Correlations between a regional climate model and spaceborne gravimetry and altimetry for the Antarctic ice sheet

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Summary

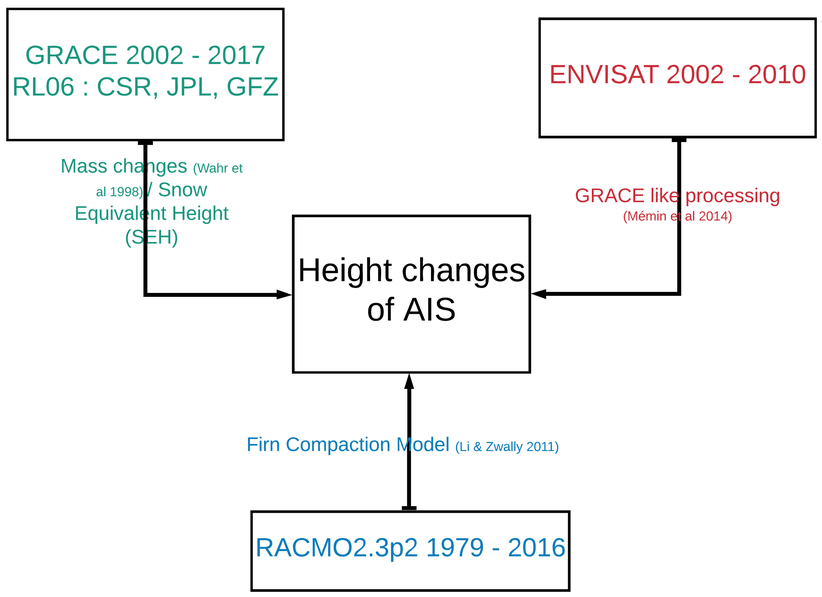
Precisely quantifying the Antarctic Ice Sheet (AIS) mass balance remains a challenge as several processes compete at differing degrees in the basin-scale with regional variations.

We study the AIS changes using surface-elevation and gravity changes derived from Envisat data and GRACE solutions respectively. We use surface-mass balance from the climate model RACMO to estimate height changes of the AIS which can be compared with other observations.

Data

- Period of study: Envisat lifetime (09/2002 – 09/2010)
- Reference: 03/2004
- Gravity changes from GRACE solutions:
  - Ensemble of RL06 solutions from CSR, JPL, GFZ
  - Cosine filtered between degrees 30 and 50
  - Converted to mass changes [1]
- Data from Envisat and RACMO2.3p2 undergoes GRACE like filtering [2]
- Climate parameters from RACMO2.3p2 [3] including surface mass balance (SMB), temperature, wind velocity, etc.

Methodology



- Mass changes derived from GRACE is converted to snow equivalent height (SEH)
- Firn compaction model is implemented to compute height changes from climate parameters

Firn Compaction Model

- Height changes is the sum of accumulation, compaction, ablation, motion and bedrock upliftment[4]
- Ablation and bedrock upliftment and is neglected across AIS since it is negligibly small
- Compaction is triggered by changes in accumulation or temperature or both
- A semi-empirical firn compaction model is implemented [5] [6]

