SLR, GRACE and SWARM gravity field determination and combination

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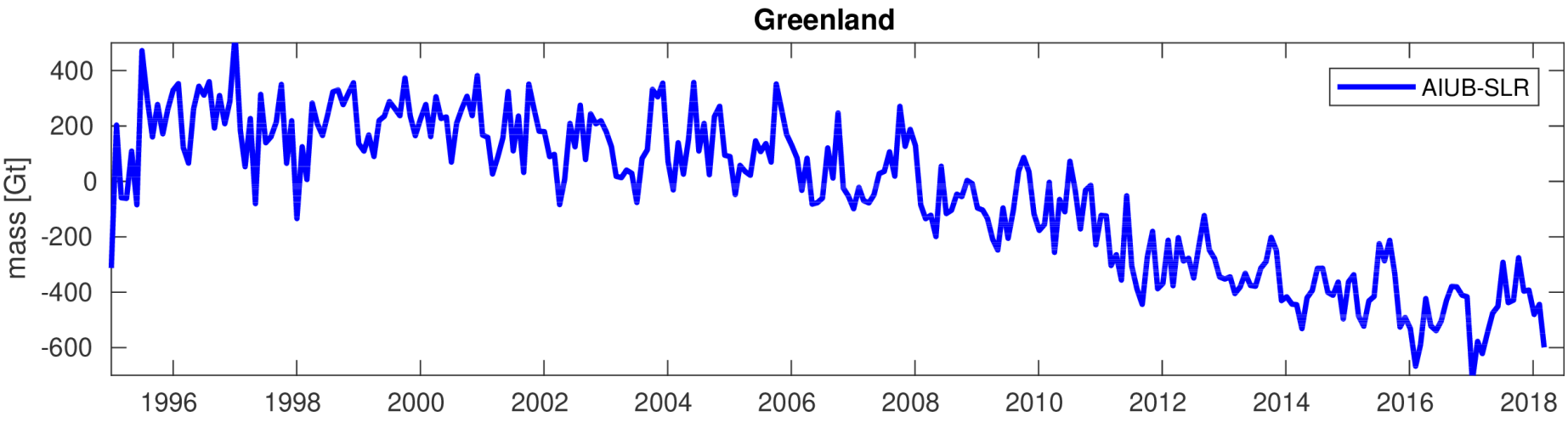
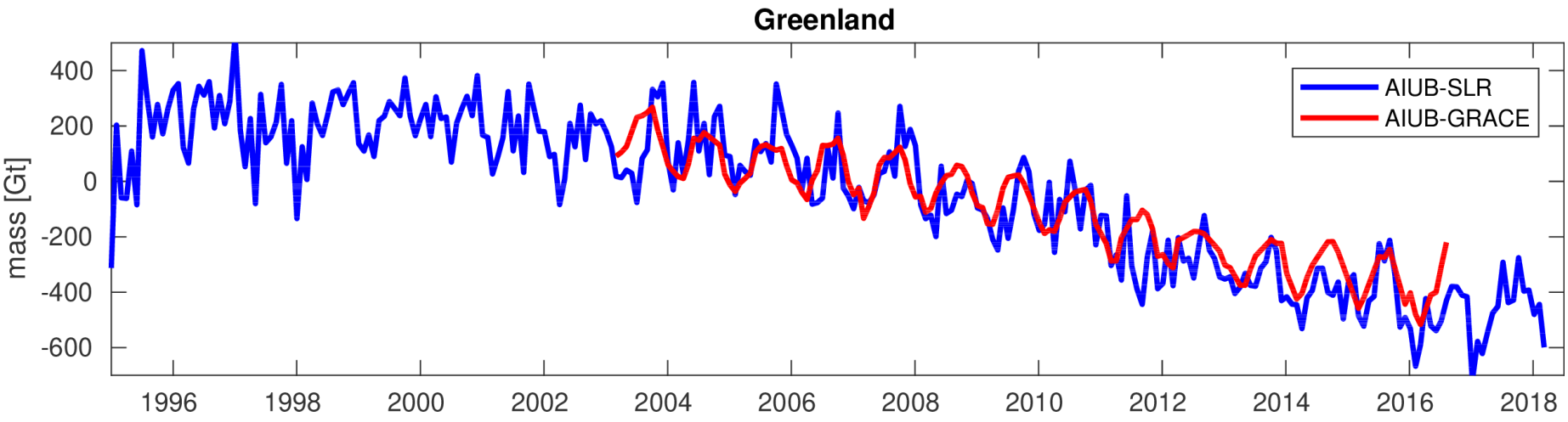
  - SWARM + SLR
- Summary and Outlook

Ice melt in Greenland from SLR



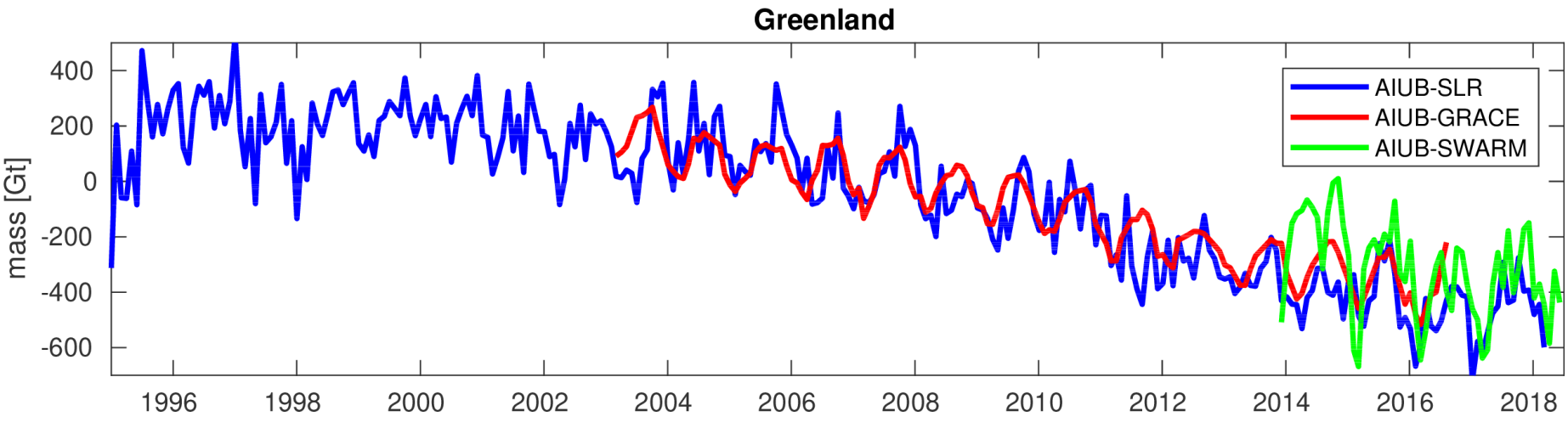
- LAGEOS 1+2: 30 d solutions based on 10 d arcs.
- SLR-LEOS (Beacon-C, Ajisai, Starlete, Stella, Larets, Lares): 30 d solutions based on 1 d arcs.
- Gravity field: 5 x 5 + C_{61} and S_{61}; C_{50} constrained.
- A priori gravity: static 7 y GRACE (AIUB-APR).
- A priori orbits: LAGEOS own predictions, LEOS CPF

