How to optimize the spatial resolution of GRACE data for studying mass anomaly trends of the Greenland and Antarctic Ice Sheets? (PPT)

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How to optimize the spatial resolution of GRACE data for studying mass anomaly trends of the Greenland and Antarctic Ice Sheets?

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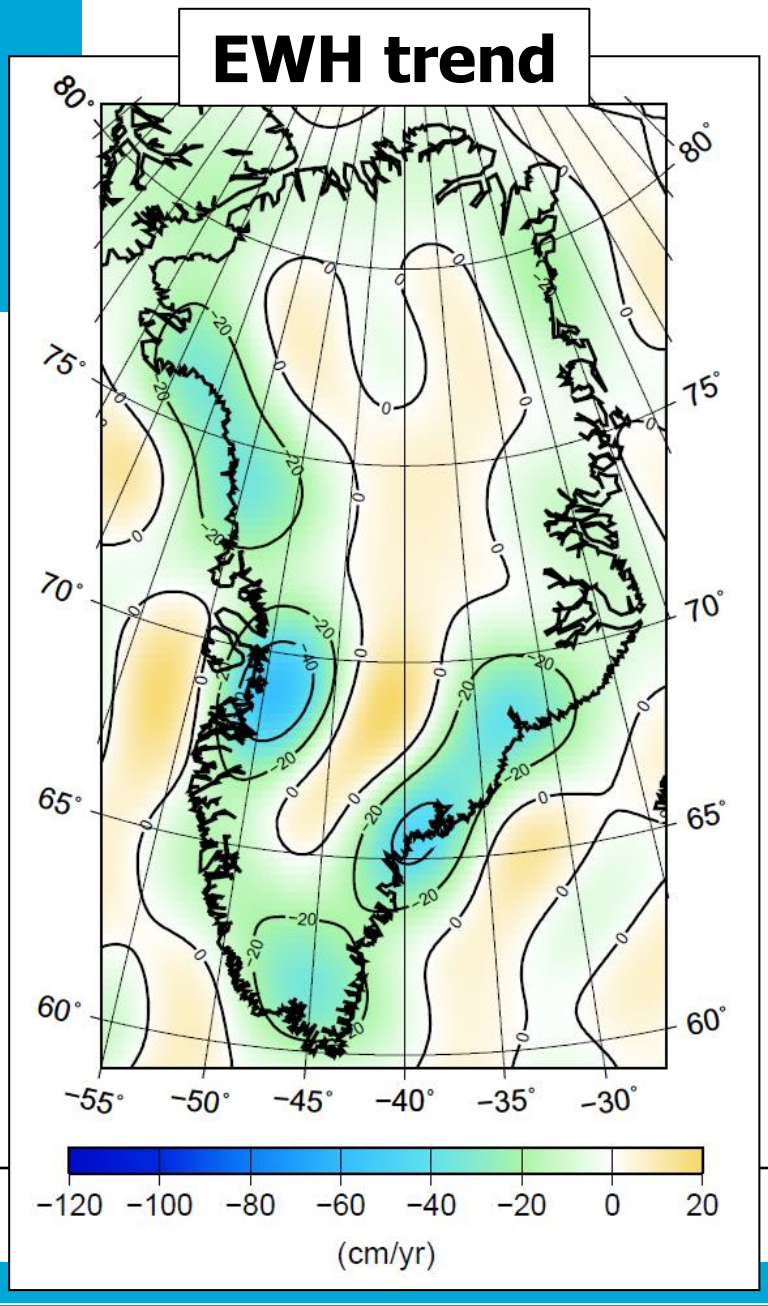
Research questions

- How to obtain unbiased high-quality high-resolution estimates of mass trends within the ice sheets from GRACE data?
- How robust are the obtained estimates?

