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
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 and Grace un-modeled ocean RMS
Amazon

- GRACE RL06 CSR 750km Gaussian smoothing
- SWARM RL01 750km Gaussian smoothing
- GRACE RL06 CSR 1000km Gaussian smoothing
- SWARM RL01 1000km Gaussian smoothing

Equ. Water Height [m]

Time:
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
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