

Complete 5-years time series of combined monthly gravity field models derived from Swarm GPS data

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Multi-approach gravity field models from Swarm GPS data

- ESA/DISC funded project (since 9/2017)
- Provide highest-quality monthly-independent Swarm gravity field models
- Combine individual gravity solutions, computed with:
 - different kinematic orbit solutions
 - different inversion approaches
- Monthly combined Swarm gravity field models:
 - from Dec. 2013 to Sept. 2018
 - available from:
 - ICGEM (<http://icgem.gfz-potsdam.de/series>)
 - ESA (<https://earth.esa.int/web/guest/swarm/data-access>, soon)

Kinematic orbit solutions

- TU Delft: **GPS High precision Orbit determination Software Tool** (GHOST) Helleputte (2004); Wermuth et al. 2010
- AIUB: **Bernese** v5.3 Dach et al., (2015); Jäggi et al. (2007)
- IfG: **Gravity Recovery Object Oriented Programming System** (GROOPS) Zehentner et al. (2016)

Gravity field estimation approaches

- AIUB: **Celestial Mechanics Approach** (CMA), Beutler et al. (2010)
- ASU: **Decorrelated Acceleration Approach** (DAA), Bezdek et al. (2014); Bezdek et al. (2016)
- IfG: **Short-Arc Approach** (SAA), Mayer-Gürr (2006)
- OSU: **Improved Energy Balance Approach** (IEBA), Shang et al. (2015)

Combination of individual gravity field solutions

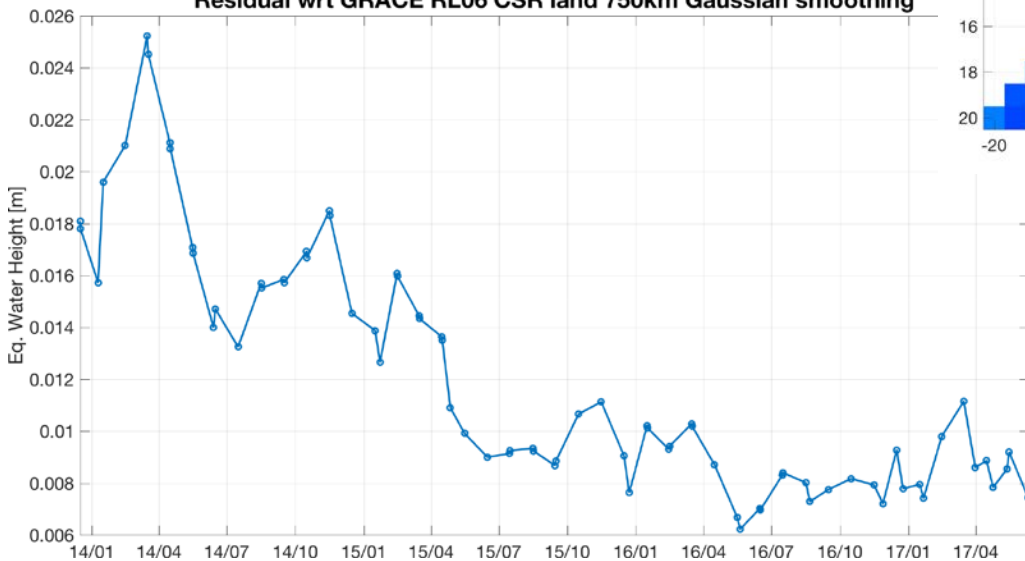
- Combination at the level of solutions, up to degree 40
- Weights derived from Variance Component Estimation (VCE)
- Degrees 2-20 considered in VCE
- Combination at the level of Normal Equations was tested but has slightly larger discrepancies w.r.t. GRACE (not shown)

Gravity field model pre-processing

- Truncation to degree 40
- C_{20} replaced with value from *GRACE Technical Note 11*
- Temporal variations relative to static GGM05G (GRACE and GOCE)
- Gaussian smoothing with 750-km radius (unless noted)
- GRACE CSR RL06 considered (with same pre-processing)
- GRACE and Swarm solutions interpolated to the union of both time domains (identical for all scenarios)