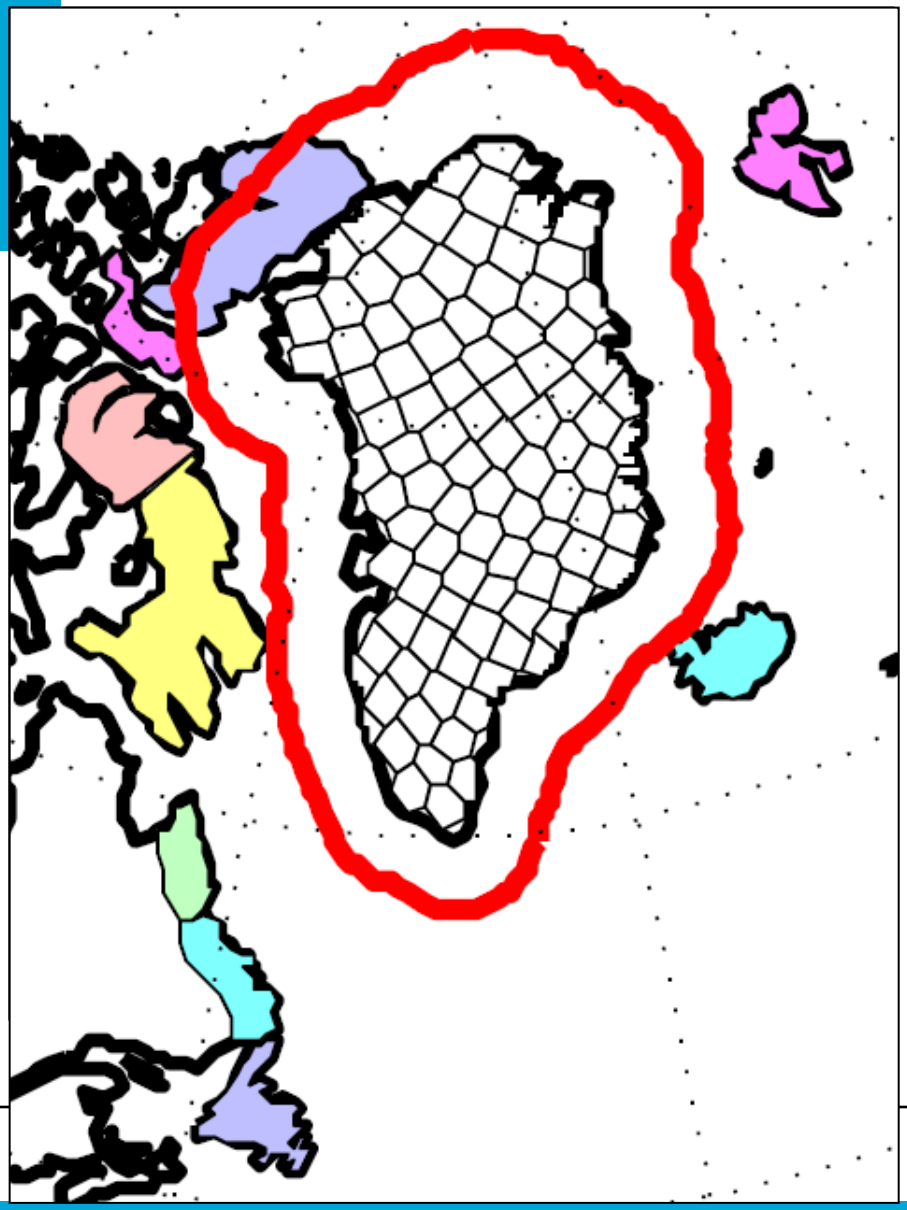
Primary input data



- GRACE gravity field solutions:
  - ITSG-Grace2016 (90x90)
  - (Degree-1, C_{20}): Y.Sun et al (2016)
  - GIA: A et al (2013)

- Time interval: 2003 – 2012

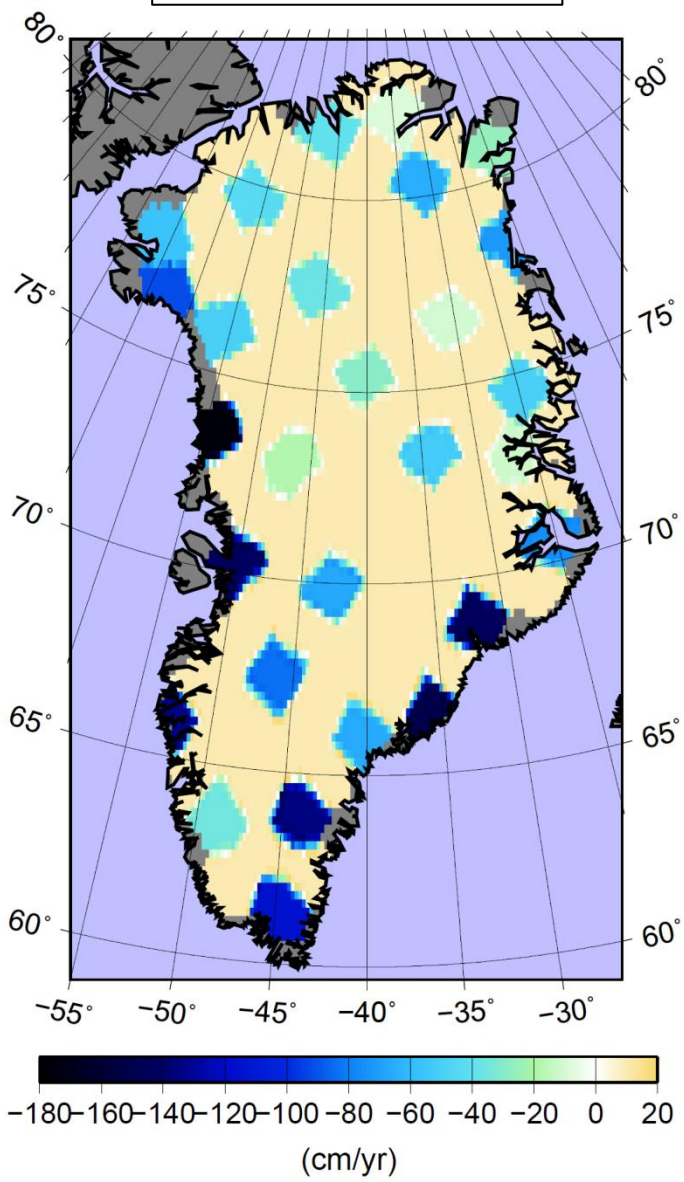
Mascon approach



- **Synthesized gravity disturbances:**
  - **h = 500 km**
  - **Point-to-point separation: 1°**
  - **Buffer width: 300 km**
  - **Inspired by: Forsberg & Reeh (2007)**
- **Parameterization:**
  - **Many small equal-size homogeneous patches inside Greenland**
  - **9 homogeneous patches around Greenland**
- **Inversion:**
  - **bounded above (trend<10 cm/yr)**

Inversion result (150-km patches)

