Ocean mass time series from GRACE: influence of corrections, masks and filters

Roelof Rietbroek[1], Bernd Uebbing[1]

(1) Institute of Geodesy and Geoinformation, University of Bonn

Introduction

The Gravity Recovery and Climate Experiment (GRACE) has the unique ability to directly observe mass variations in the ocean. Ocean mass trends in particular provide information on the melting of ice sheets and glaciers, groundwater depletion and other terrestrial water storage changes. Furthermore, by combining GRACE with geometric sea level changes from altimetry, it is possible to infer volumetric (steric) changes in the ocean, which are linked to the warming of the ocean.
However, several processing steps are necessary in order to obtain time series of the Ocean's mass. This poster sheds some light on the question:

"How do processing choices affect estimates of GRACE derived ocean mass time series?"

Methodology

To quantify the effect of the individual processing choices, we apply a brute force approach and vary 9 different parameters (see below) to compute time series and trends for all possible combinations. Then, we extract a sub-ensemble of time series which have a certain processing choice fixed. Figures 2-10 illustrate the influence on the ocean mass time series when varying a certain processing parameter. The trendbars indicate the min, max and median trends extracted from the time series of the sub-ensemble.

For each processing parameter we plot a figure ((semi-)annual harmonics removed):

- Fig. 2 → **Filter** (no filter, Gaussian with halfwidth of 200km, 400km, anisotropic filter [1] DDK1, DDK5)
- Fig. 3 → **Glacial Isostatic Adjustment correction** (two models based on ICE-5G and one empirical model with a lower Antarctic signal)
- Fig. 4 → **Spherical harmonic truncation** (maximum degree 60 vs. 90)
- Fig. 5 → **Geocenter motion correction** ([2, 3])
- Fig. 6 → **Ocean/Atmosphere restoring** (GAC vs. GAD)
- Fig. 7 → **Processing center** (CSR vs. GFZ)
- Fig. 8 → **Ocean mask** (with and without 300km coastal strip, see Fig. 1)
- Fig. 9 → **Leakage correction** (no correction vs. a correction according to [4])
- Fig. 10 → **Averaging method** (spectral domain vs. spatial domain)