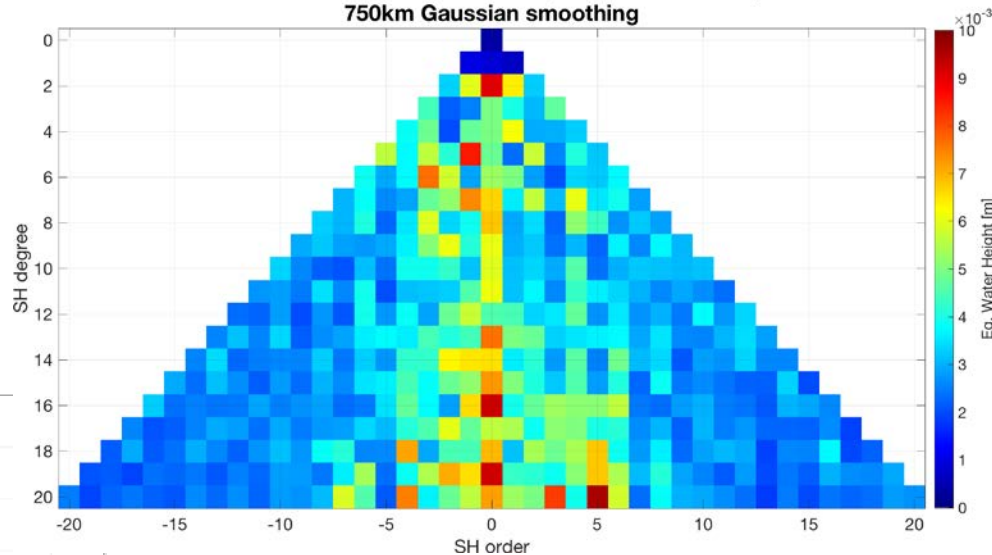
Agreement with GRACE over Land areas

Residual wrt GRACE RL06 CSR land 750km Gaussian smoothing



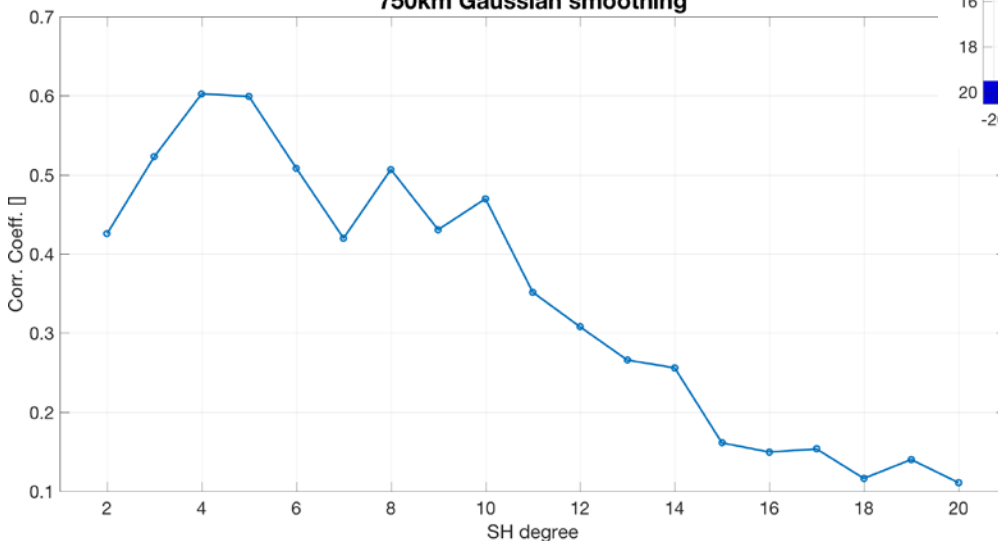
swarm r101 temporal RMS land (2013-12 to 2018-09)

750km Gaussian smoothing



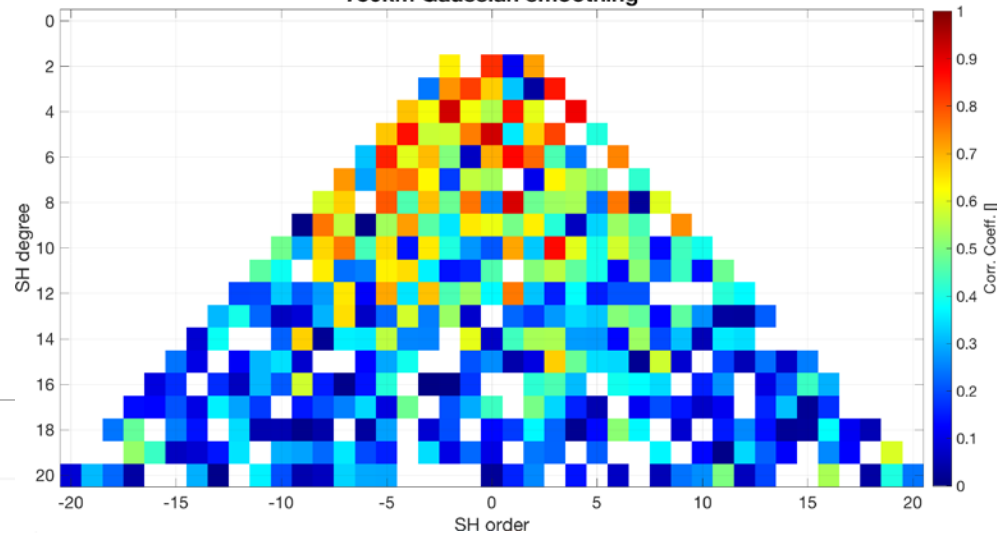
Agreement with GRACE over Land areas

degree-mean temporal corr. coeff.
wrt GRACE RL06 CSR land (2002-04 to 2018-12)
750km Gaussian smoothing

