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Improving the representation of ice-sheet mass changes in the global inversion for sea-level contributions

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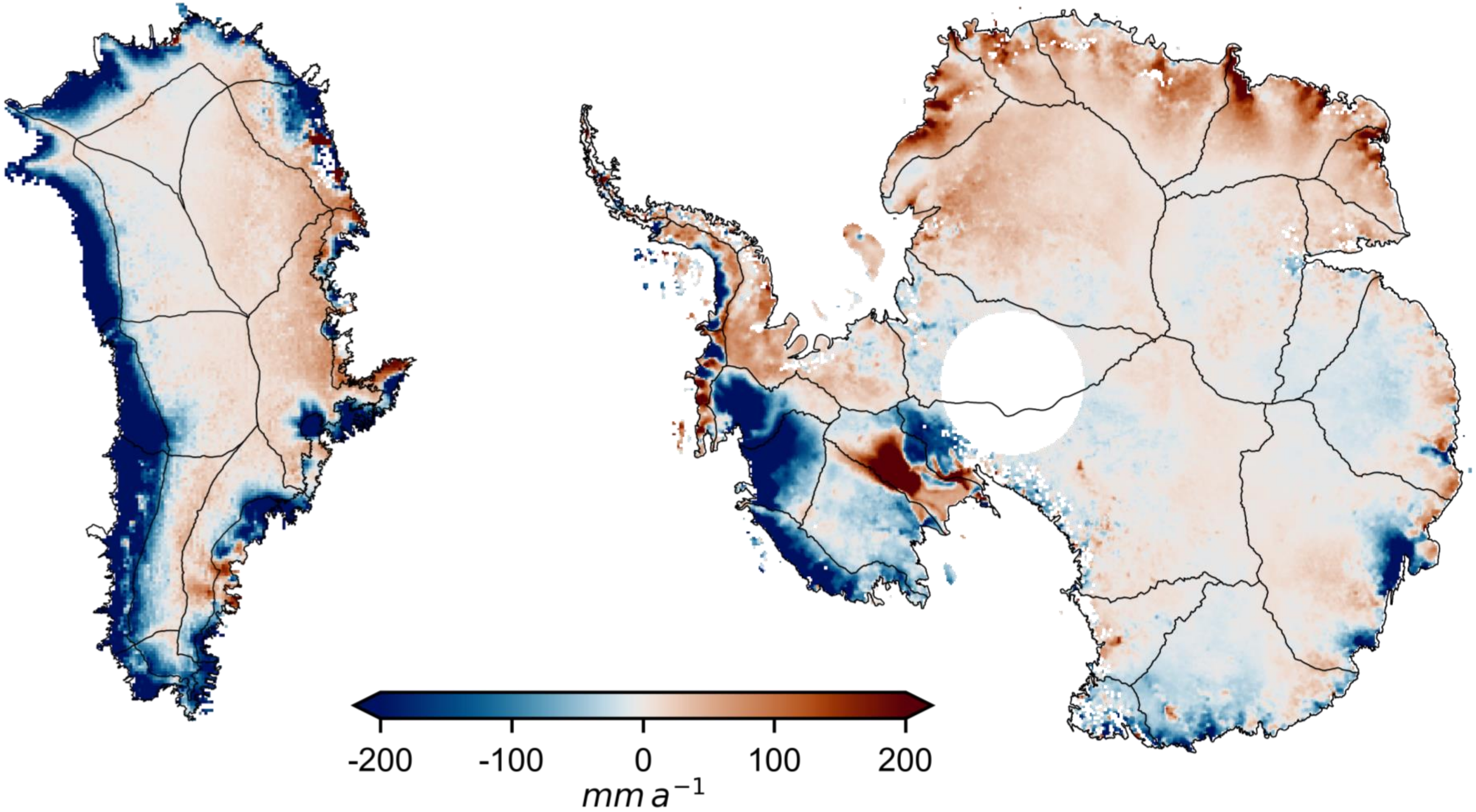
Overview