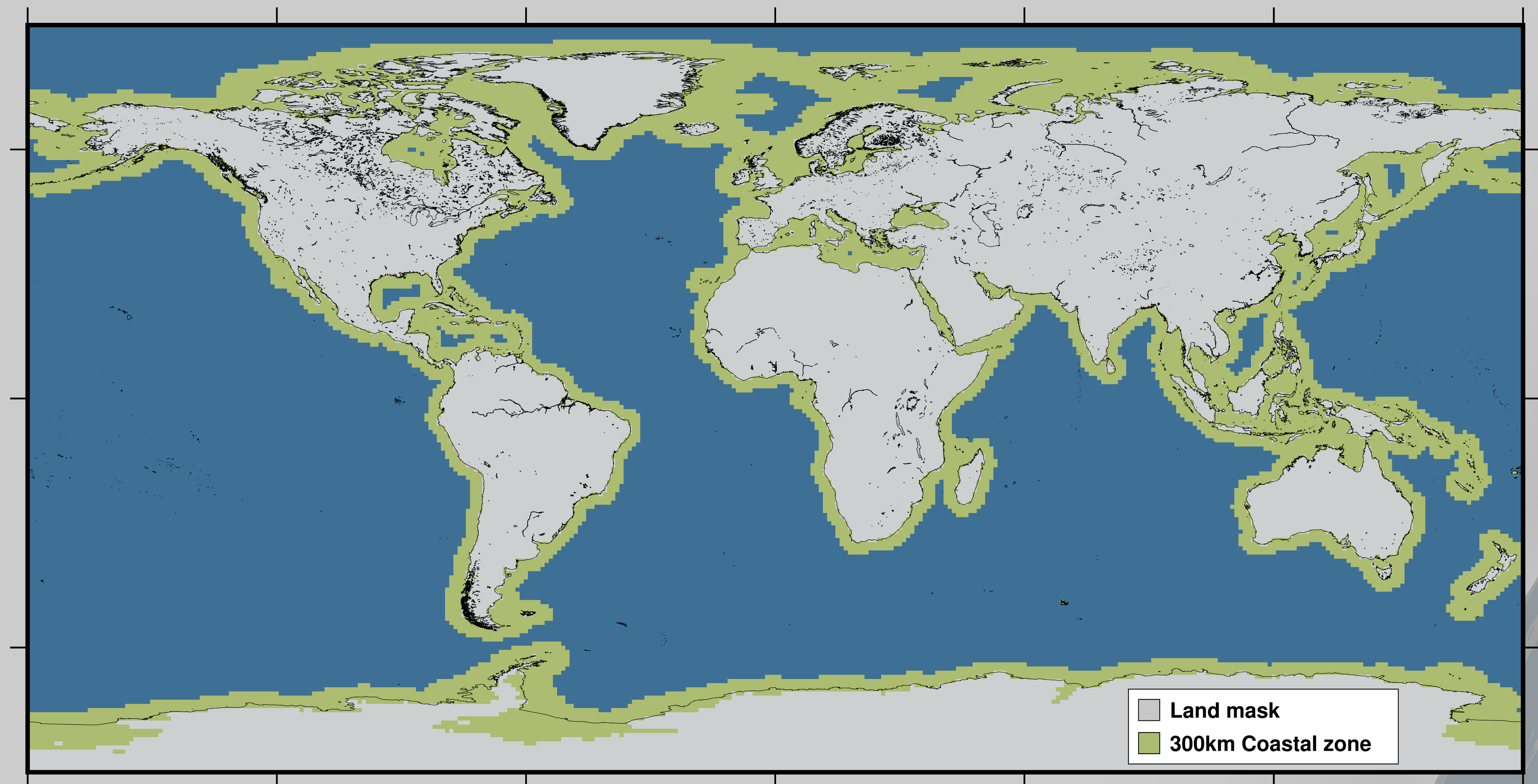

Fig. 1 Land mask and additional 300km coastal strip used in the varying ocean masks.

GRACE global ocean mass ensembles with trends (min, max, median)

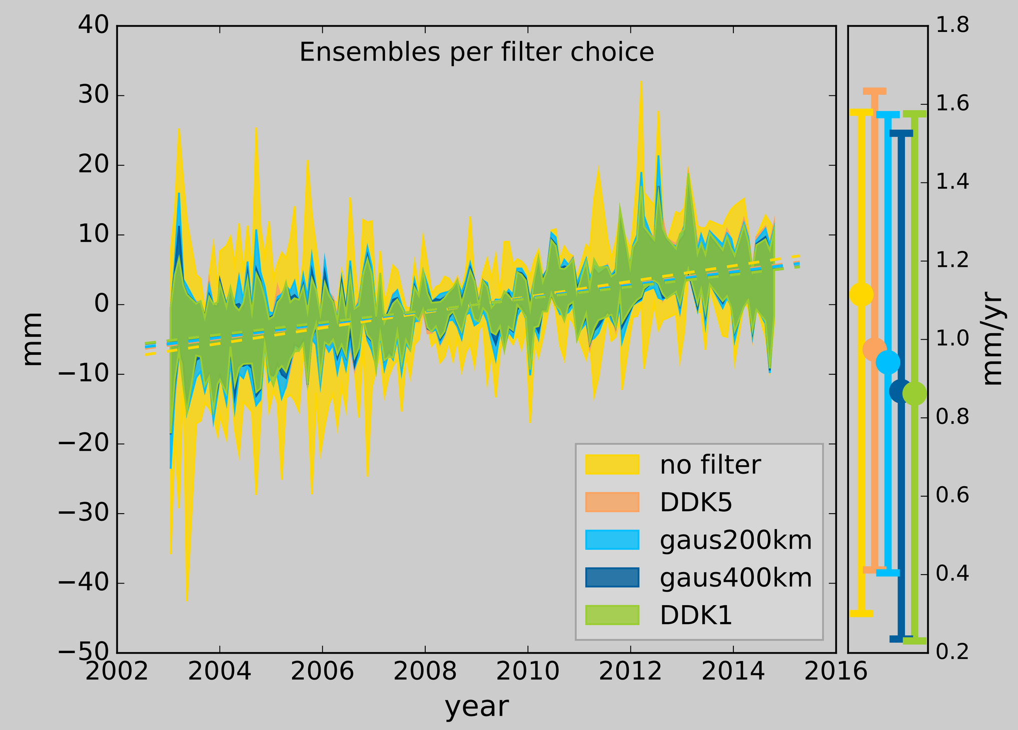

Fig. 2 Applying a filter (Gaussian or anisotropic [1]) attenuates the variation of the ocean mass series, yielding a smaller trend (by about 0.1-0.2 mm/yr).