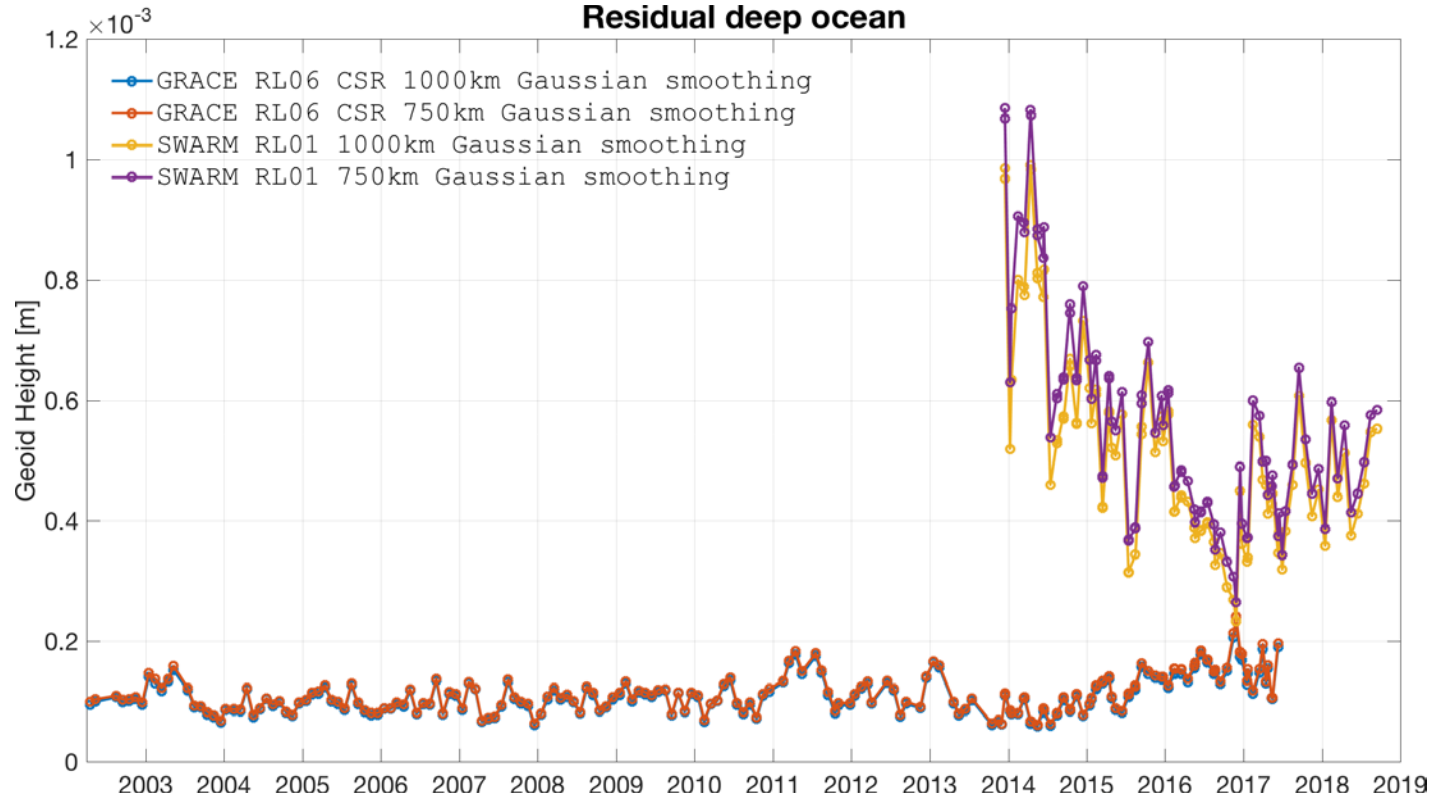


swarm r101 temporal corr. coeff. land (2013-12 to 2018-09)

