Using Swarm to derive global sea level budgets

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Abstract

A combination of GRACE and altimetry has been used in a joint inversion to split total sea level change into its individual components, such as GIA, melting of ice sheets and glaciers, steric changes, hydrology, etc. (Rietbroek et al., 2016). This approach is only possible, when both (GRACE and altimetry) are available. Regarding the gap between GRACE and GRACE-FO and the monthly GRACE gaps, it is of great importance to extend the time series of sea level contributions. Lück et al. (2018) have shown that monthly global mean ocean mass changes can be derived from Swarm with a root mean square error of 4.0 mm with respect to GRACE.

Here, we will show preliminary results of integrating Swarm into a global fingerprint inversion. The results indicate that differences to the original inversion arise mostly from the lack of the inter-satellite measurements of Swarm, rather than the lower degree of the gravity field.

Data & Method

GRACE RL06

- unsolved ITSG-Grace2018 normal equations
- ITSG-Grace2018 gravity fields (for comparison)
- JPL RL06 mascons (for comparison)

Swarm RL06

- normal equations computed at IGG Bonn (Lück et al., 2018)
- IGG-Swarm gravity fields (for comparison)

Altimetry

- Along-track Jason-1/-2/-3 altimetry data from the Radar Altimetry Database System (RADS)

Fingerprint Inversion (Rietbroek et al., 2016)

- The fingerprint inversion combines altimetric and gravimetric data to split total sea level change into different components

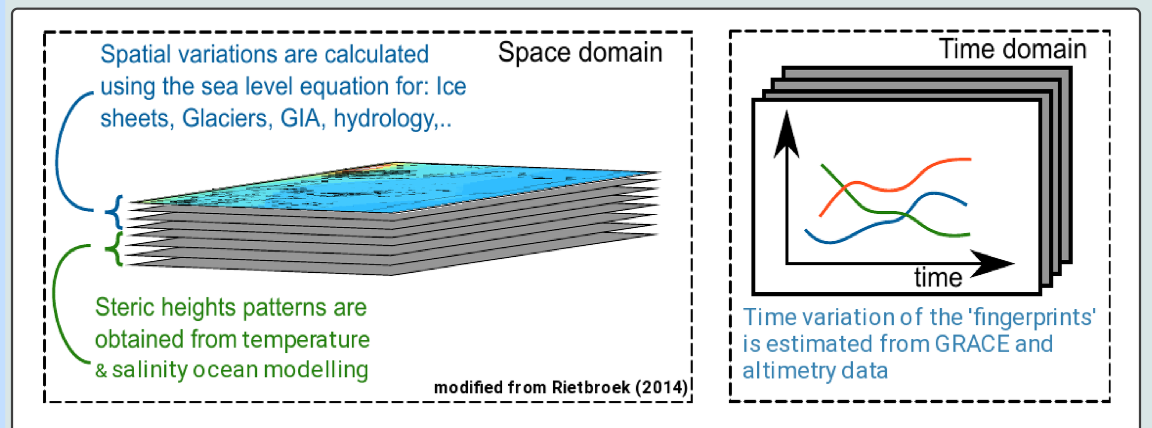

Figure 1: Time-variable amplitudes (right) are fitted to time-invariant patterns (left)

- Each contribution is parameterized by predefined spatial patterns ('fingerprints')
- Fingerprints are either mass-related (glaciers, antarctica, greenland, hydrology, internal mass veriation) or steric (FESOM)
- The temporal evolution for each fingerprint is estimated in a least squares adjustment

Results

- Ocean mass from the inversion fits better to the mascon solution (RMSE 2.9 mm) than to the direct GRACE solution (RMSE 6.8 mm) (see Fig. 2)
- Reducing the resolution of the inversion has an effect on the trend that needs to be investigated (see Tab. 1)
- Adding Swarm to the inversion only has a small effect, if GRACE data is available → it will be interesting to look at GRACE gaps and the Swarm-only solution (see Tab. 1)
- Mass is overestimated in the Swarm-only inversion, while the steric part is underestimated (see Fig. 4)
- Experiment-1 shows the similar (smoothed) trend patterns as base run (see Fig. 5)