EWH trend

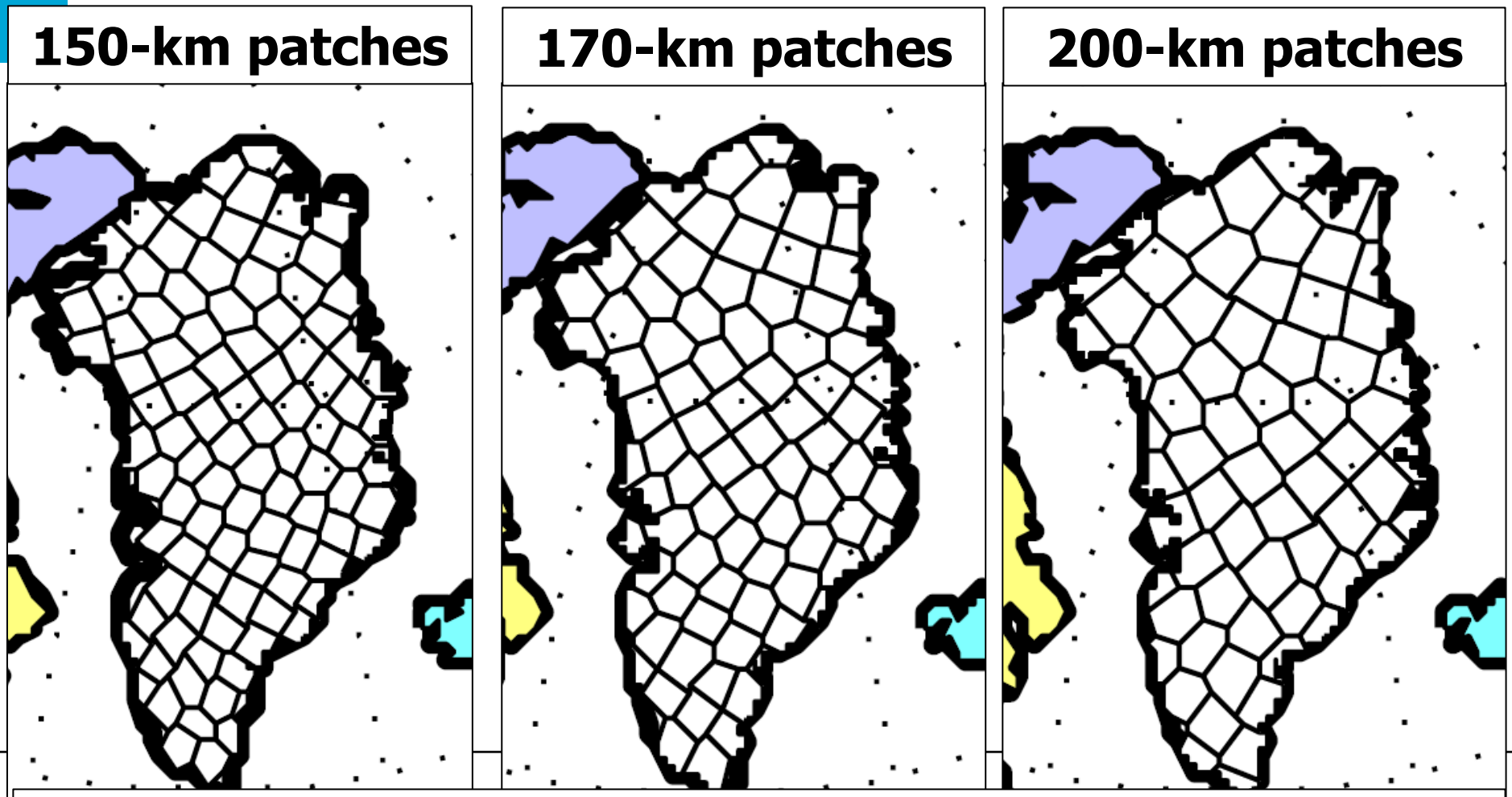


Major problem with high-accuracy data:

- Model (discretization) errors: actual mass anomalies are not constant within patches (J.Ran)

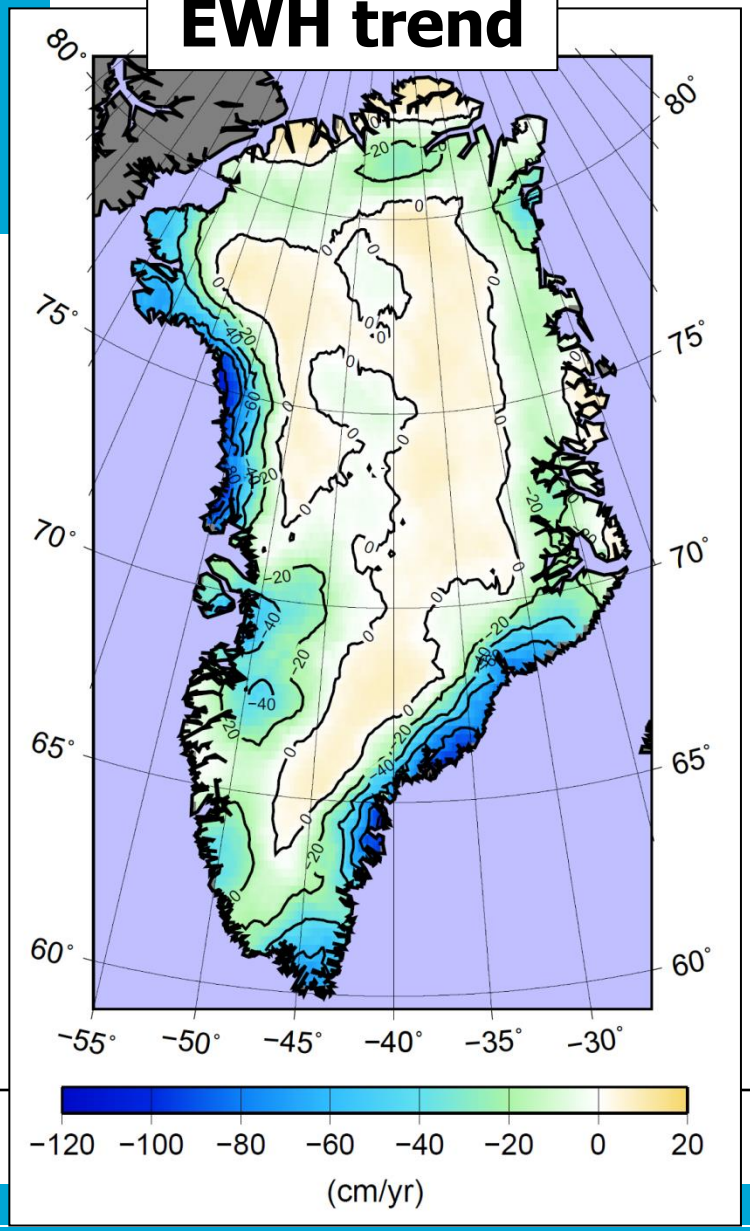
-> <u>Dynamic patch approach:</u>
Let us average multiple estimates obtained with slightly different parametrizations