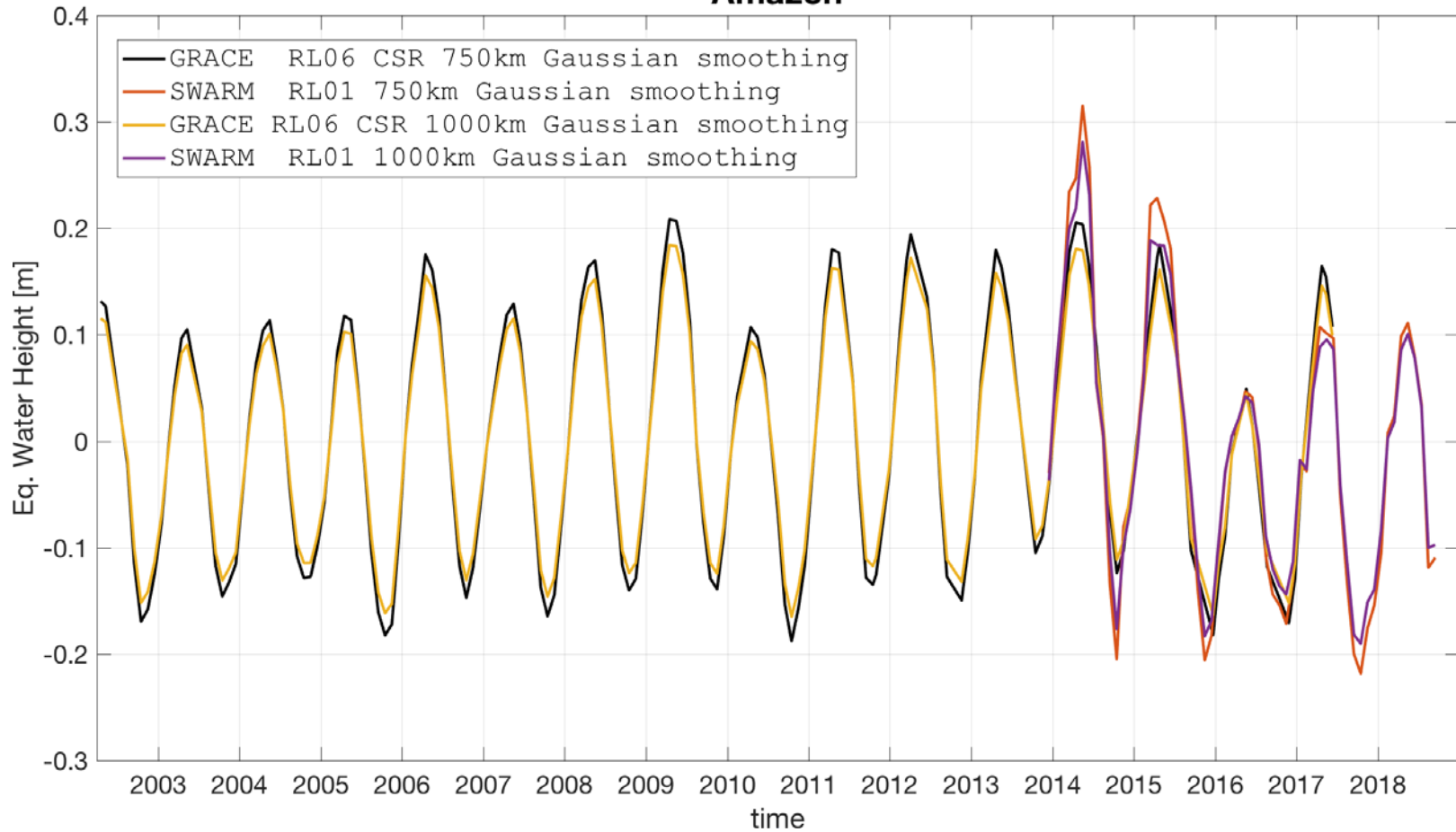
750km Gaussian smoothing



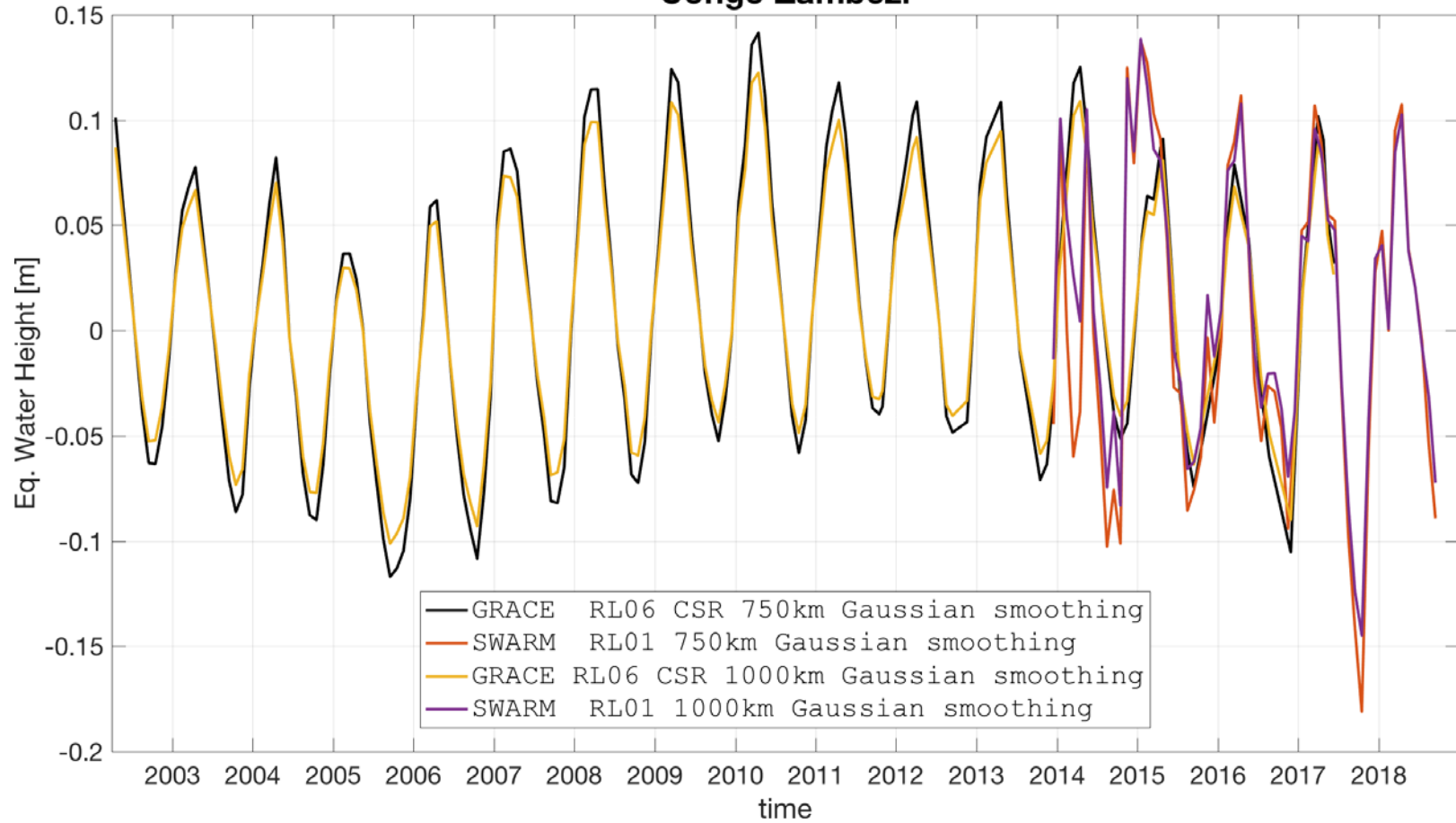
Swarm and Grace un-modeled ocean RMS



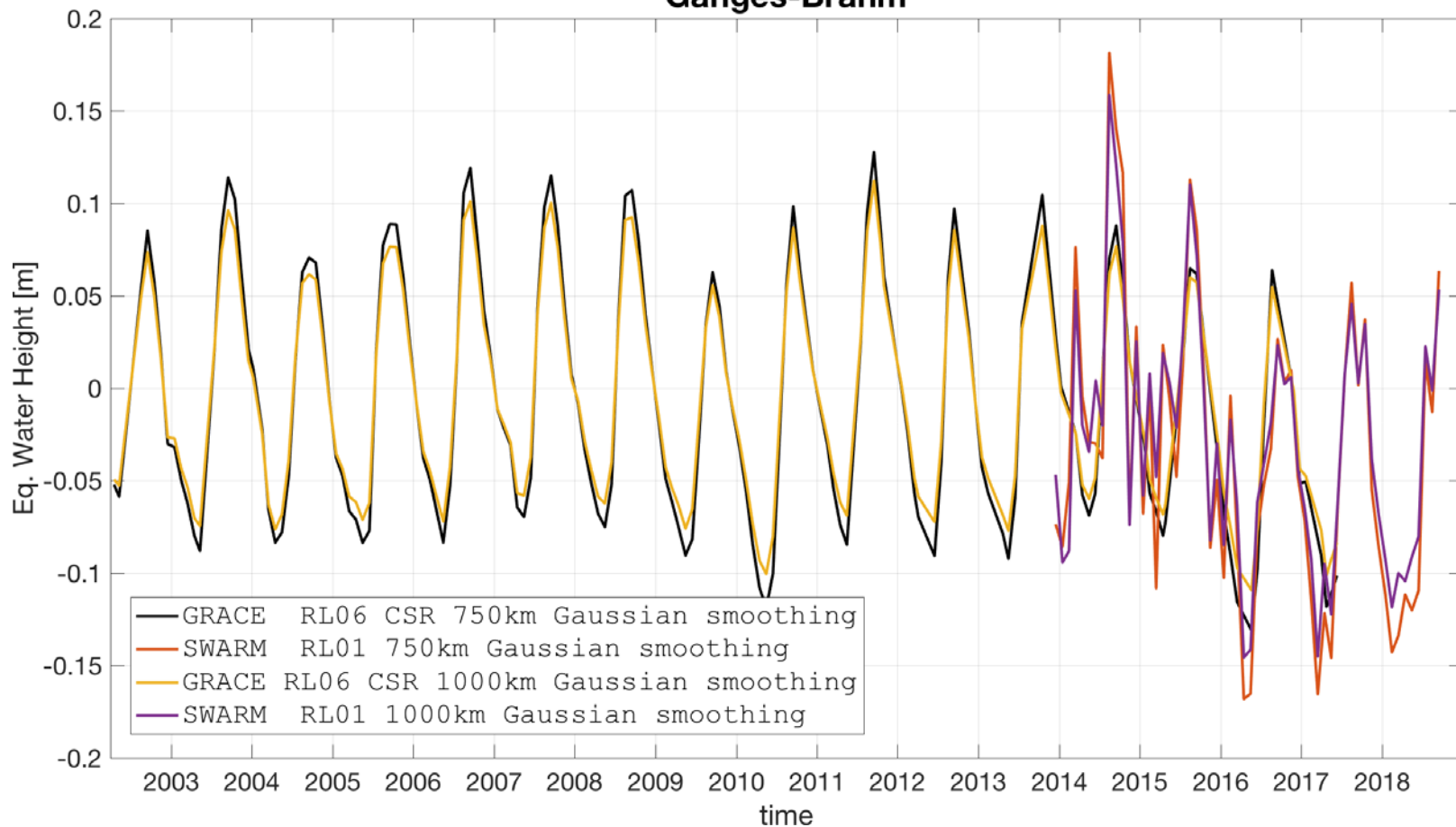
Amazon



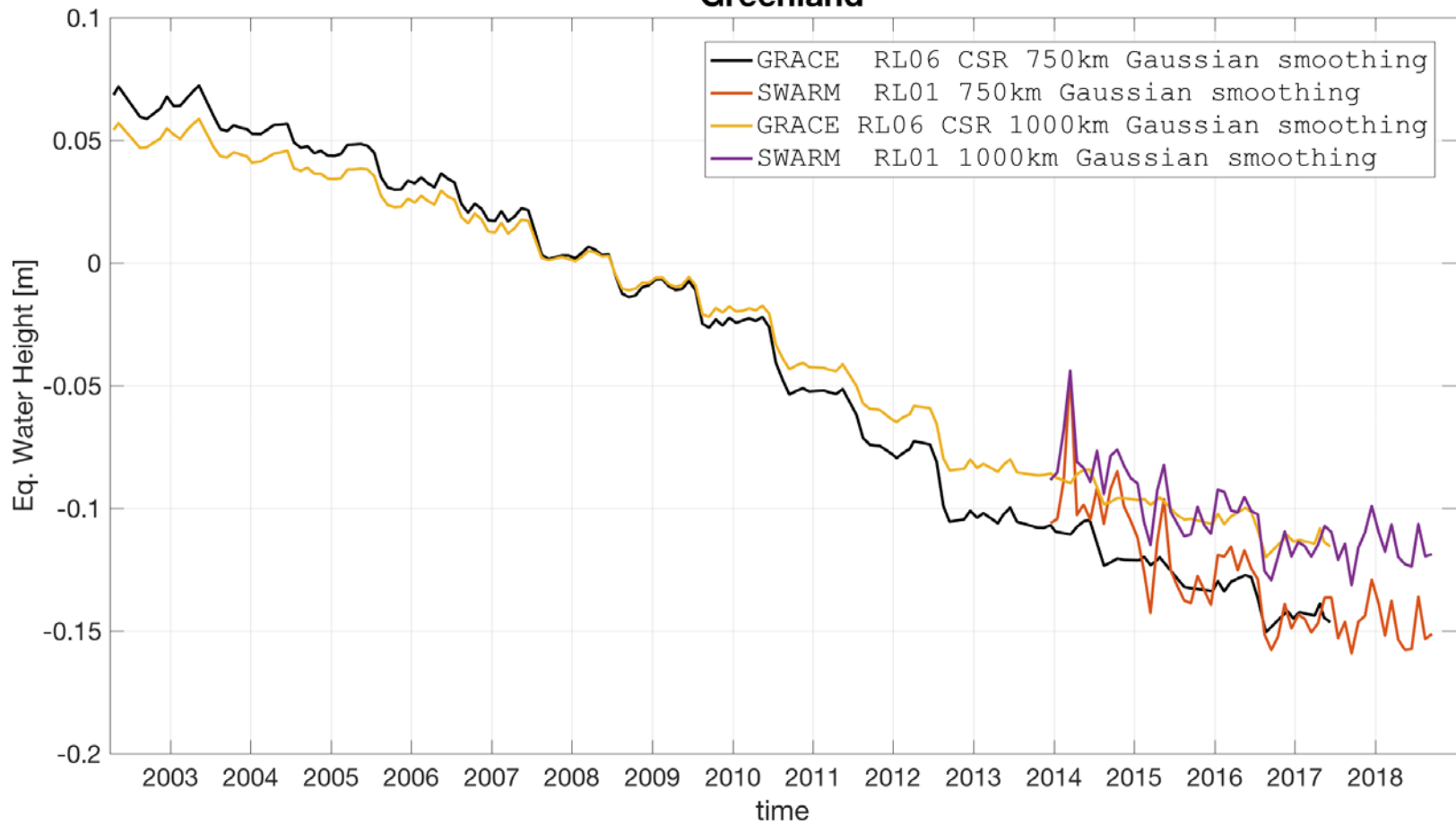