Ice melt in Greenland from GRACE



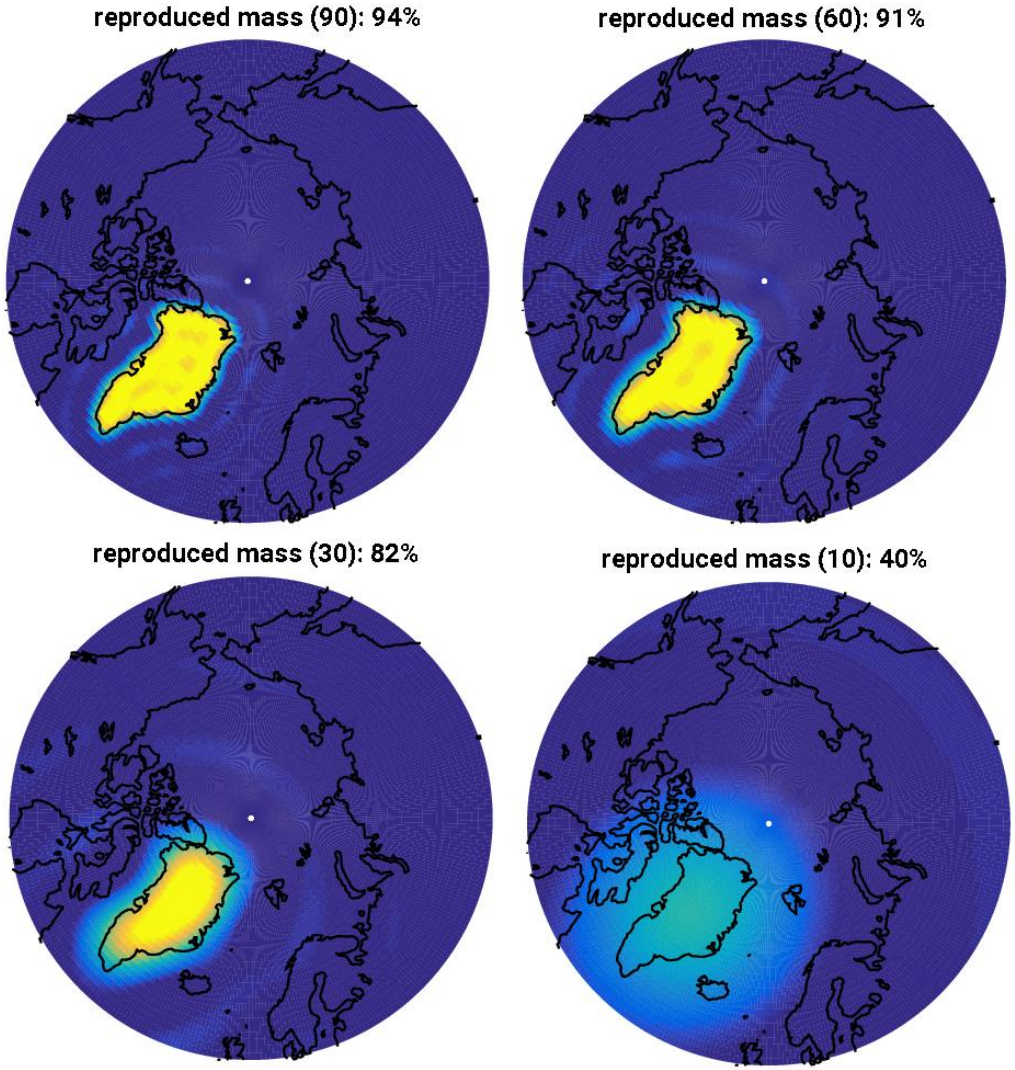
- GRACE GPS+K-band: monthly 90 x 90 gravity field solutions, truncated at degree / order 6.
- Degree 2 excluded.
- Degree 1 fixed to 0.
- No filter applied.