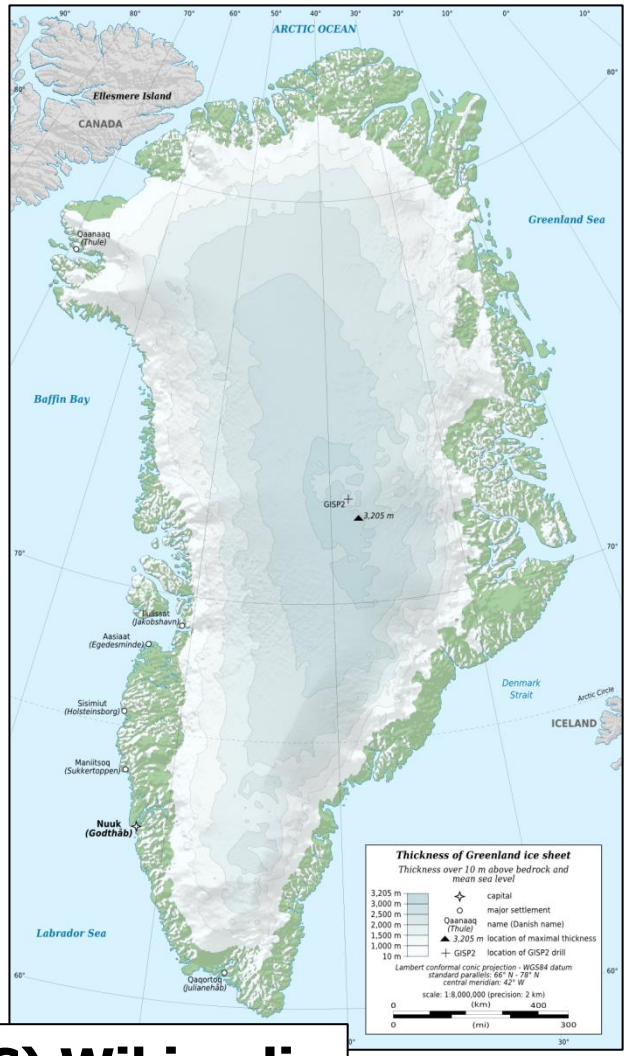
Parametrizations of the dynamic patch approach: a few examples



A set of ~100 alternative parametrizations is typically considered

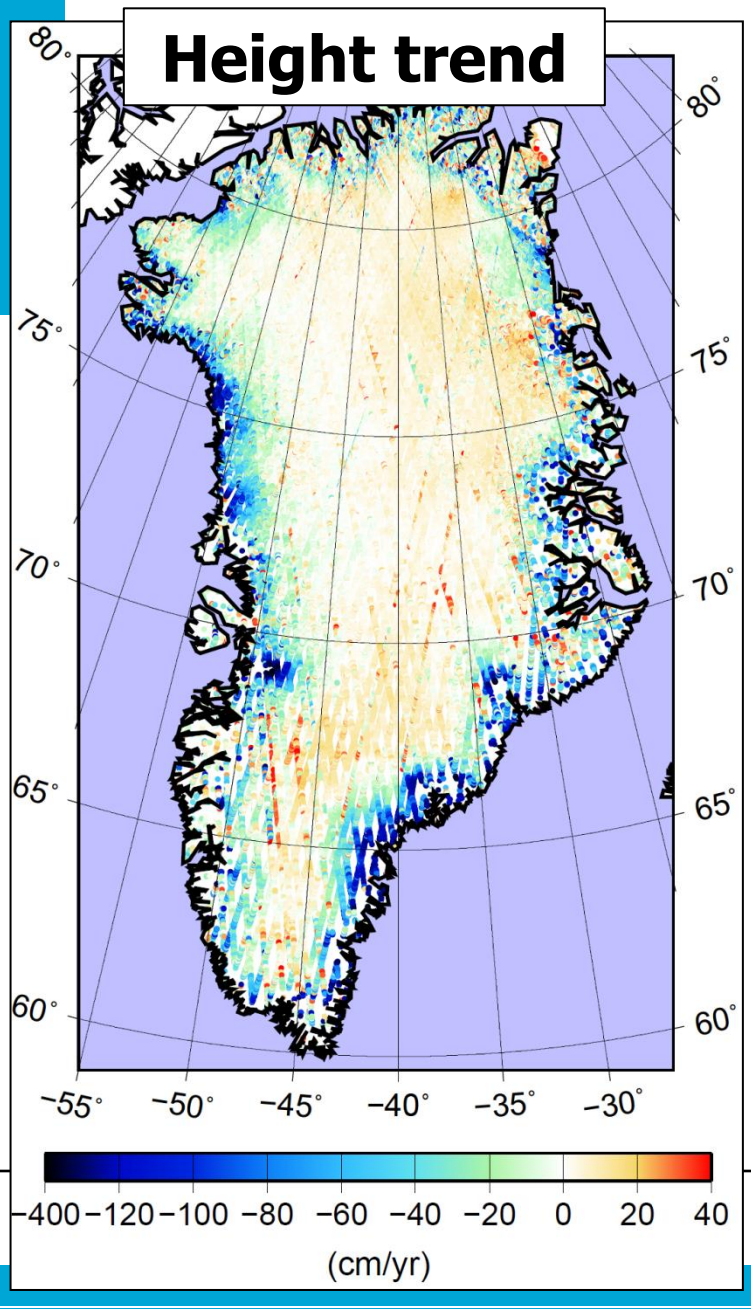
Result of the dynamic patch approach (patch sizes 150 : 0.5 : 200)