Congo Zambezi



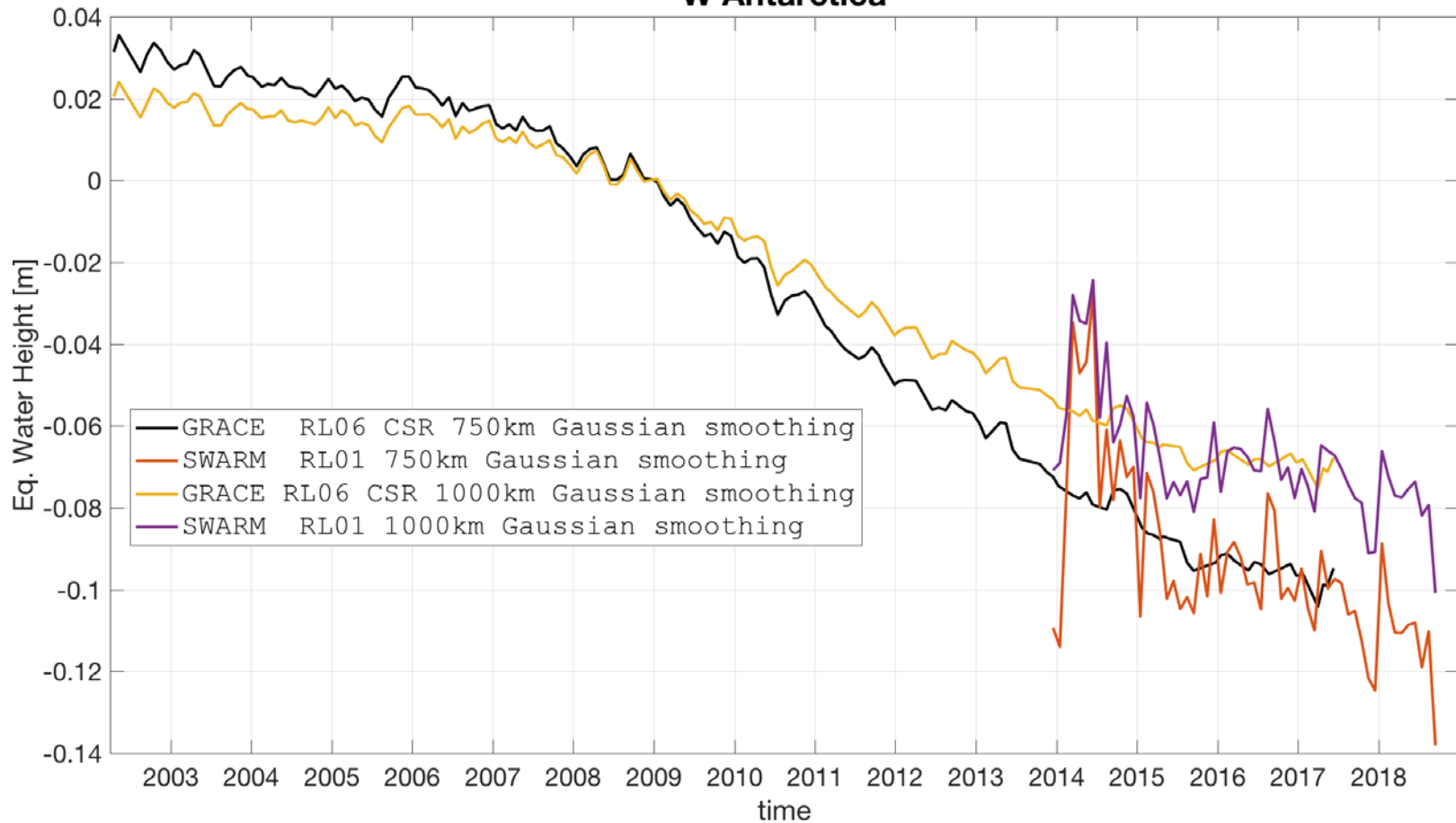
Ganges-Brahm



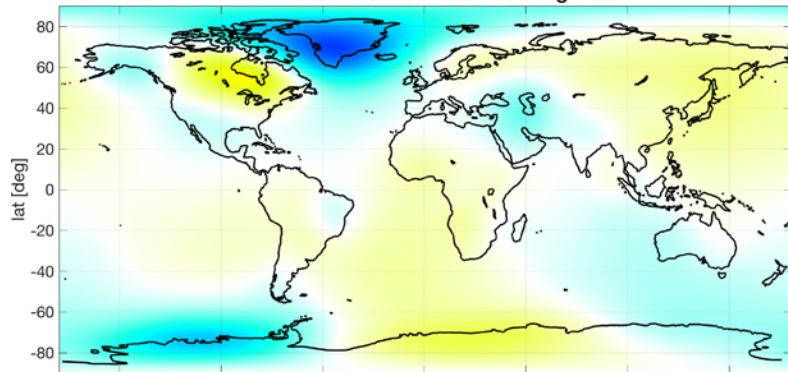
Greenland



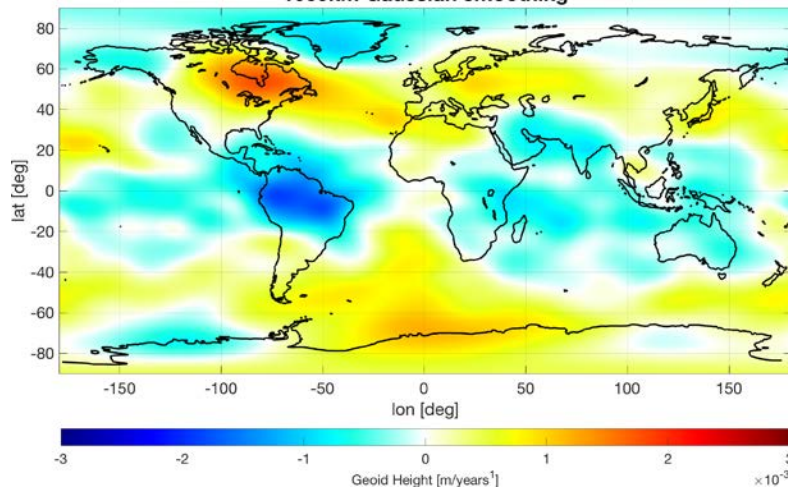
W Antarctica



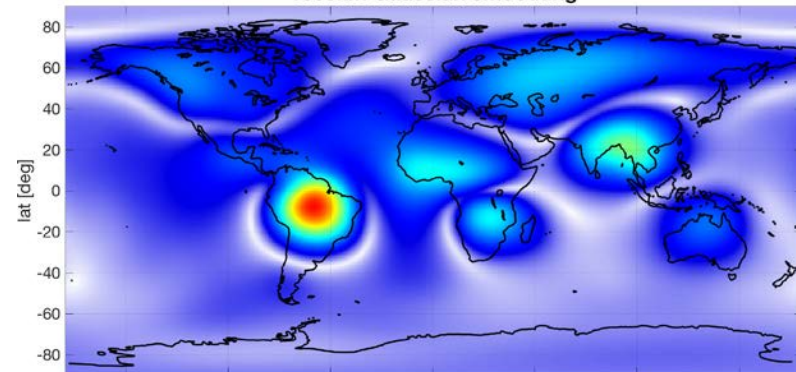
