Time-variable gravity field recovery from Swarm
- First simulation results

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Outline

- Motivation of the project
- Swarm constellation
- Simulation conditions
- Simulation results
- Conclusion and outlook
Motivation

• GRACE enables measurement of temporal gravity changes, which are due to mass movement and redistribution in the Earth System
• GRACE solutions widely used in hydrology, oceanography, ice etc. studies
• With eventual failure GRACE can be out-of-service
• Motivation: can Swarm be a gap-filler between GRACE and its follow-on?
• Jointed project with DTU (Swarm)
The Swarm constellation

- Three satellites with near polar orbits: $l_c = 88^\circ$, $l_a = l_b = 87.4^\circ$
- Initial altitude: Swarm C at 530 km and A, B at 450 km
- Drifting orbital plane
The Swarm constellation (cont.)

- 3 single CHAMP-like satellites
- Baseline A-C (changing), A-B (cross-track)
- Criterion to exclude not qualified epochs for A-C
- Max. 23% of all epochs to form A-C baseline

“Science fiction constellation“

- GRACE-type (A-A1 with K-band)
- Swarm A-B with K-band
- GRACE-Swarm (A-A1-B with K-band)
Simulation conditions

**Noise level [mm]**

<table>
<thead>
<tr>
<th>noise (σ)</th>
<th>Abs. position</th>
<th>Abs. velocity</th>
<th>Rel. position</th>
<th>Rel. velocity</th>
</tr>
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<tr>
<td>10</td>
<td>0.1</td>
<td>1</td>
<td>0.01</td>
<td></td>
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**Orbit height**

Swarm C: 500 km, Swarm A/B: 350 km
(corresponds approximately to Swarm mission 3 years after launch)

**Simulation duration**

01.2003 – 12.2004 (24 months)

**Input signal**

EGM96 to d/o 30, Hydrology to d/o 30 (LaD), perfect de-aliasing assumed
Hydrology recovery: degree RMS plots

05.2003

10.2003
Recovery of the annual component
Differences to LaD model (GPS only constellations, d/o 30, in [mm])
Differences to LaD model (constellations with K-band, d/o 30, in [mm])

GRACE

Swarm K-band

GRACE-Swarm
Recovery of the annual component to d/o 6 (GPS only, in [mm])

LaD model
(annual component)

Swarm A

Swarm A-B
Conclusion

- Swarm can provide 3 CHAMP-like solutions for gravity recovery
- Single and baseline solutions
- Can be used for static field recovery
- Single solution preferable than baseline for time variation recovery
- Potential for long periodic variations in low degree and order
- May be the gap filler with much lower accuracy (further study needed)

Next step:

- Aliasing error study (atmosphere-ocean, ocean tides)
- Accelerometer noise analysis
Thank you very much for your attention!

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