(C) Wikipedia

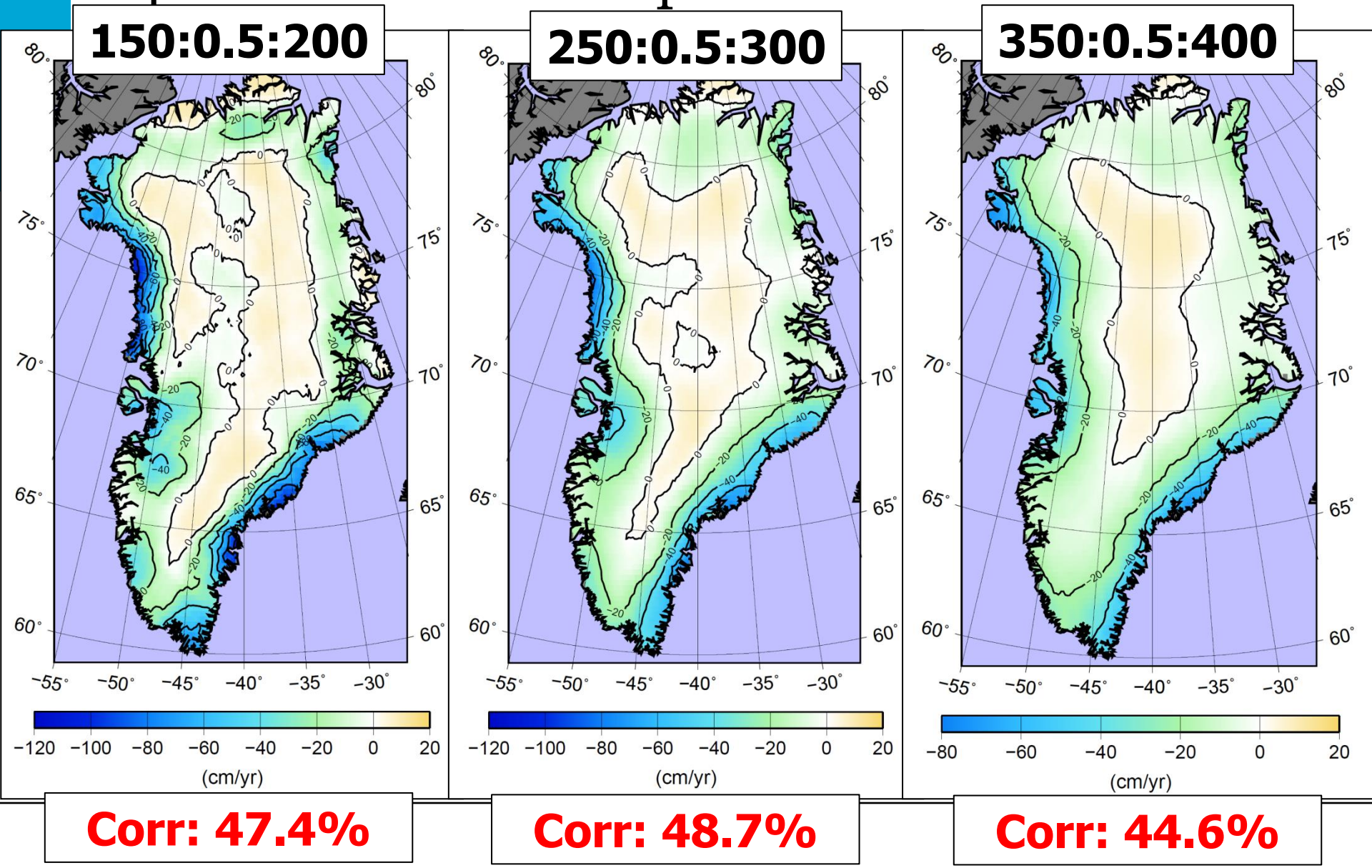
Validation data



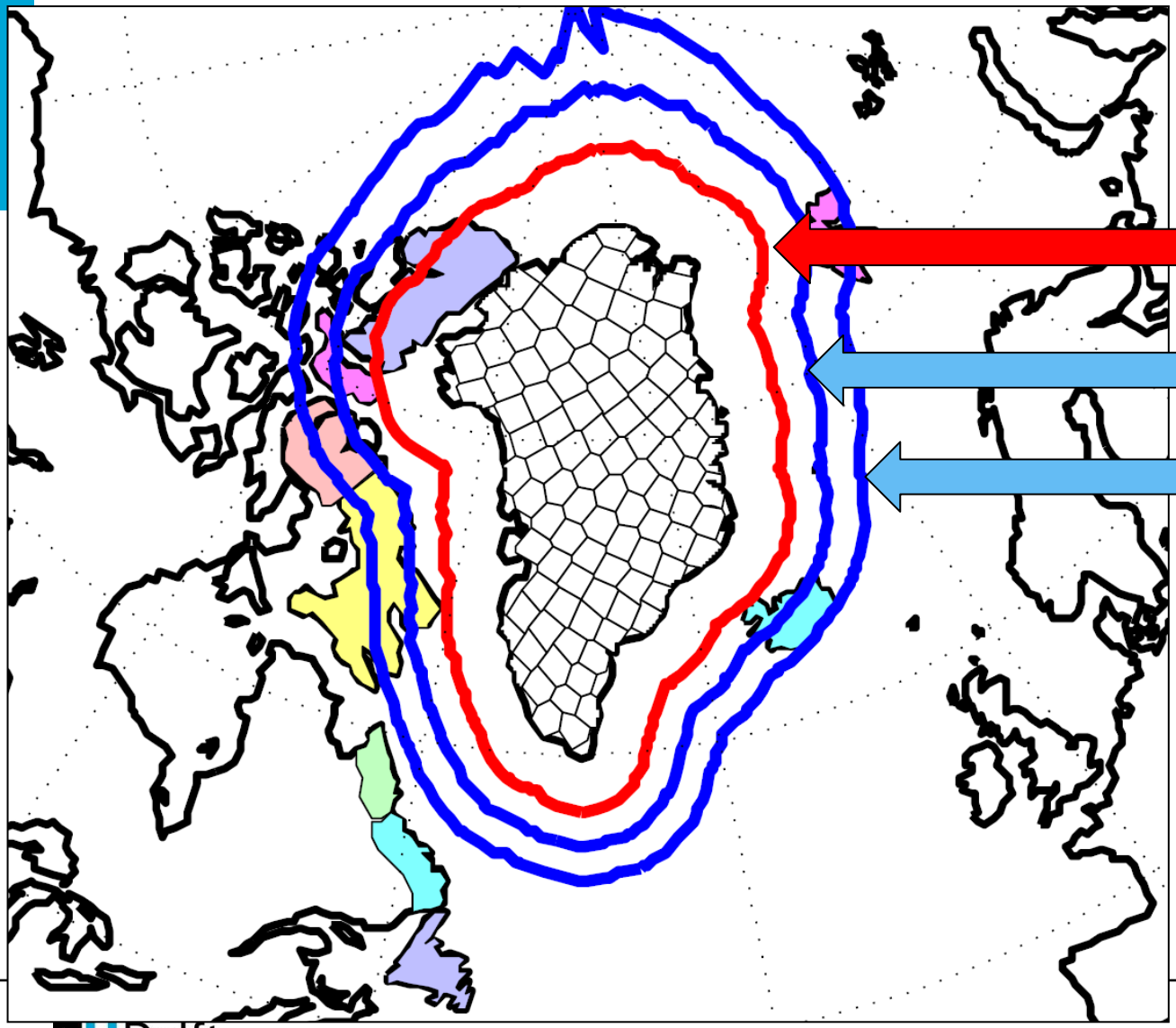
- ICESat-based height trends:
  - Resolution: 20x20 km
  - Time interval: 2003 – 2009
  - Courtesy: B. Gunter