Ice melt in Greenland from SWARM



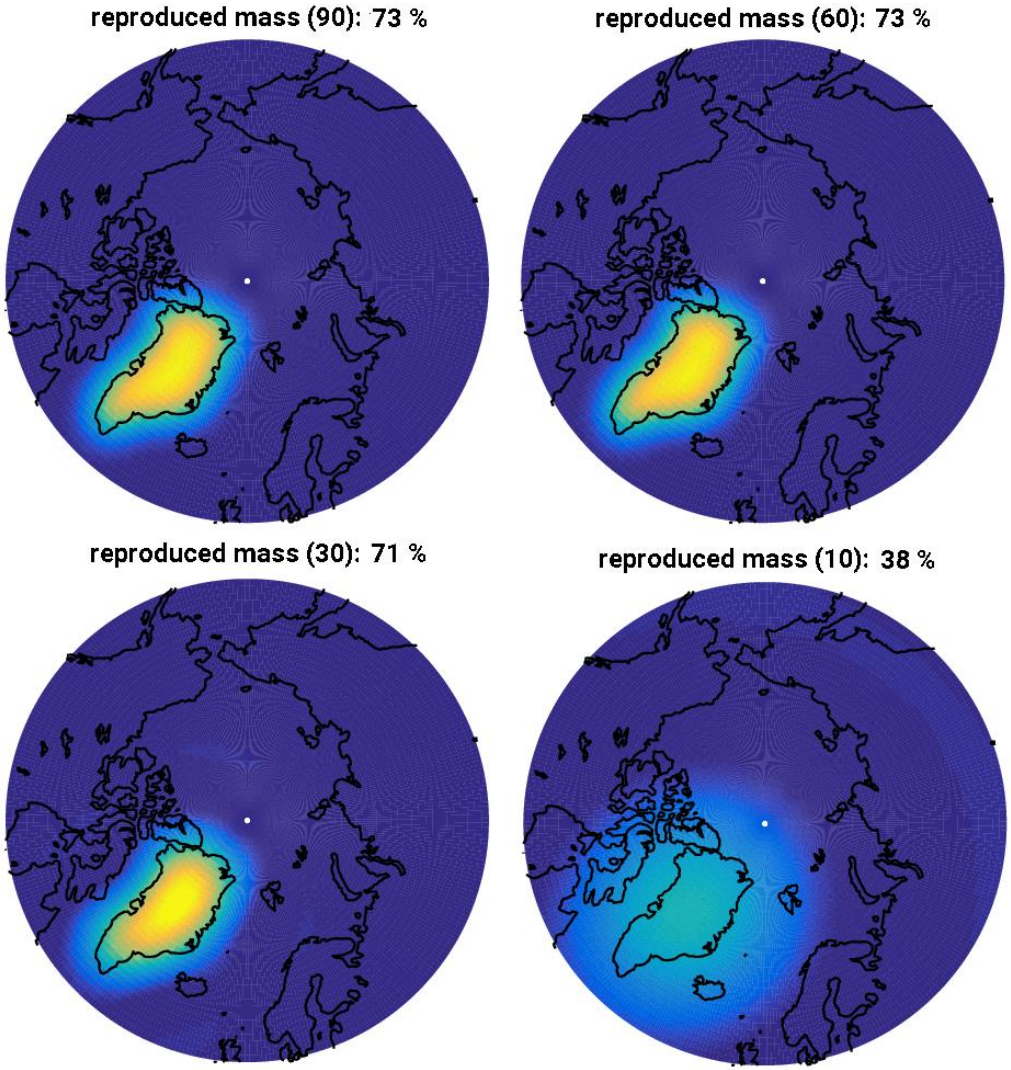
- SWARM GPS: monthly 70 x 70 gravity field solutions, truncated at degree / order 6.
- Degree 2 excluded.
- Degree 1 fixed to 0.
- No filter applied.

Spatial resolution and leakage



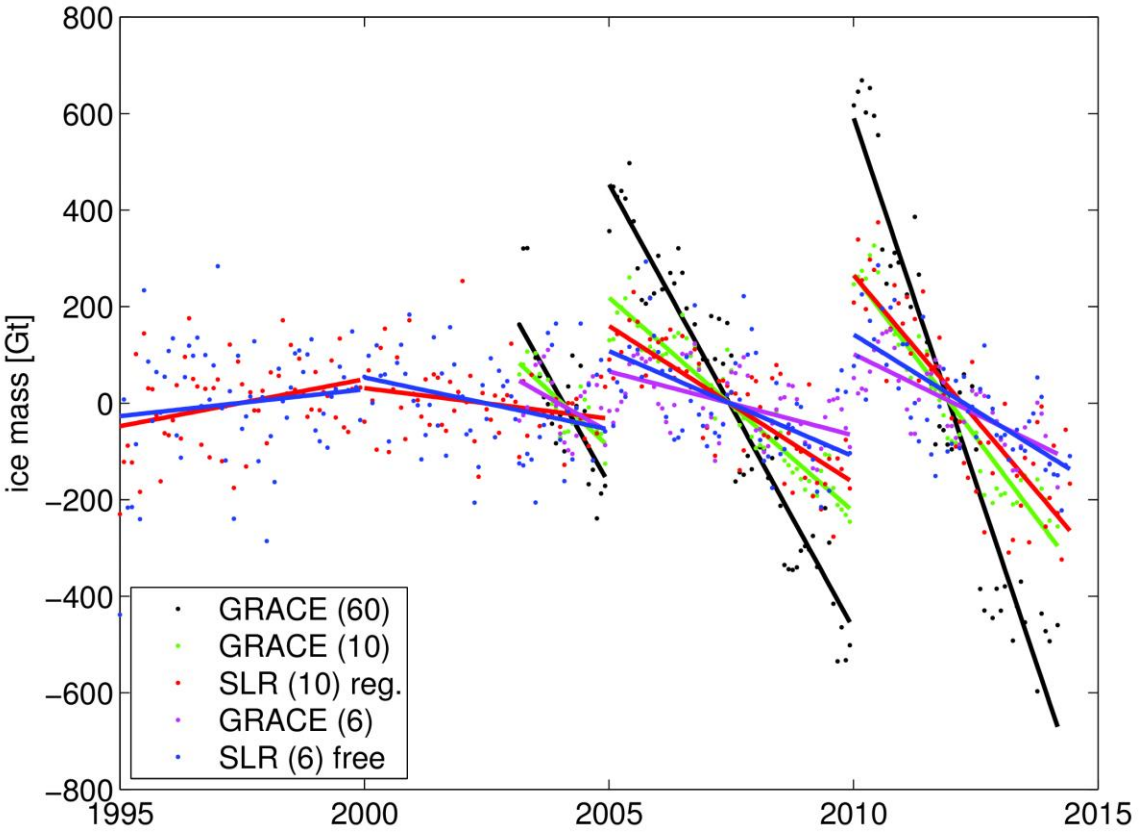
- The truncation of a spherical harmonic expansion leads to signal leakage.
- Sensitivity for monthly mass variations:
  - GRACE : 60–90
  - SWARM: 12–20
  - SLR: 6–10
- With knowledge about the original mass distribution leakage can be corrected by scaling.

