Time-variable gravity field recovery from Swarm

- First simulation results

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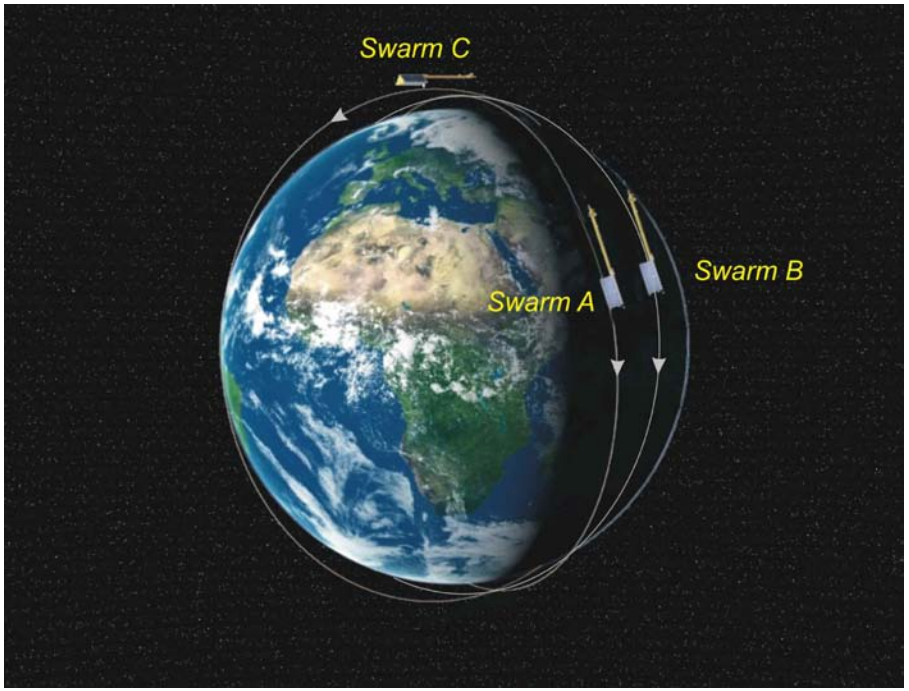
Outline

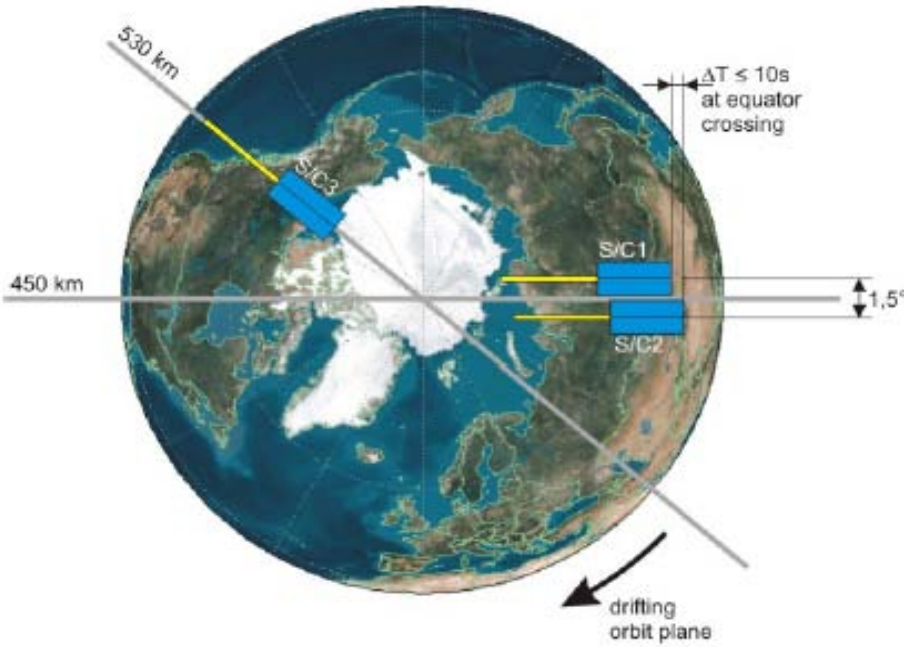
- Motivation of the project
- Swarm constellation
- Simulation conditions
- Simulation results
- Conclusion and outlook