Correlation coefficients between ICESat-based and GRACE-based trends are estimated

Dynamic patch approach: dependence on the patch size



Dynamic patch approach: dependence on the data area

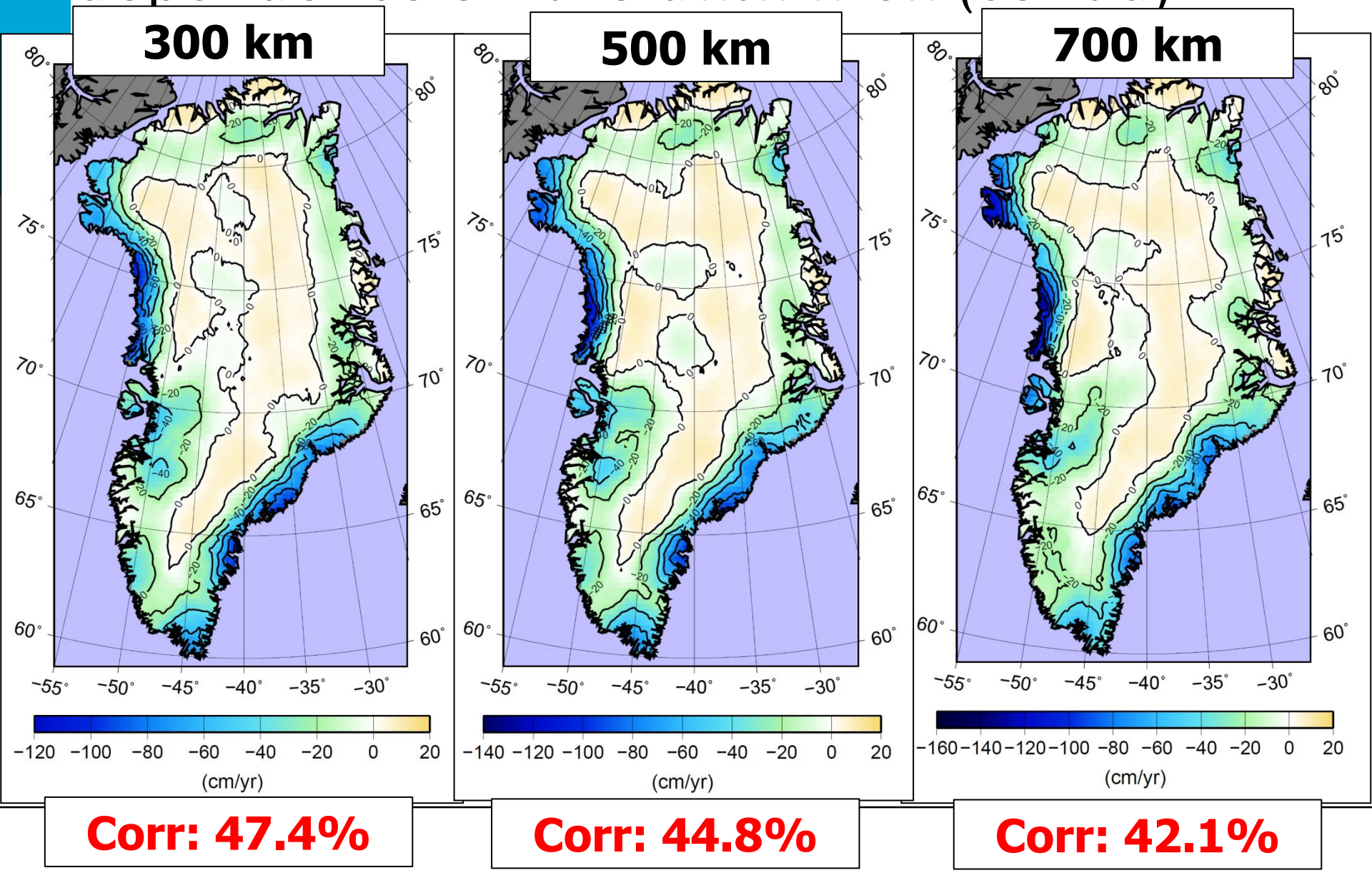


300 km

500 km

700 km

Dynamic patch approach: dependence on the data area (cont'd)



