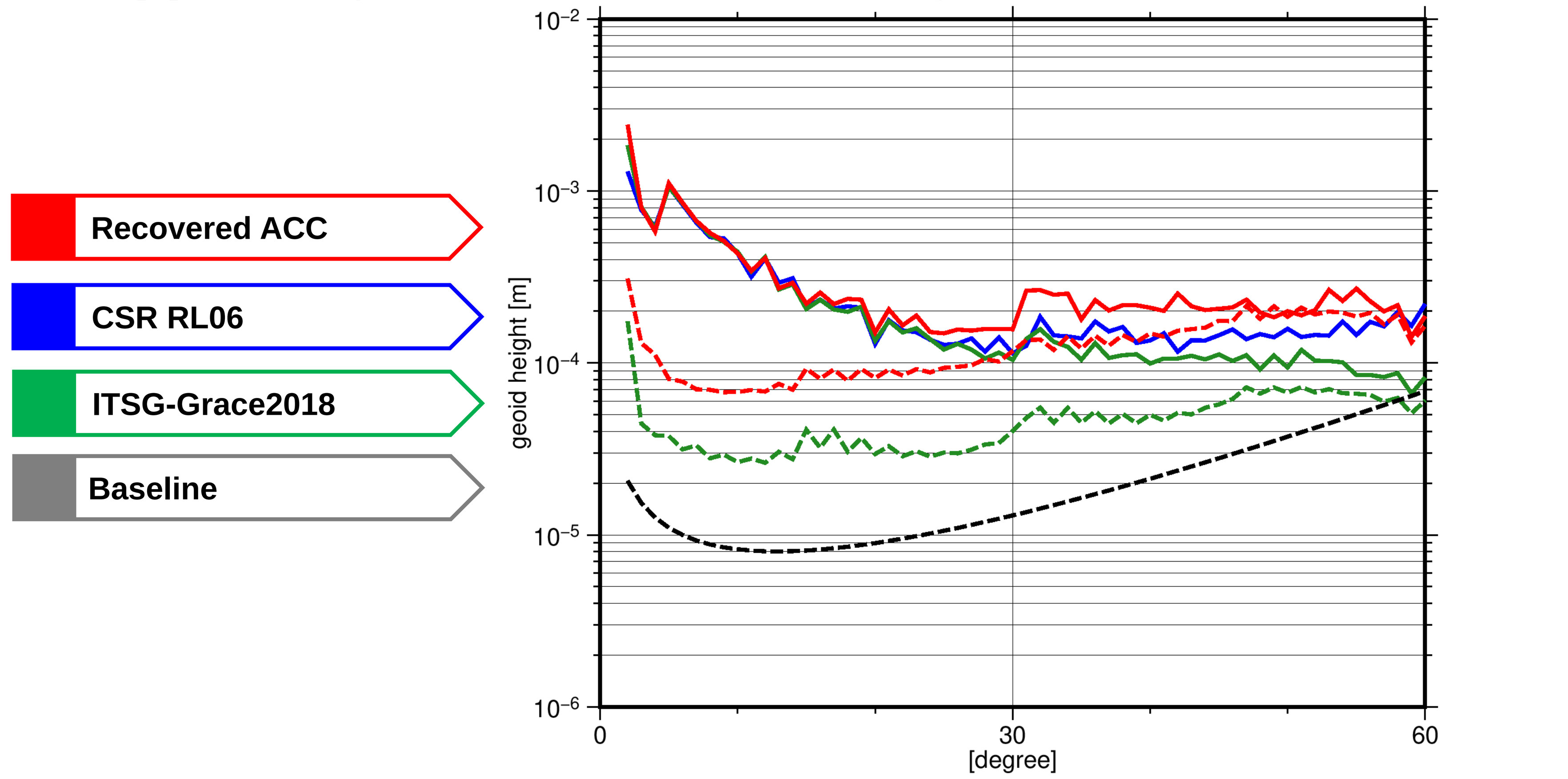


Fig.3: Difference of the degree amplitudes of the recovered monthly gravity field solution for the March 2015 computed w.r.t the ITSG-GraceGoce2017 static field.

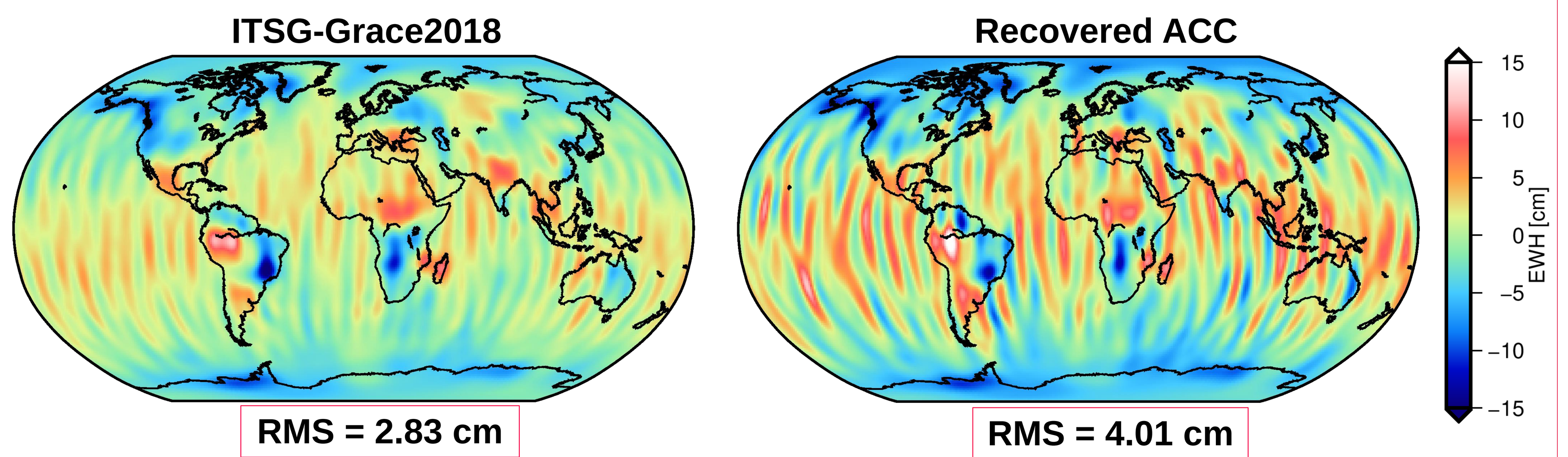


Fig.4: Monthly gravity field solutions w.r.t the reference field in terms of equivalent water height, 400 km Gaussian filter is applied.

Conclusion and outlook

- One major limiting factor in recovery of the GRACE-B ACC is the different aerodynamic forces experienced by each satellite due to a slight difference in their attitude. By using more precise aerodynamic force model and apply model corrections, we improve the quality of recovered data up to 30% in radial direction.
- **Next steps:**
  - Thruster response model of GRACE-B,
  - GFO real data analysis and gravity field recovery as soon as GFO data products are available.

Acknowledgments

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