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

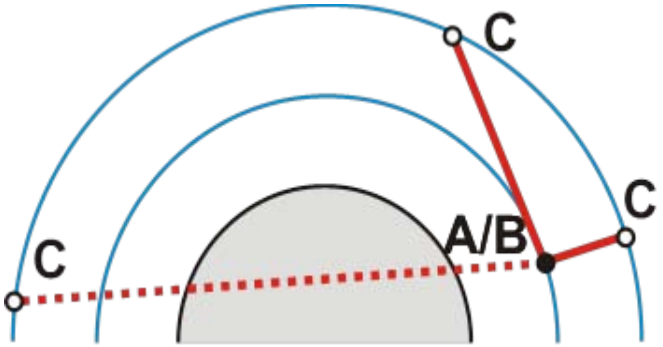




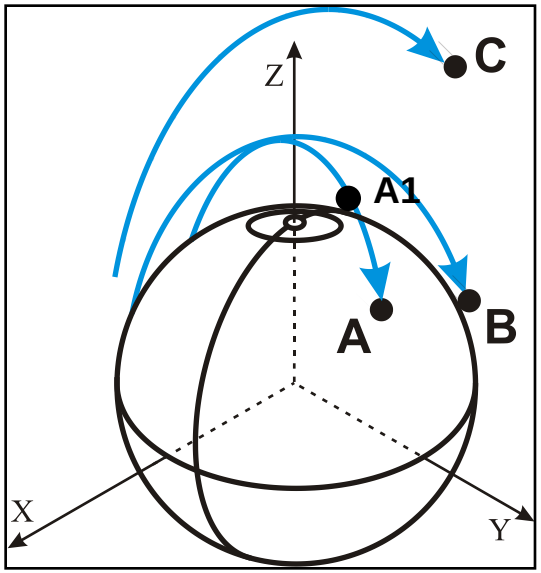
- Three satellites with near polar orbits: $I_c = 88°$, $I_a = I_b = 87.4°$
- Initial altitude: Swarm C at 530 km and A, B at 450 km
- Drifting orbital plane

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]

	Abs. position	Abs. velocity	Rel. position	Rel. velocity
noise (σ)	10	0.1	1	0.01

Orbit height

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

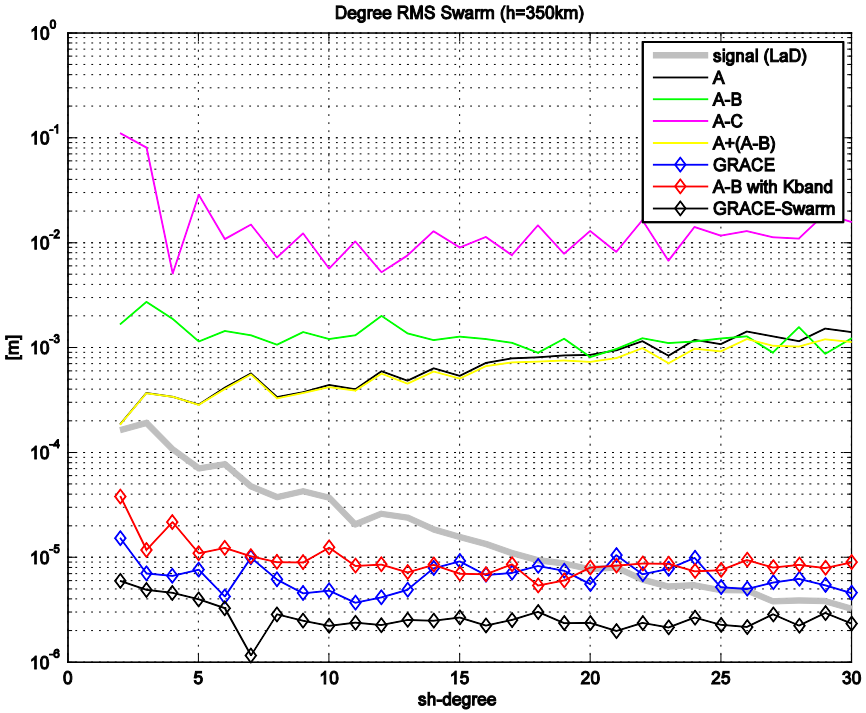
Simulation duration

01.2003 – 12.2004 (24 months)