linear term for grace r106 csr (2002-04 to 2017-06)
1000km Gaussian smoothing



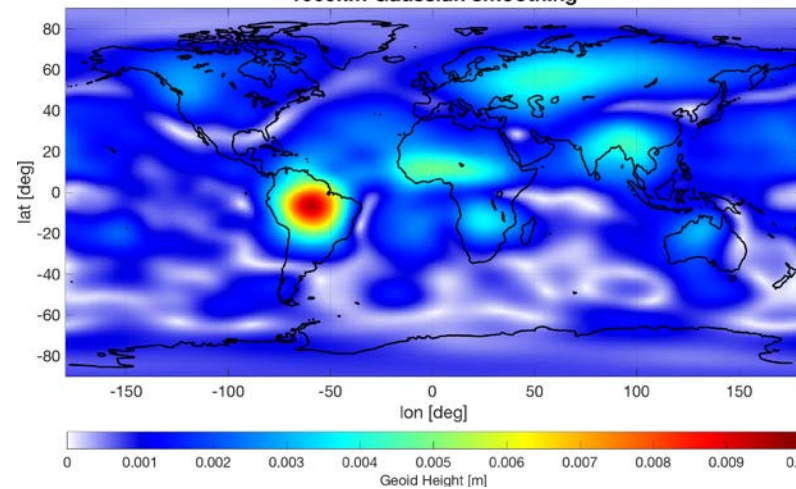
linear term for swarm r101 (2013-12 to 2018-09)
1000km Gaussian smoothing



yearly amplitude for grace r106 csr (2002-04 to 2017-06)
1000km Gaussian smoothing



yearly amplitude for swarm r101 (2013-12 to 2018-09)
1000km Gaussian smoothing



Summary and conclusions

- Swarm signal useful below **degree 15**
- Temporal correlations decrease sharply over **degree 10**
- Swarm basin averages noisier than GRACE, except for largest basins
- Global spatial agreement with GRACE at **1 cm RMS** Eq. W. H.
 - over periods of low solar activity
 - Gaussian smoothing radius of 750 km
- **Seasonal signal** clearly resolvable by Swarm