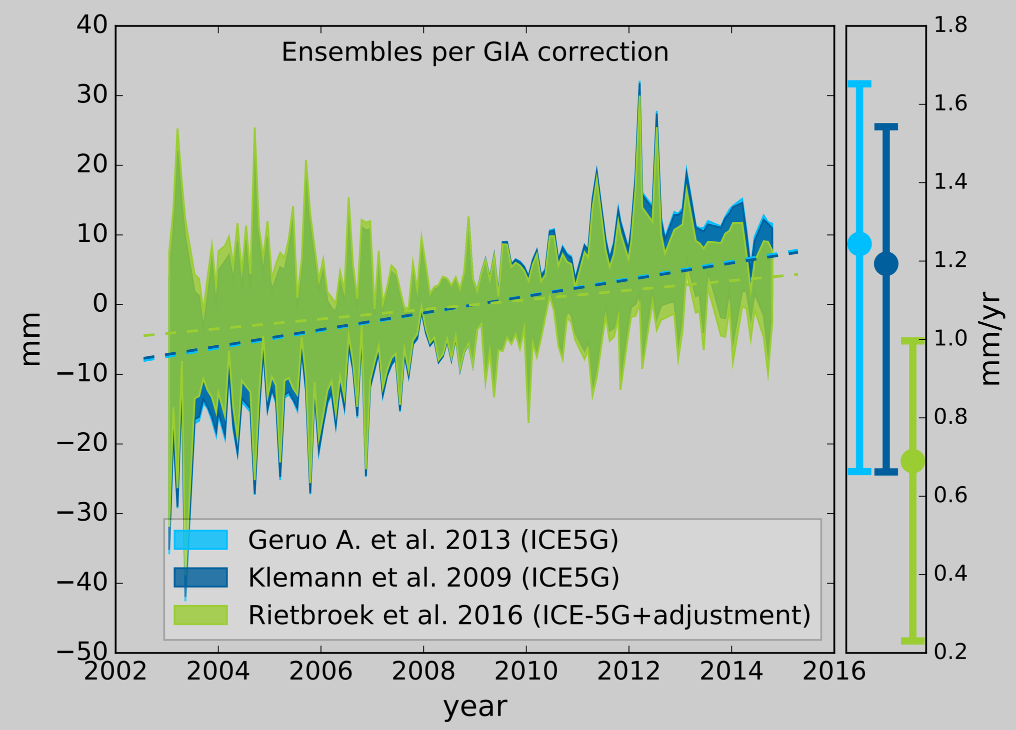

Fig. 3 Discrepancies in the GIA models (mainly in Antarctica) cause trend shifts in the order of 0.4 mm/yr!