Spatial resolution and leakage



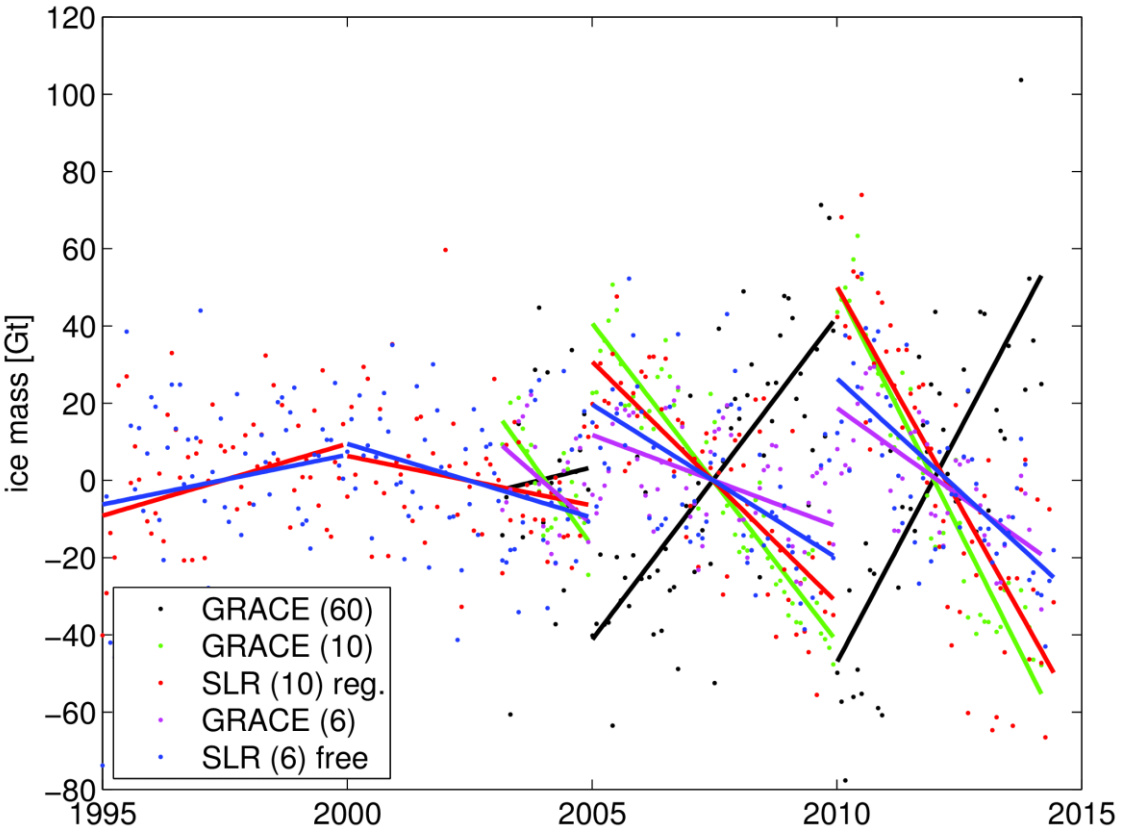
- Common filters (e.g. Gauss 300km) lead to drastic leakage even for GRACE.
- All signal above degree 60, and significant signal above degree 30 is attenuated!
- In case of SLR no filter is applied.

Ice mass change: Greenland Coast



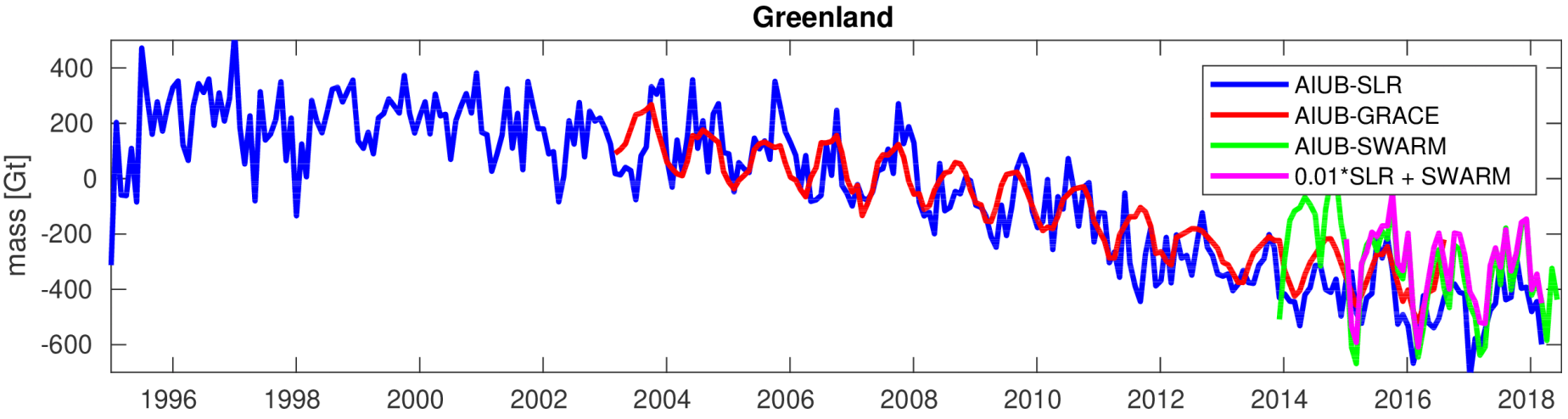
- SLR and GRACE provide consistent mass trends when truncated at the same degree / order.
- By scaling, the original amount of mass loss can be recovered almost completely (but not the spatial detail).

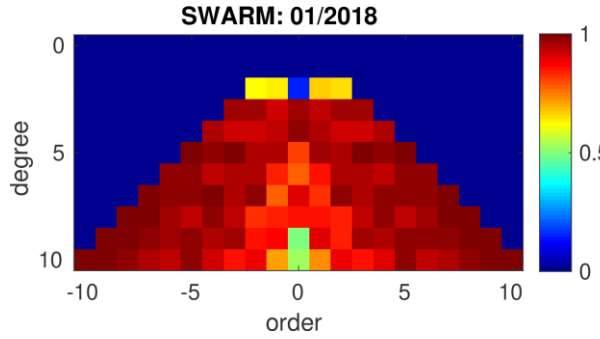
Ice mass change: Greenland Inland



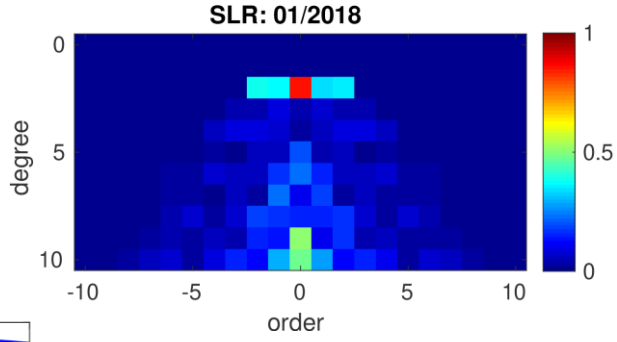
- Details at small spatial scales are lost. A separation between Greenland coast and inland is not possible with SLR.