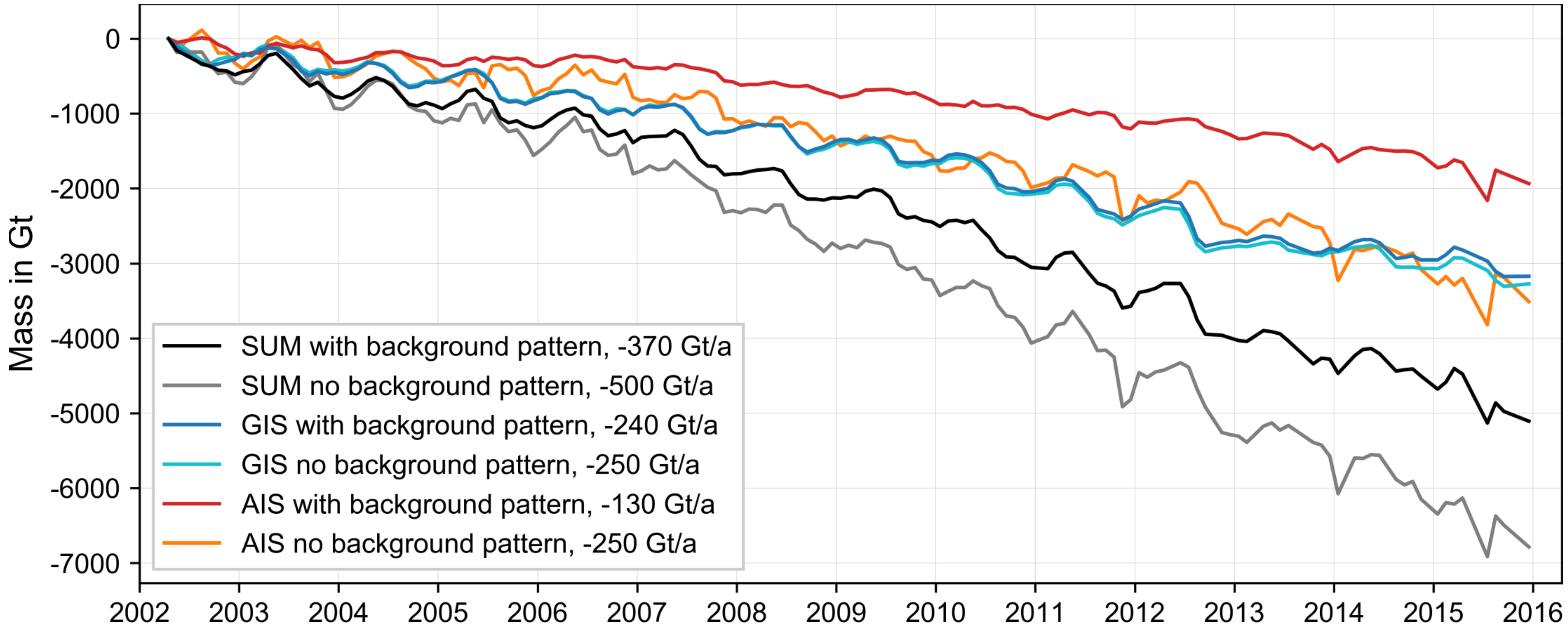
- in the inversion framework (Rietbroek et al., 2016), GRACE and altimetry data are combined with prescribed patterns to solve for the sea level budget
- so far in the framework ice sheets are represented by uniform mass changes in drainage basins
- here trend patterns derived from ice altimetry observations are implemented to allow for a more realistic spatial variability in each drainage basin
- we attempt to overcome limitations on co-estimating the glacial isostatic adjustment (GIA) signal with an improved GIA parameterization in our future work
- here we present preliminary results from an approach which uses globally consistent patterns to parameterize GIA
- the approach is applied to simulated gravity changes and ice height changes over Antarctica