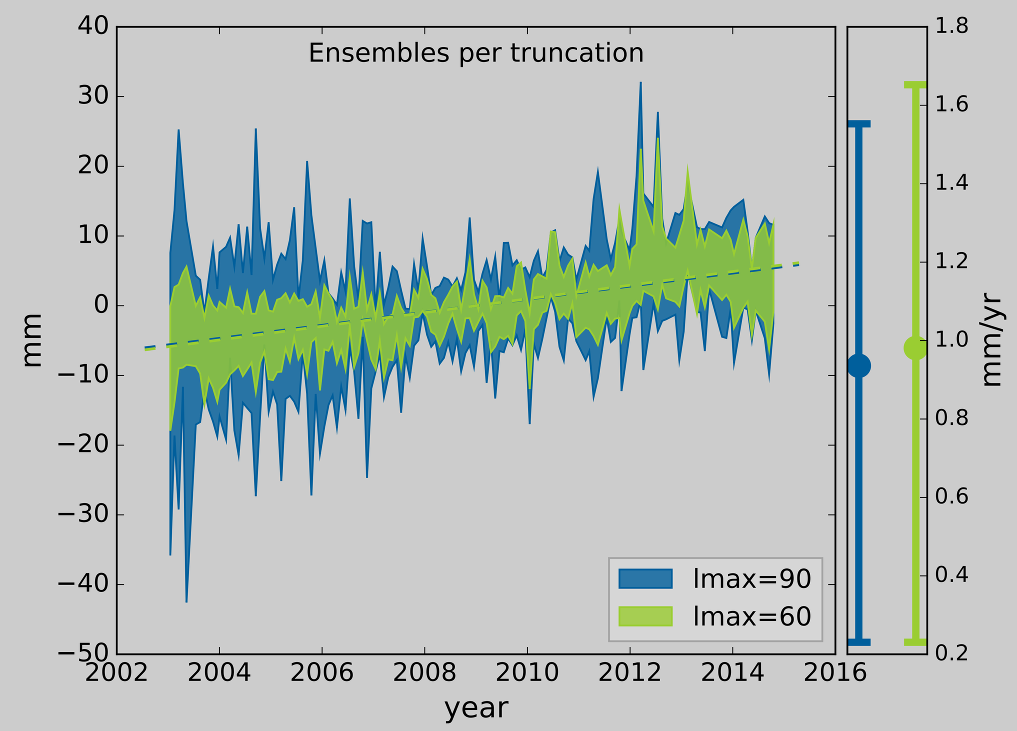

Fig. 4 A lower truncation degree acts similar to a filter. Trends are not significantly affected, while short time fluctuations are attenuated.

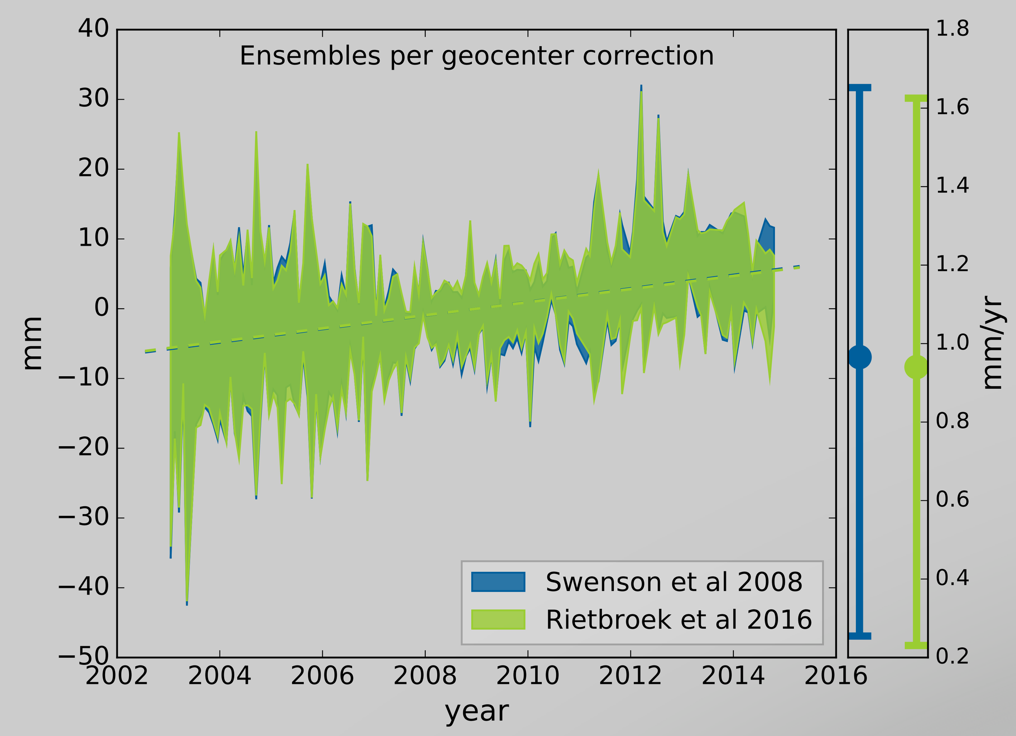

Fig. 5 The different geocenter motion corrections produce no significant differences in the time series and trends.