Combination of NEQs: SWARM + 0.01 * SLR

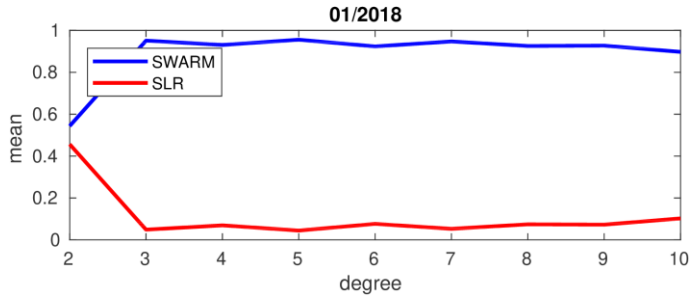




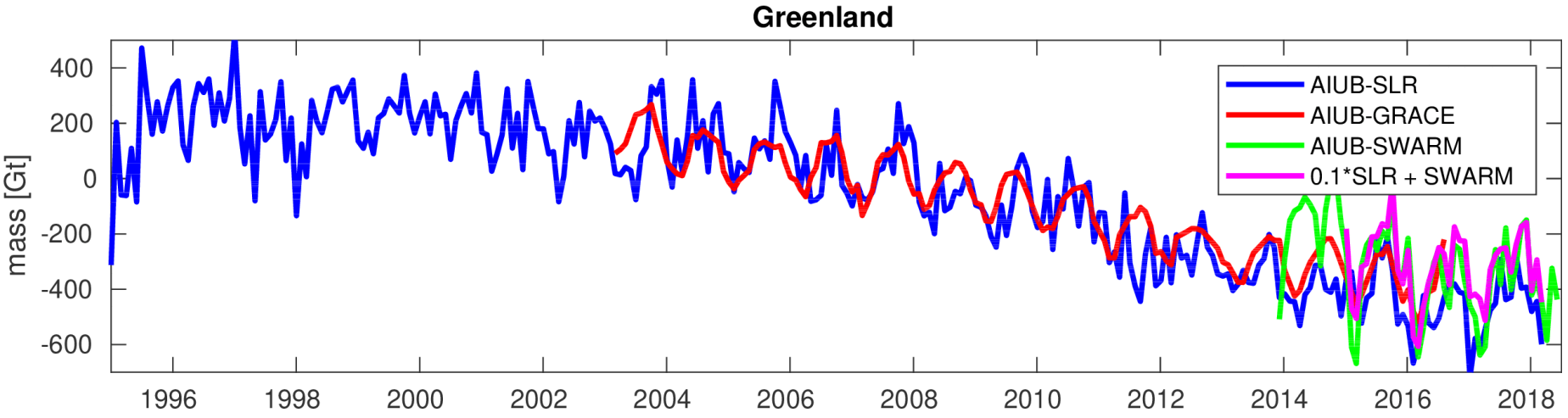
Contribution analysis per SH coefficient.

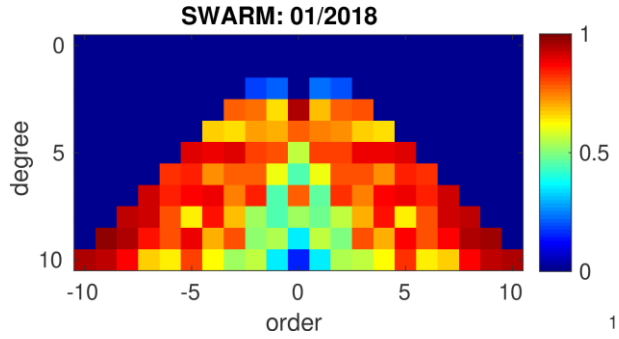


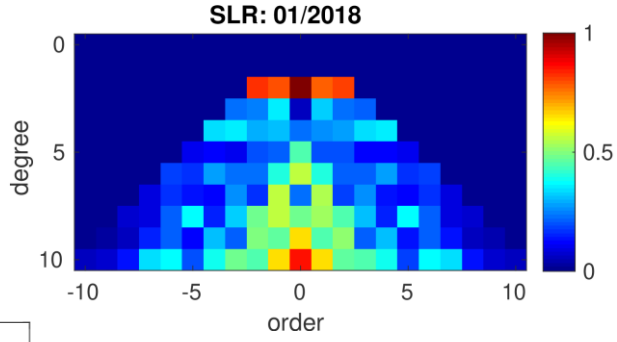
Mean contribution per degree.