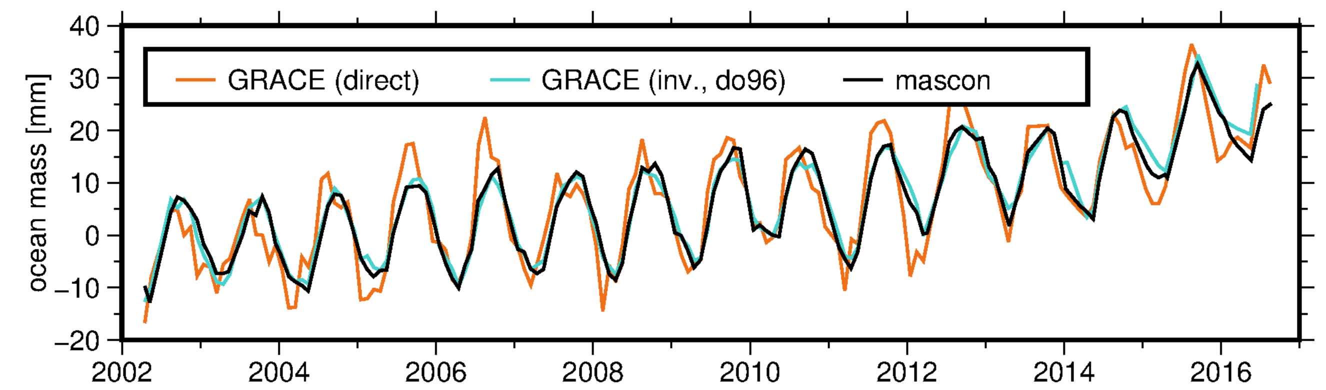

Figure 2: Comparison of ocean mass from GRACE, inversion and GRACE-mascons

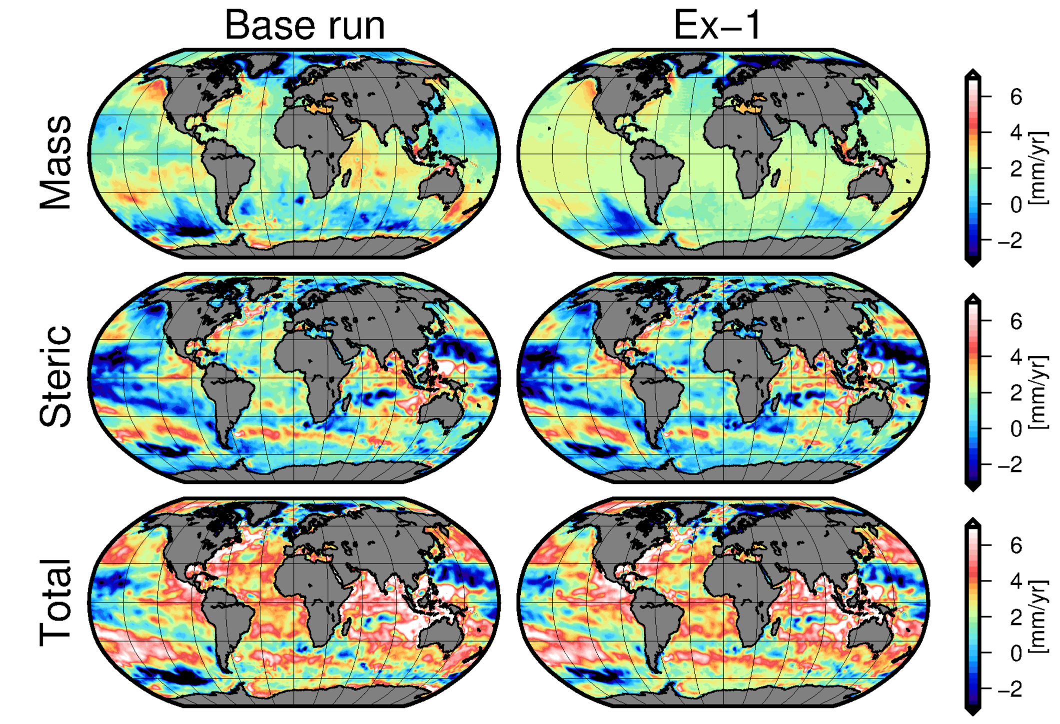

Figure 3: Trend maps of inversion base run and lower resolution-version

Trends [mm/yr] for GRACE period

	Base run	Experiment-1	Experiment-2
Mass	1.70	1.88	1.88
Steric	1.17	1.05	1.04
Total	2.86	2.92	2.92

