SLR, GRACE and SWARM gravity field determination and combination

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Contents

- Monthly mass variations in Greenland:
  - SLR
  - GRACE
  - SWARM
- Interpretation:
  - Spatial resolution
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- Combination of normal equations:
  - SWARM + SLR
- Summary and Outlook
Ice melt in Greenland from SLR

- LAGEOS 1+2: 30 d solutions based on 10 d arcs.
- Gravity field: $5 \times 5 + C_{61}$ 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).

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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

Mean contribution per degree.

Contribution analysis per SH coefficient.
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

Mean contribution per degree.

Contribution analysis per SH coefficient.
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• 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.