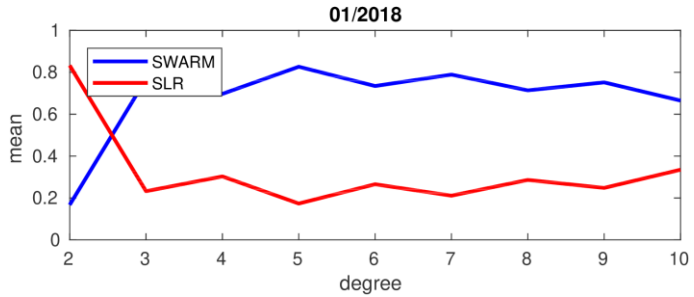
Combination of NEQs: SWARM + 0.1 * SLR





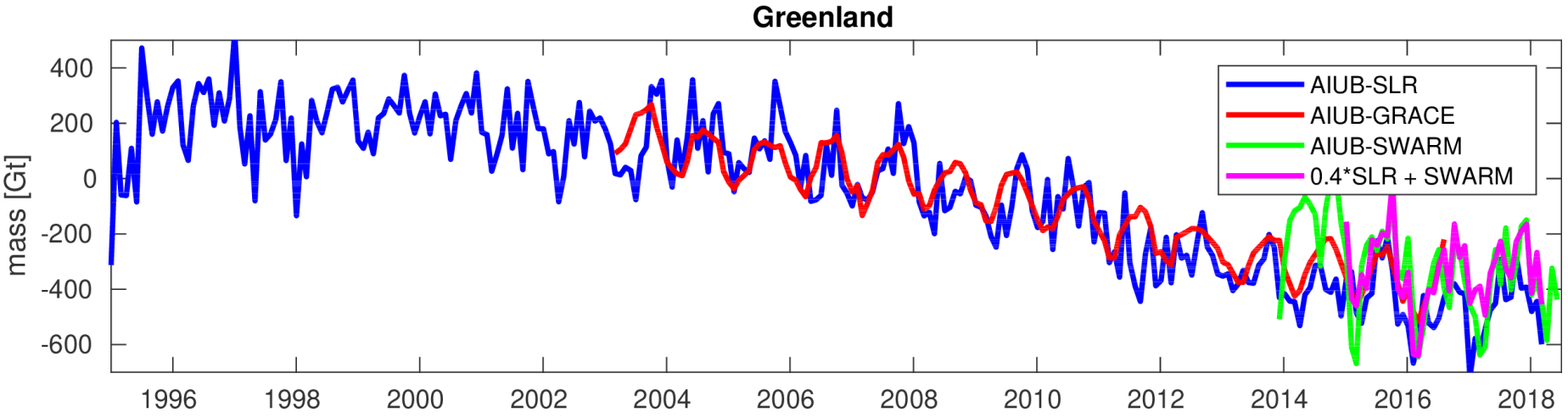


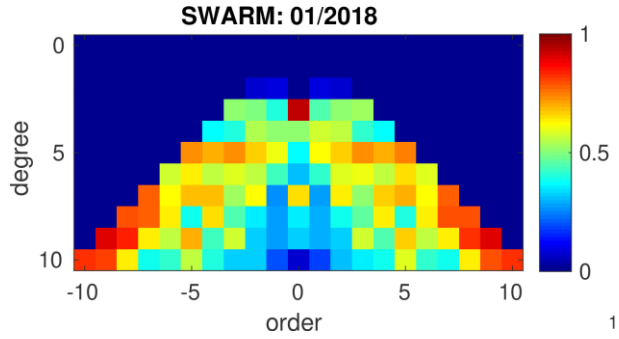
Contribution analysis per SH coefficient.



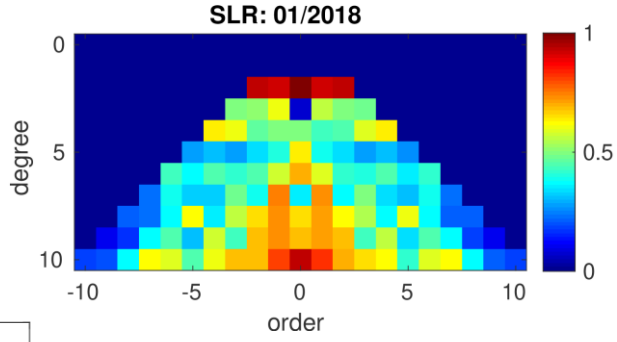
Mean contribution per degree.

Combination of NEQs: SWARM + 0.4 * SLR

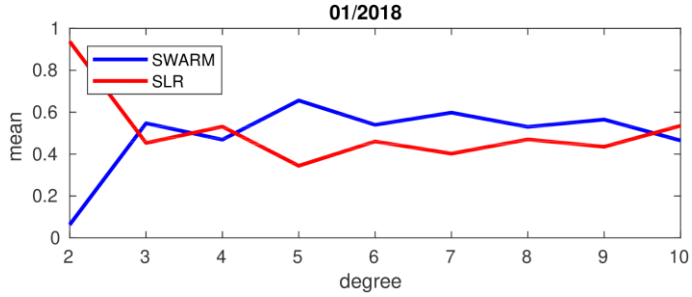




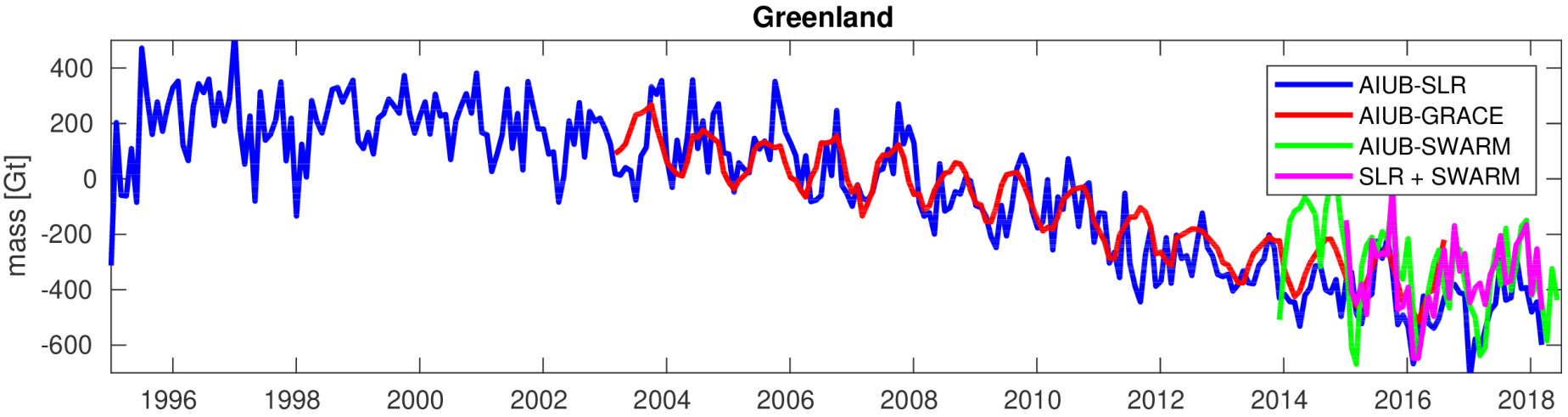
Contribution analysis per SH coefficient.

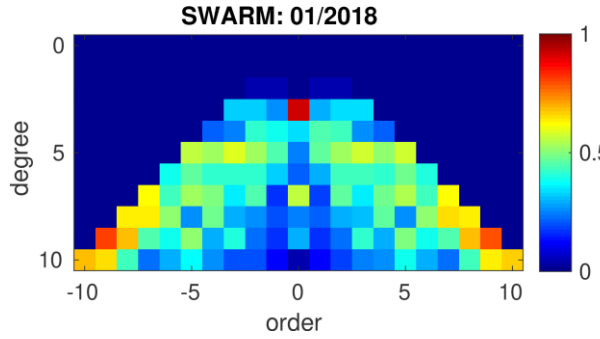


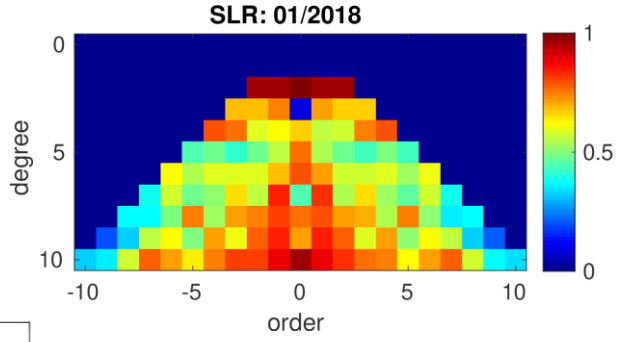
Mean contribution per degree.