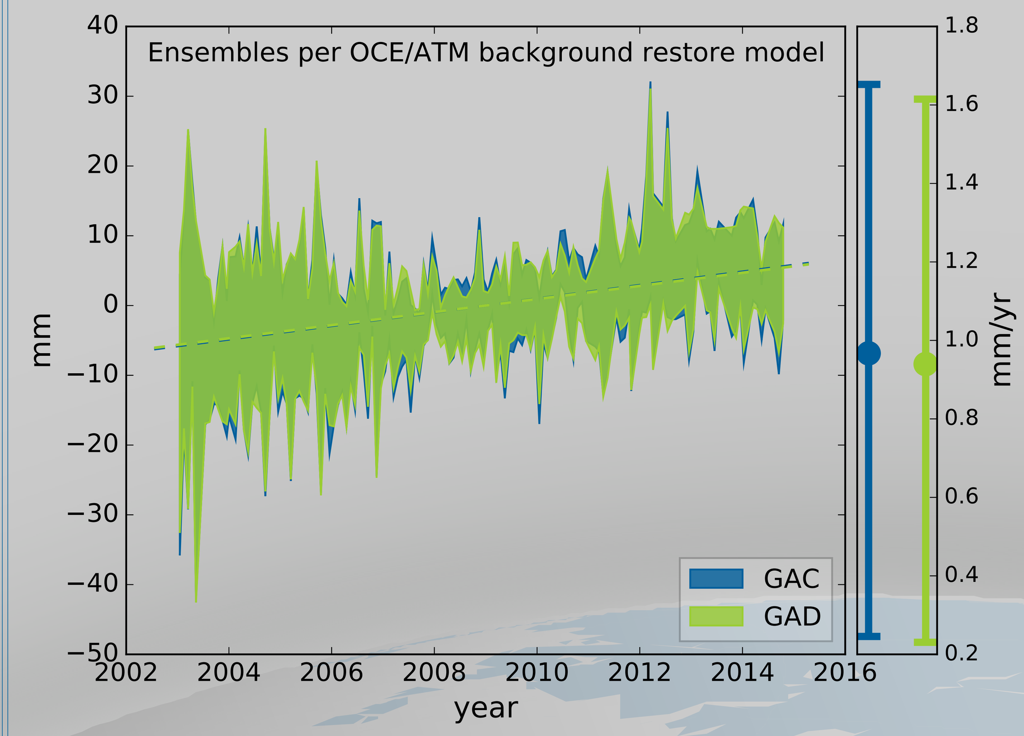

Fig. 6 The selection of the GAC or GAD product has a slight affect on the variability but leaves the trend practically the same.

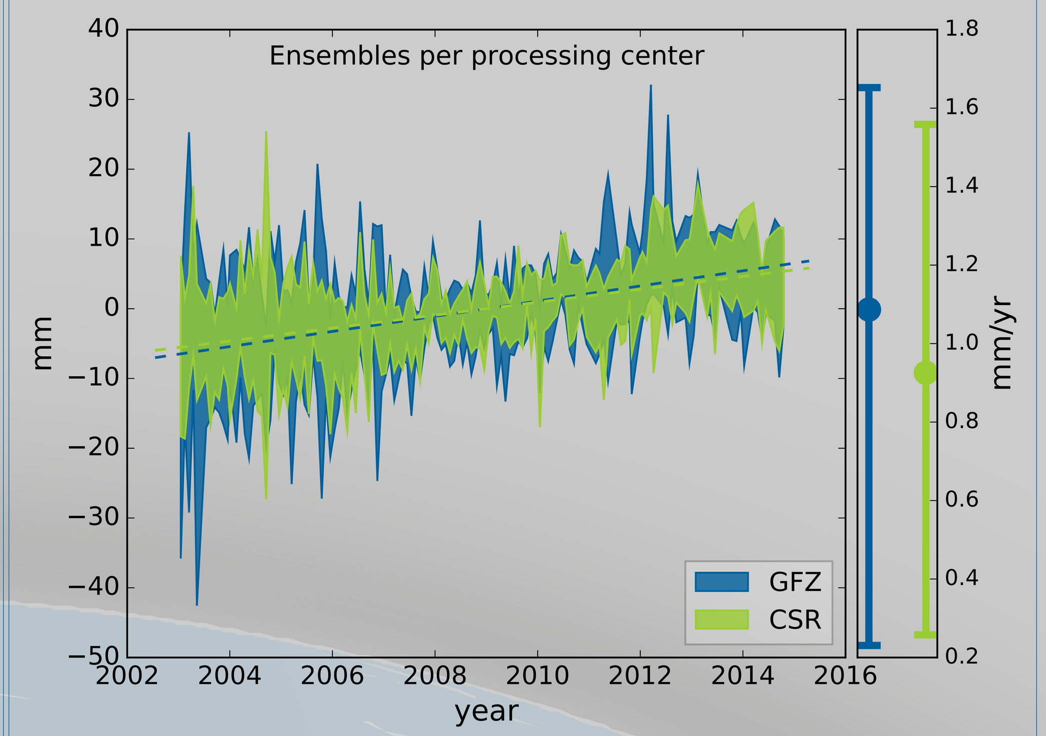

Fig. 7 The variability of the mass time series is somewhat larger when using the GFZ solutions.