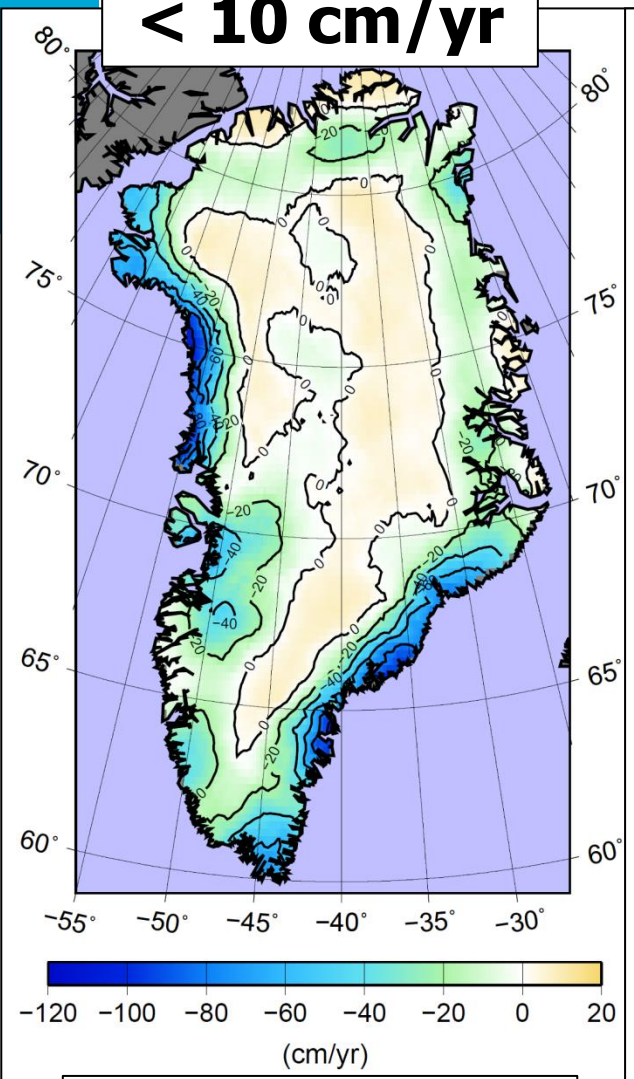
Corr: 47.4%

Corr: 44.8%

Corr: 42.1%

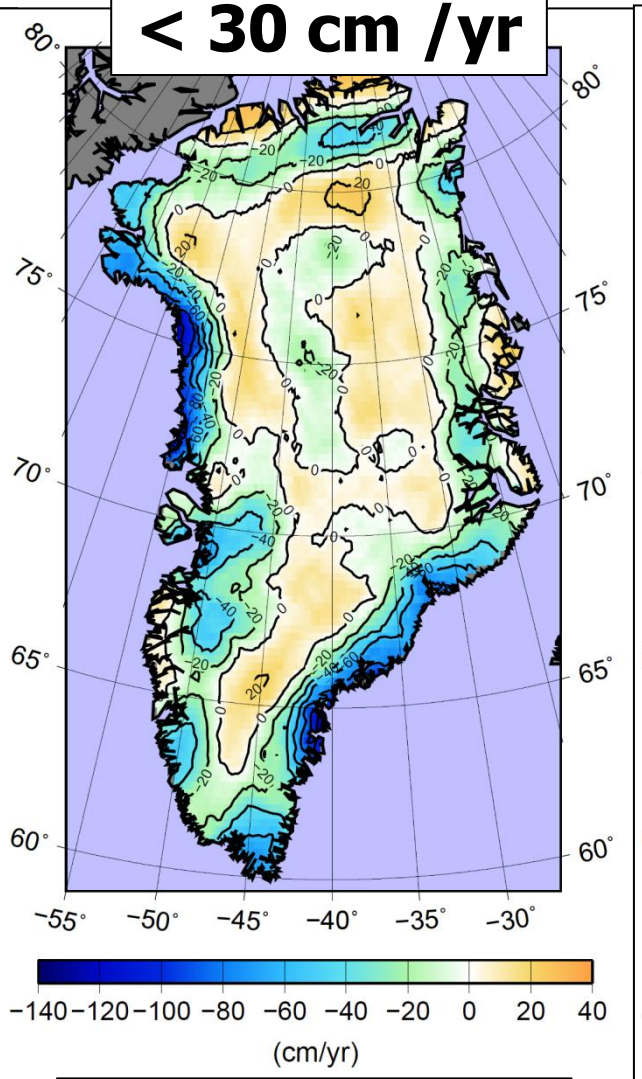
Dynamic patch approach: dependence on the upper bound