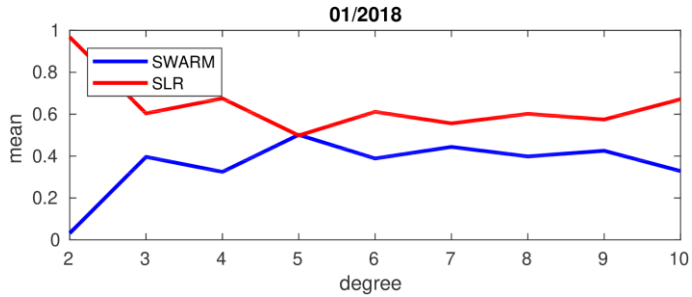
Combination of NEQs: SWARM + SLR





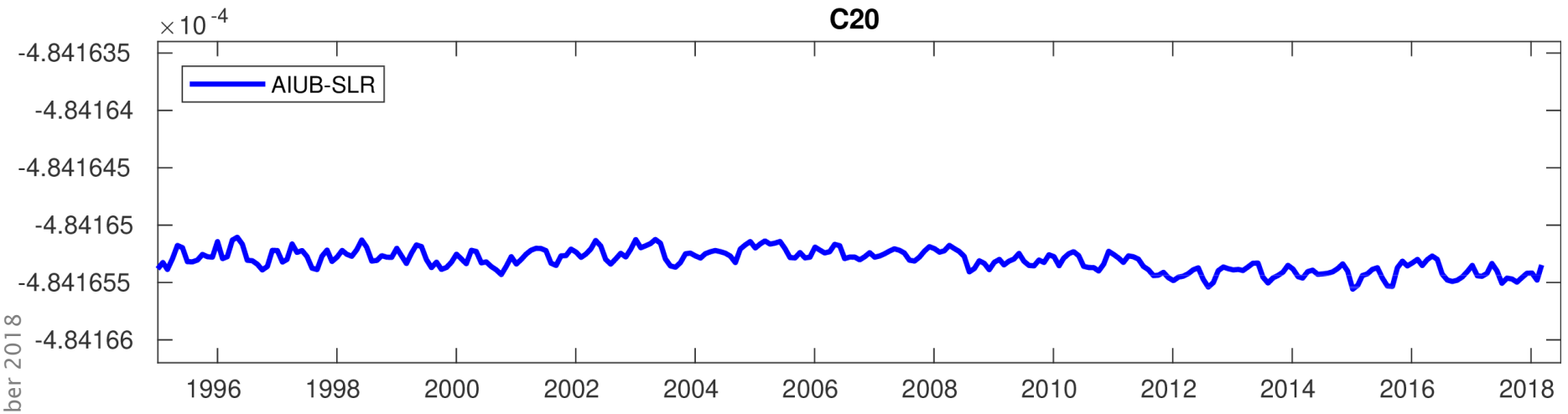


Contribution analysis per SH coefficient.



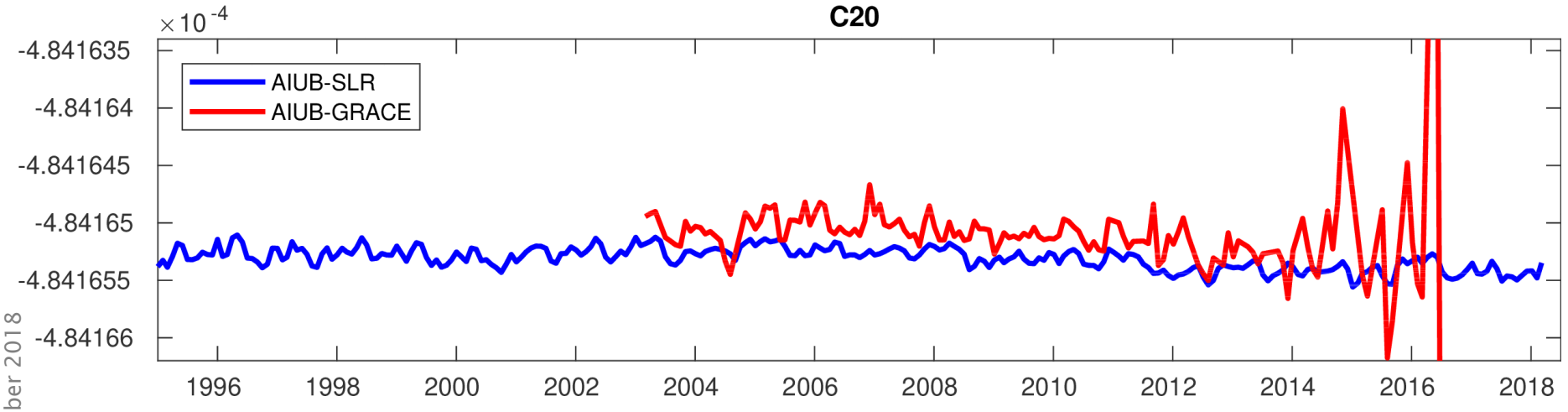
Mean contribution per degree.