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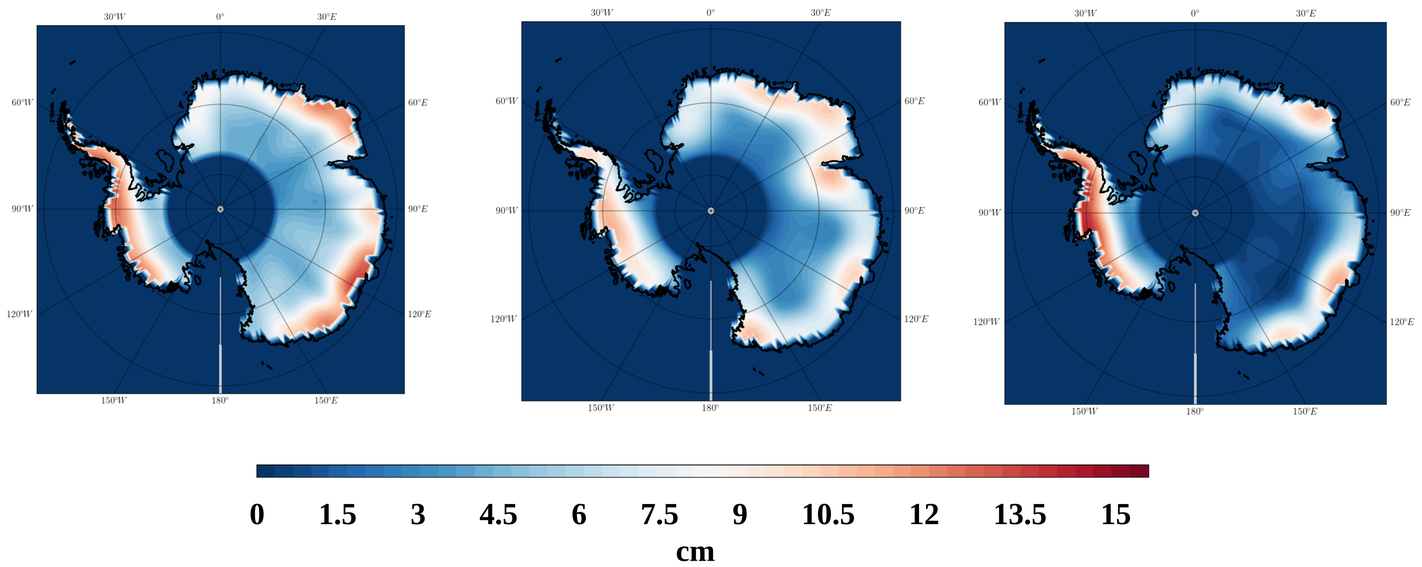
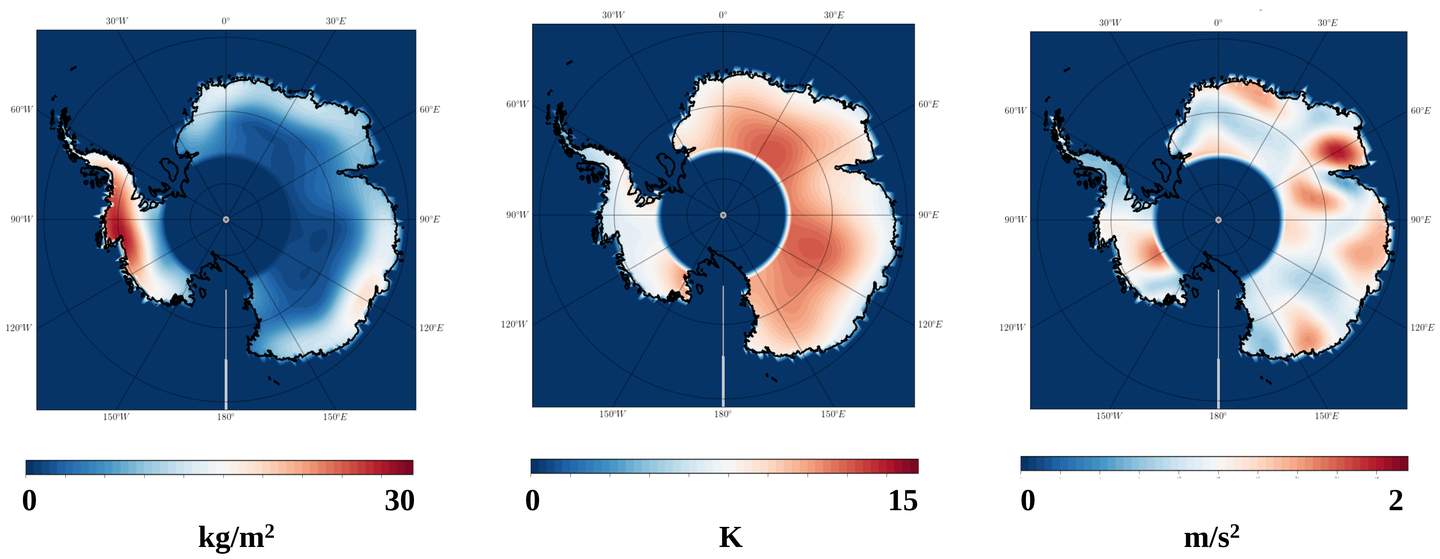
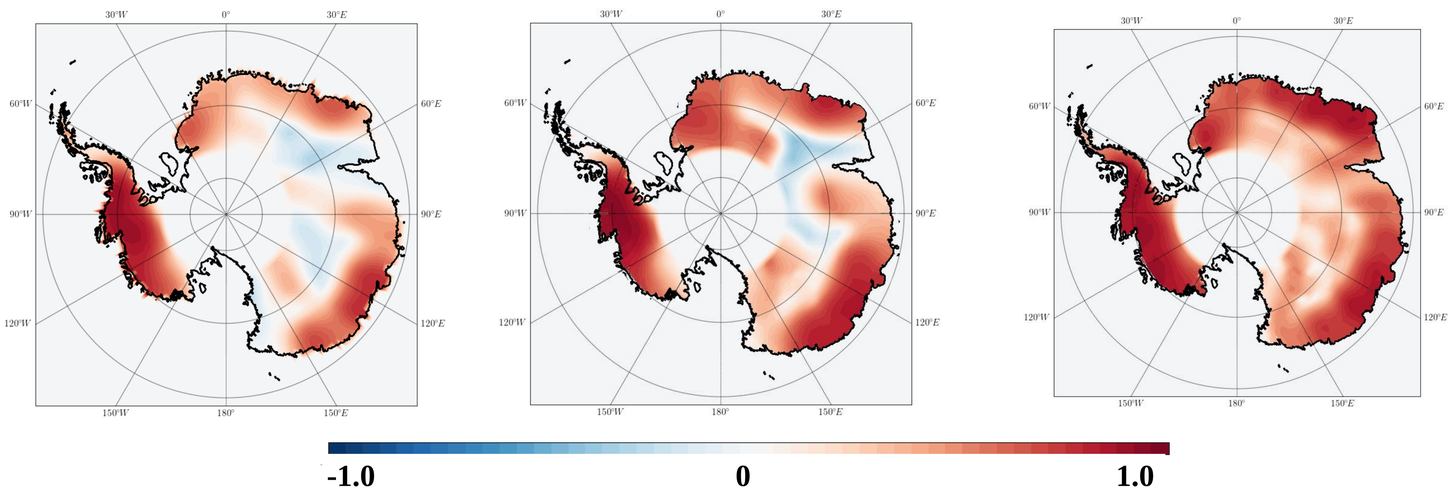
Standard deviation of the AIS height changes estimated from



Standard deviation of influencing parameters:



Maps of coefficient of correlation between:



Results and Conclusions

- Good correlation between estimates from spaceborne geodesy and the climate model
- Height change estimates agree very well especially along the coasts
- No clear evidence on impact of temperature and wind velocity on altimetry

References:
[1] Wahr et al., J. Geophysical Research: Solid Earth (1998)
[2] Memin et al., Earth and Planetary Science Letters (2014)
[3] Van Wessem et al., Cryosphere (2018)
[4] Zwally and Li, J. Glaciology (2002)
[5] Li and Zwally, J. Glaciology (2015)
[6] Max Stevens et al., GMD (2020)