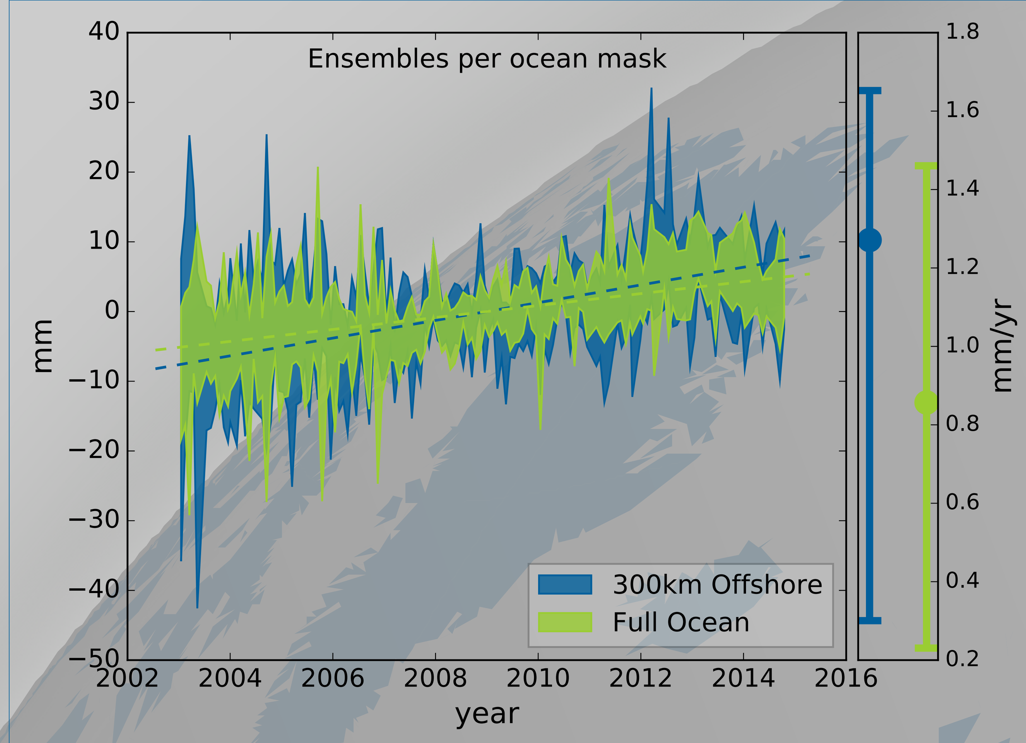

Fig. 8 Excluding a coastal strip of 300km in the coean mask, pushes the median trend upward by about 0.4 mm/yr!