C20



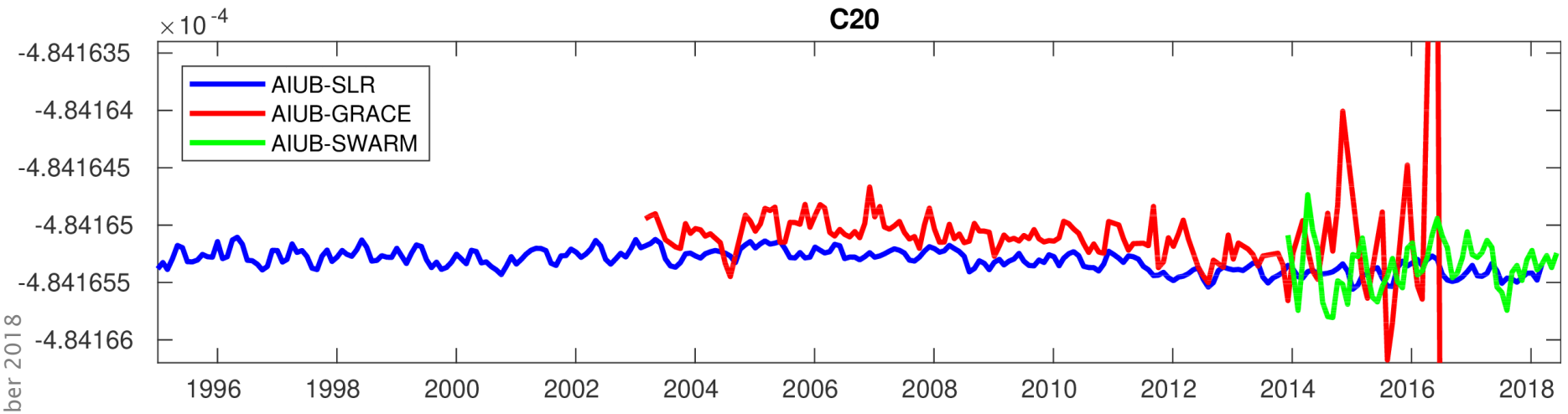
- LAGEOS + SLR-LEOs: 30 d C_{20} values

C20



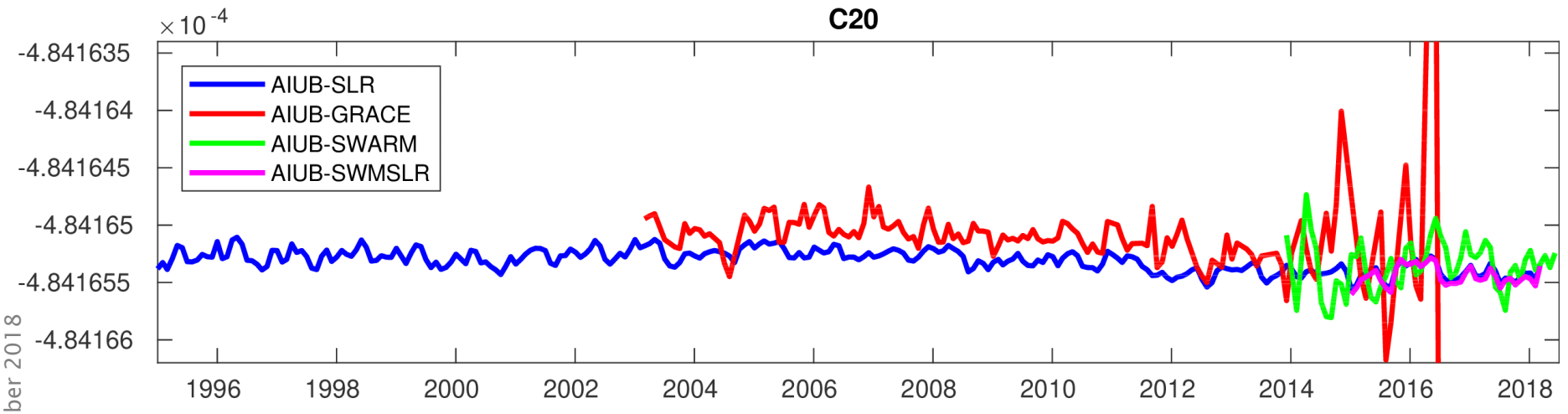
- LAGEOS + SLR-LEOs: 30 d C_{20} values
- GRACE: monthly C_{20} values, strong correlation with accelerometer temperature

C20



- LAGEOS + SLR-LEOs: 30 d C_{20} values.
- GRACE: monthly C_{20} values, strong correlation with accelerometer temperature.
- SWARM: monthly C_{20} values (no accelerometers used for signal separation).

C20



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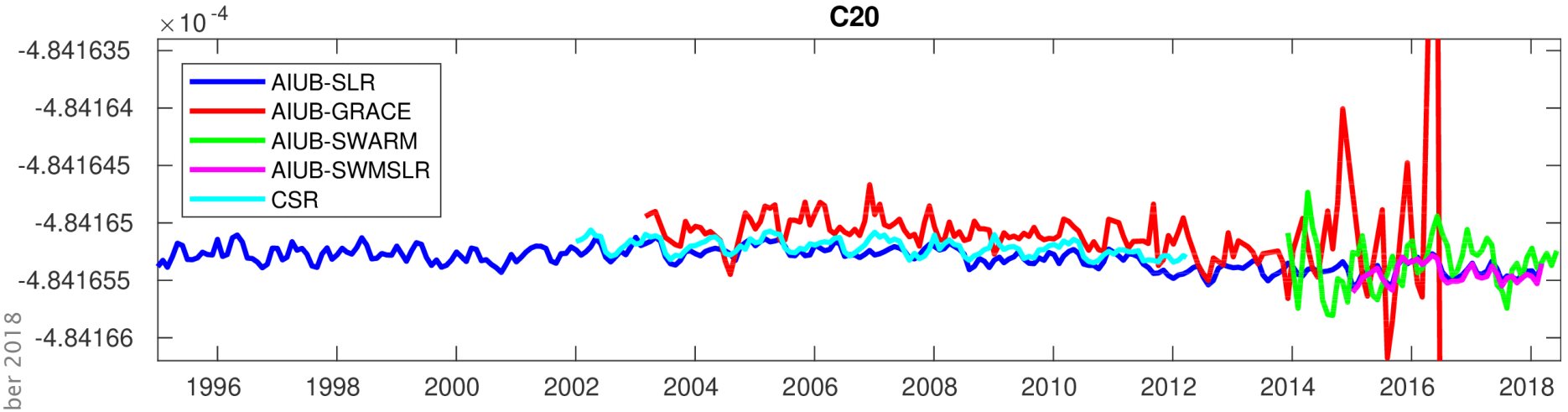
- SWARM: monthly C_{20} values (no accelerometers used for signal separation).
- SLR + SWARM: C_{20} dominated by SLR

C20



- LAGEOS + SLR-LEOs: 30 d C_{20} values.
- GRACE: monthly C_{20} values, strong correlation with accelerometer temperature.
- SWARM: monthly C_{20} values (no accelerometers used for signal separation).
- SLR + SWARM: C_{20} dominated by SLR
- Reference CSR: monthly C_{20} values for GRACE

Summary and Outlook

- Truncated to the same spherical harmonic resolution the three space geodetic techniques SLR, high-low-SST (GPS) and low-low-SST (K-band) provide comparable ice mass trends.
- Taking spectral leakage into account the low resolution SLR mass trends are in agreement with high resolution GRACE results.
- Best SLR + SWARM combination results are achieved with equal weighting.