Table 1: Trends for existing GRACE months between 2002-04 and 2016-06

Time series for inversion experiments

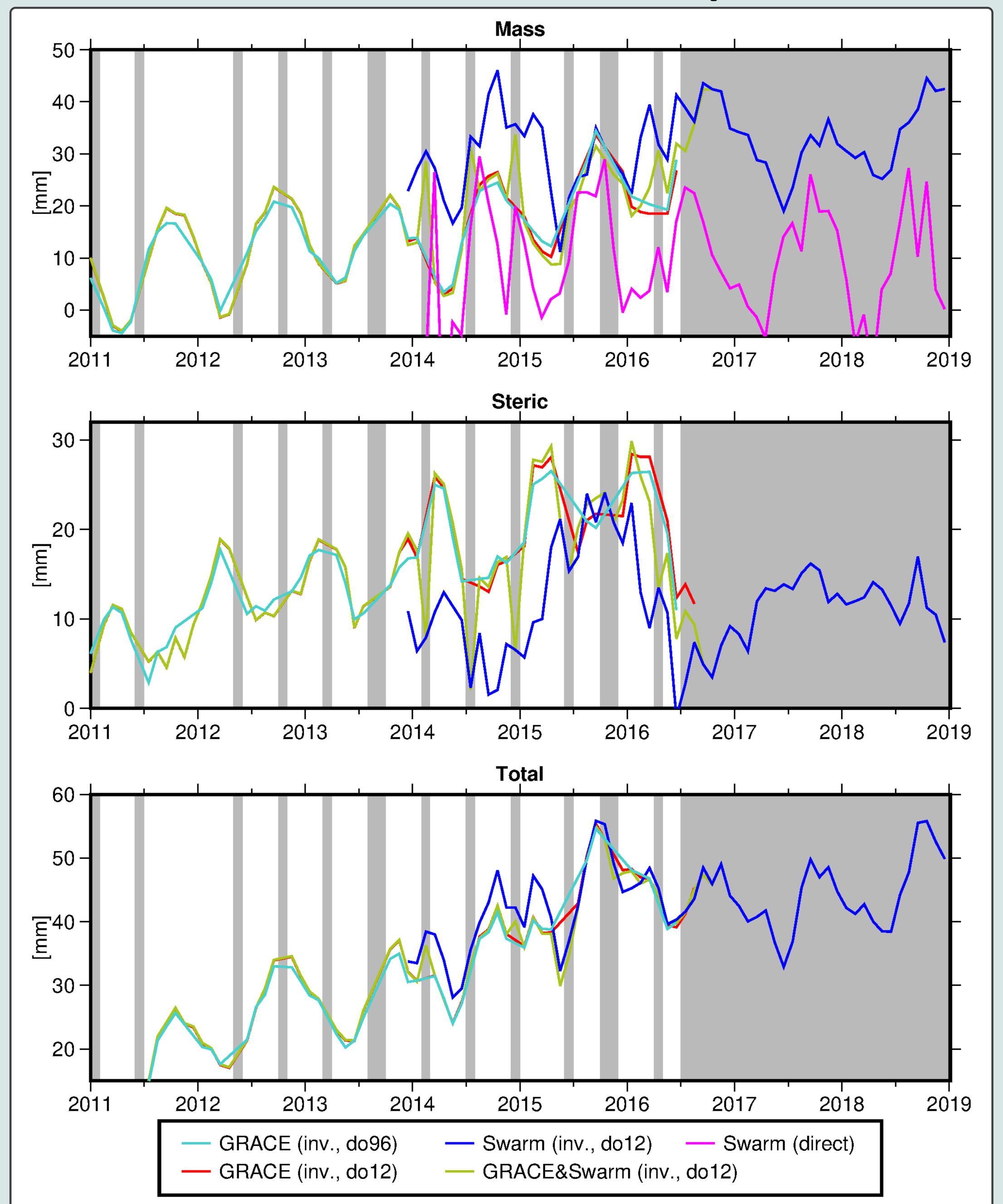

Figure 4: Sea level budget from the inversion experiments

Experiments

We will show three experiments:

- inversion base run, using all available degrees of GRACE
- using GRACE up to d/o 12 to mimic the Swarm resolution
- using GRACE & Swarm up to d/o 12

	Base run	Experiment-1	Experiment-2
GRACE NEQ	d/o 96	d/o 12	d/o 12
Swarm NEQ	-	-	d/o 12
# mass patterns	169	35	35
# steric patterns	250	250	250

Conclusion

- Experiment-1 shows similar results to the original inversion base-run
- If GRACE data is available, Swarm only has a minor influence on the solution
- The Swarm-only inversion overestimates mass, while it underestimates the steric part
- These results indicate that the differences between the GRACE-only solution and a Swarm-only solution arise from the lack of the inter-satellite ranging system, rather than from the reduced degree and order
- Further work needs to be done for deriving a sea level budget from Swarm

References

Rietbroek, R., Brunnabend, S.-E., Kusche, J., Schröter, J. and Dahle, C., 2016: Revisiting the contemporary sea-level budget on global and regional scales. Proceedings of the National Academy of Sciences, 113, 1504-1509

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