Patterns based on trends from ice altimetry



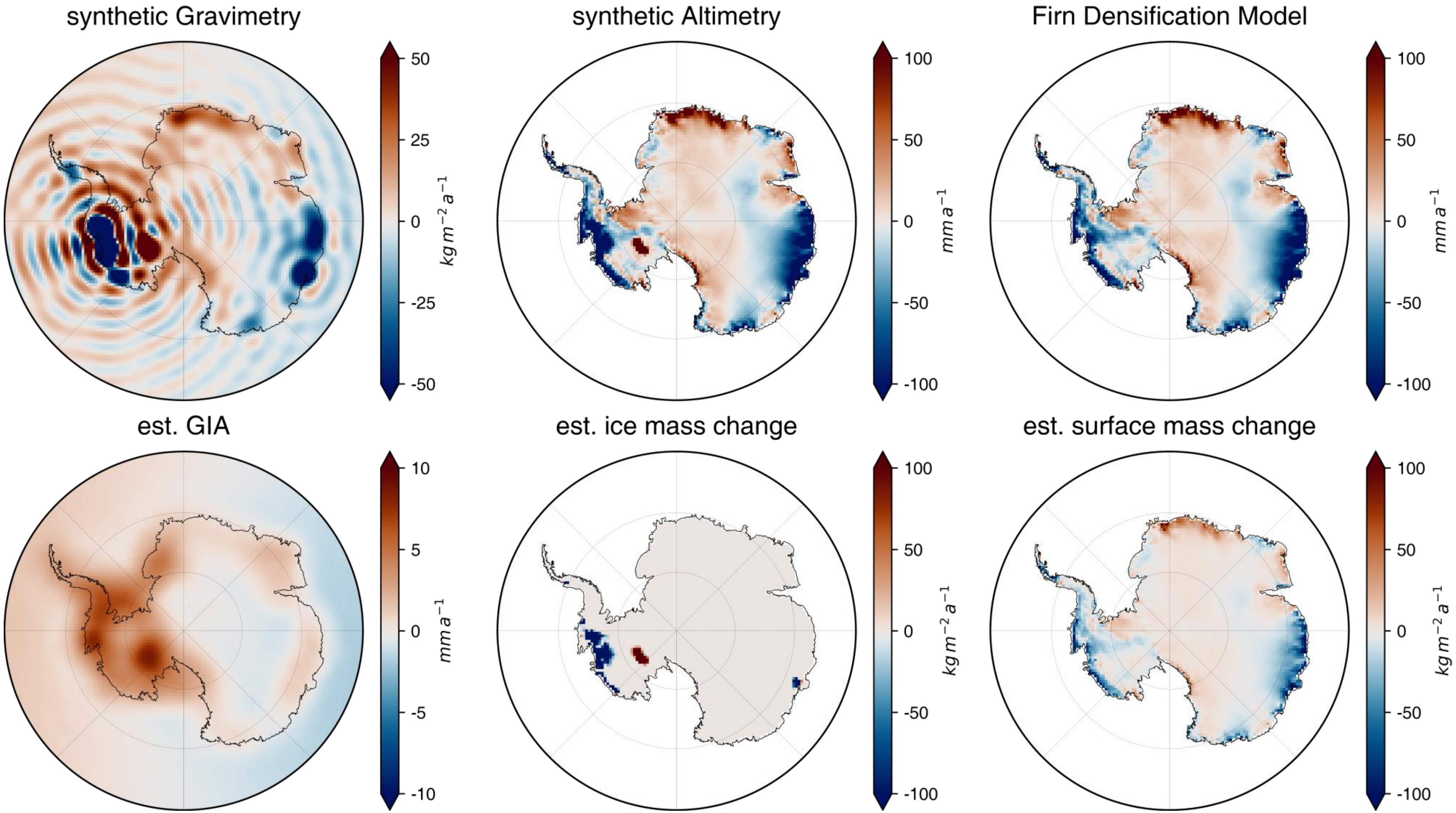
Altimetry-derived ice height trends for the Greenland Ice Sheet (left) and the Antarctic Ice Sheet (right) from Strößenreuther et al. (2020) and from Schröder et al. (2019), respectively.