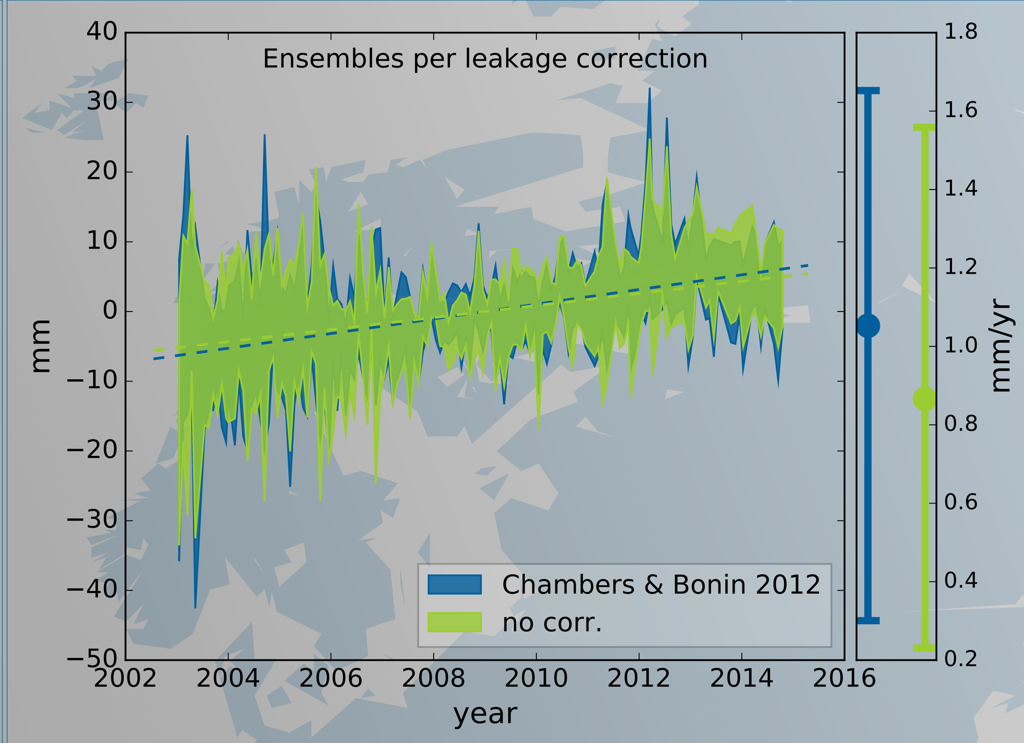

Fig. 9 Applying a leakage correction according to [4] shifts the trend upward by about 0.1 to 0.2 mm/yr.

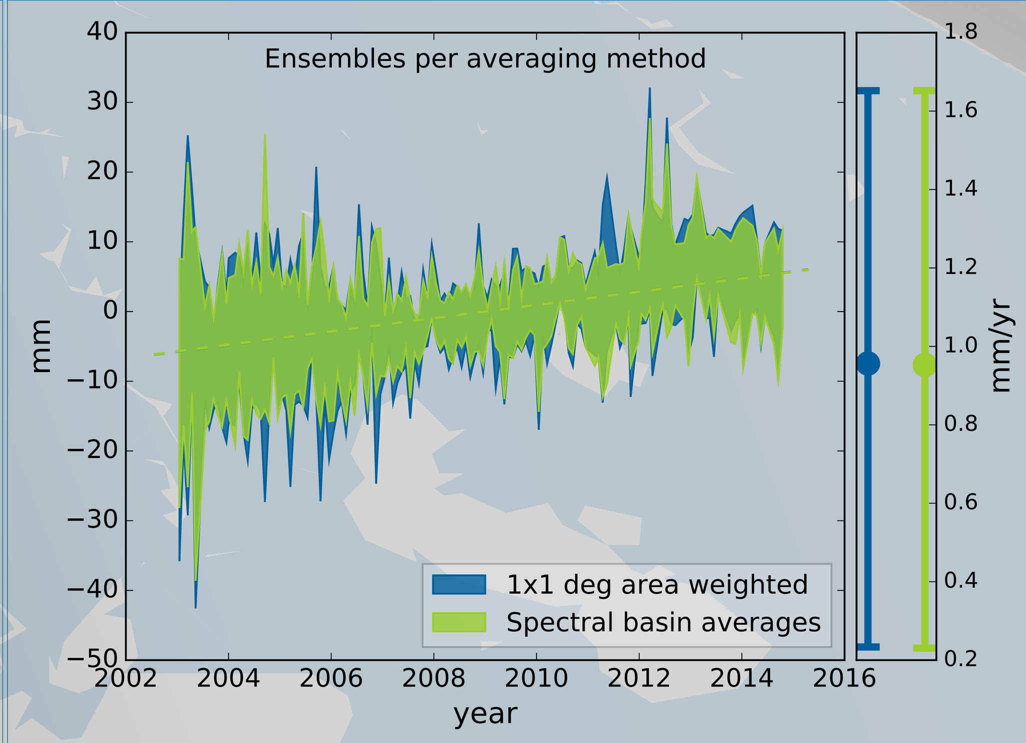

Fig. 10 Due to the spectral/spatial discretization, the averaging methods are not perfectly equivalent but (should) produce about the same time series.

Conclusions

- A GIA correction, with a weaker Antarctic signal, reduces the trend by about 0.4 mm/yr
- Furthermore, excluding an additional 300km of coastal zone in the ocean mask and applying a leakage correction shift the trend upward by about 0.4 mm/yr.
- Trends range for the entire ensemble (mm/yr): 0.2 (min), 1 (mean, median), 1.7 (max)

References

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Contact
Roelof Rietbroek
@r_rietje
roelof@geod.uni-bonn.de

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