< 10 cm/yr



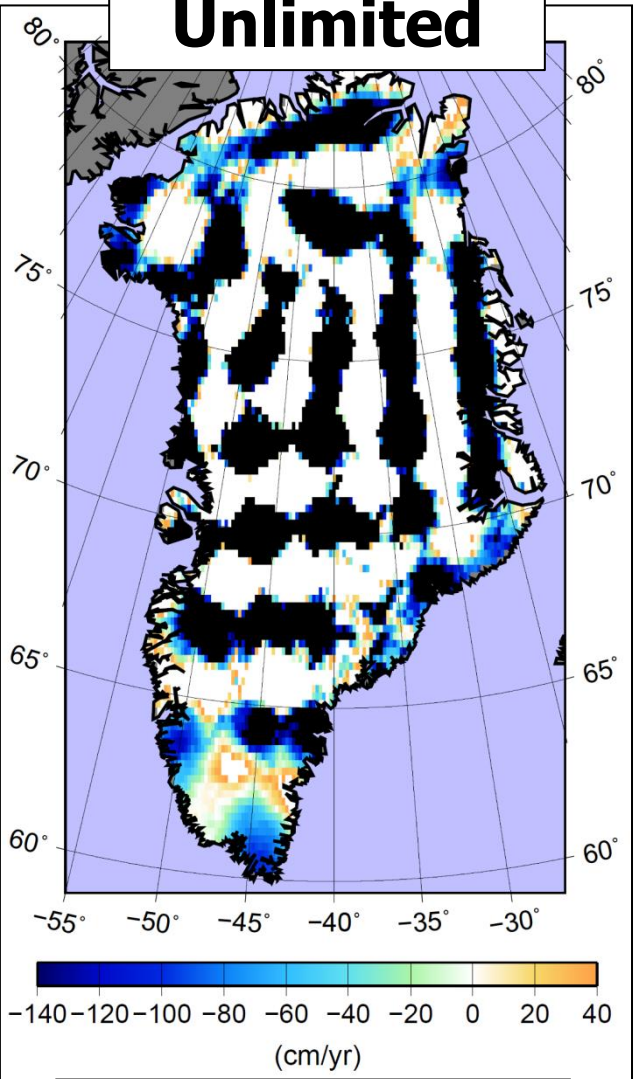
Corr: 47.4%

< 30 cm /yr



Corr: 43.5%

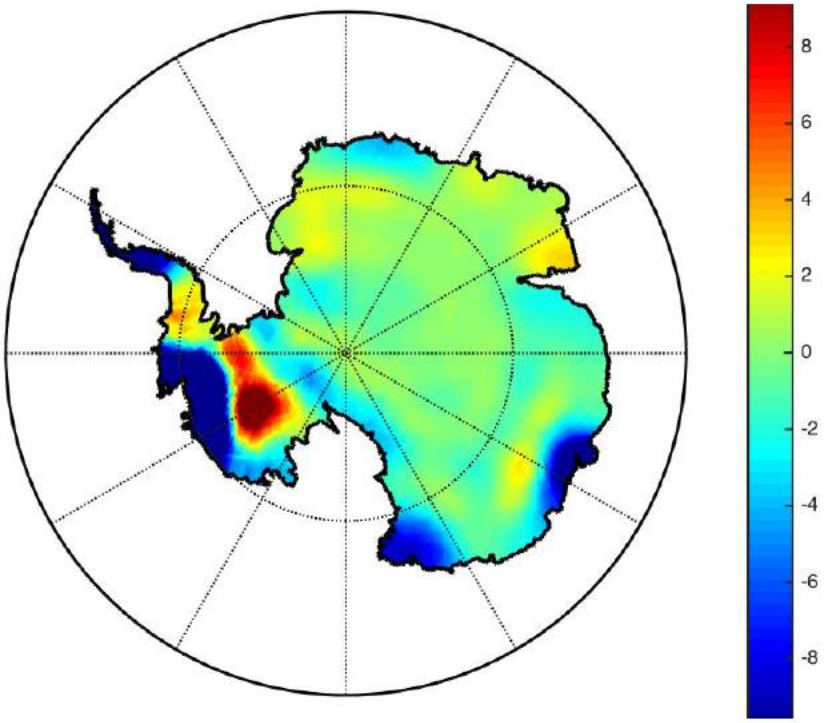
Unlimited



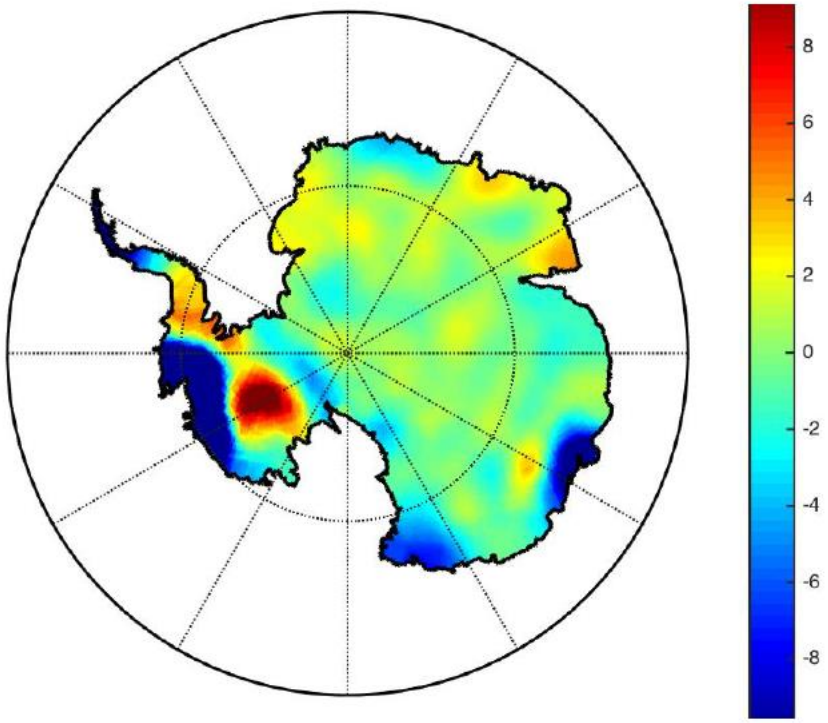
Corr: 0.1%

Antarctic ice sheet: ice mass trend in 2003-2009 (patch sizes: 320:1:420)

ICESat-RACMO



GRACE(DMT2)-ICESat-RACMO



(cm/yr EWH)

Conclusions

- Dynamic patch approach is a powerful tool to obtain high-resolution estimates of mass trends within the ice sheets from GRACE data.
- The obtained estimates show a noticeable sensitivity to the considered range of patch sizes and the chosen data area
- Setting a reasonable upper limit of trend estimates is critical (particularly, when patch sizes are small)

Future outlook

- Usage of state-of-the-art GRACE/GRACE-Follow-On data
- Further refinement of data processing strategy (incl. refinement of geographical constraints)
- Further validation of the obtained results
- Application to other geographical areas

Acknowledgements

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- Institute or Geodesy (TU Graz) for the development of GRACE monthly solutions
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- A et al for an estimation of the GIA signal (which was converted into the spherical harmonic domain by Y.Sun)
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- B. Gunter for the GrIS elevation change rates estimated from ICESat data