Mass changes of ice sheets from global inversion

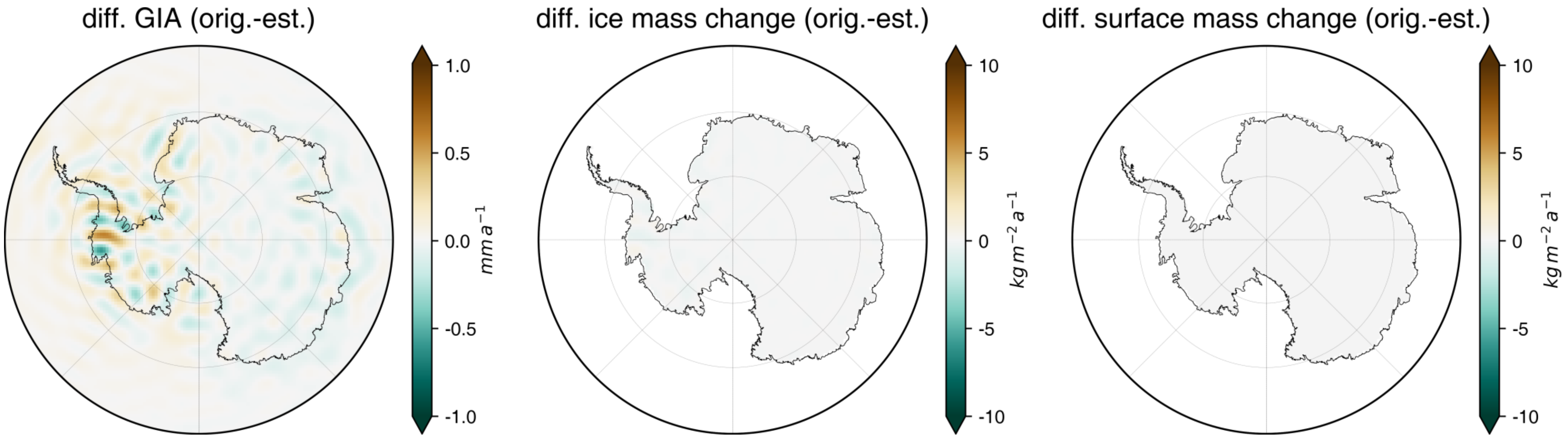


Time series of mass changes of ice sheets from GRACE and Jason-altimetry via global fingerprint inversion. One inversion run incorporates trend patterns for the Greenland Ice Sheet (GIS) and the Antarctic Ice Sheet (AIS) (black, blue, red). The other run uses uniform mass change in every drainage basins (gray, cyan, orange).

Improved parameterization of GIA applied to simulated observations



Improved parameterization of GIA applied to simulated observations



From synthetic data (Gravimetry, Altimetry, and firn trends) we separated GIA, ice mass change and surface mass change using a joint parameter estimation approach. Ice mass changes and surface mass changes are parameterized with point masses. GIA is parameterized with globally consistent patterns from GIA forward modelling (Spada and Melini, 2019). Differences between input signals an the estimated signals are small (please note the different value range).

Conclusions and Outlook

- incorporated trend patterns strongly affect the inversion results for the AIS but weakly for the GIS
- individual Antarctic basins patterns from assuming a uniform mass change much more absorb signals than patterns from assuming a variable mass change
- a large amount of the uncertainty of the sea level budget can be attributed to GIA (Uebbing et al., 2019) – in our future work we will implement the improved parameterization of GIA into the global fingerprint inversion framework along with observations from ice altimetry

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