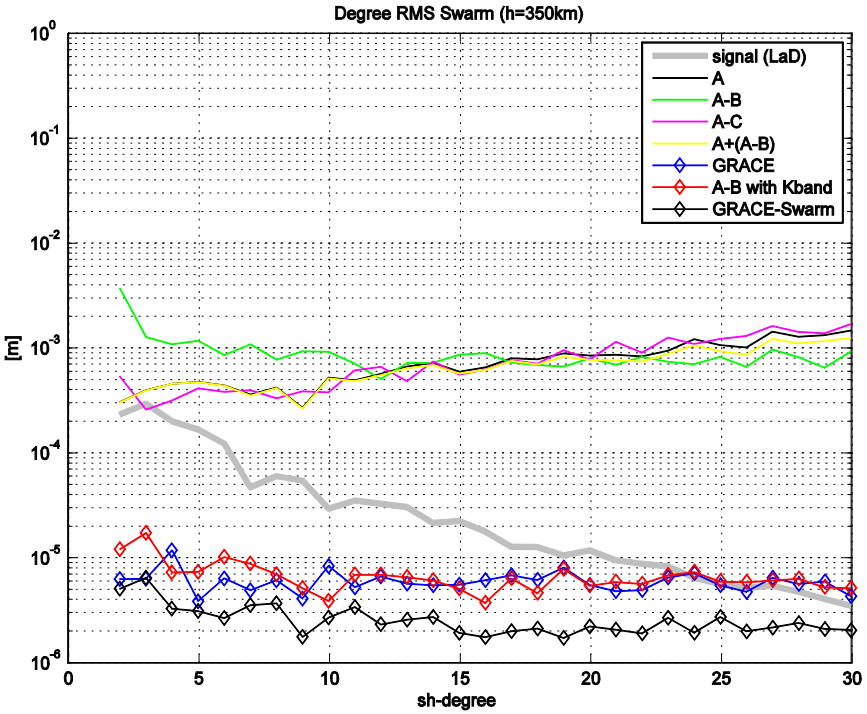
Input signal

EGM96 to d/o 30, Hydrology to d/o 30 (LaD), perfect de-aliasing assumed

Hydrology recovery: degree RMS plots



05.2003



10.2003

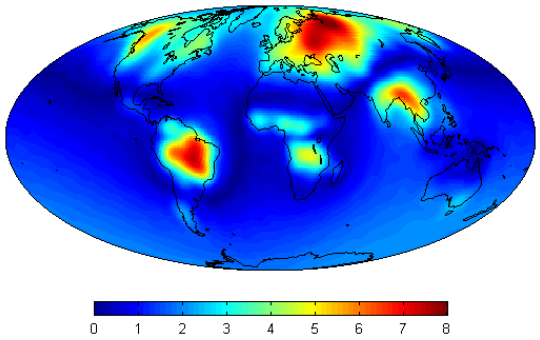
Recovery of the annual component

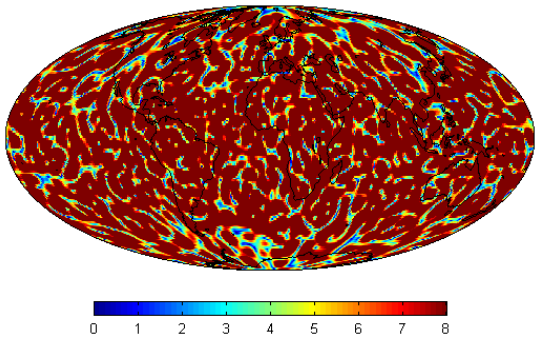
Differences to LaD model (GPS only constellations, d/o 30, in [mm])

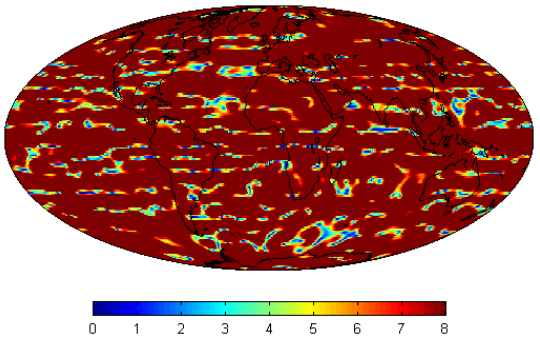
LaD model
(annual component)

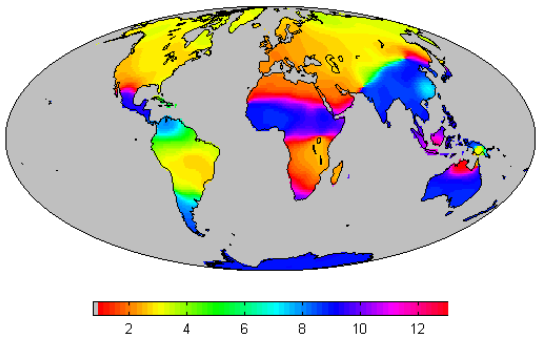
Swarm A

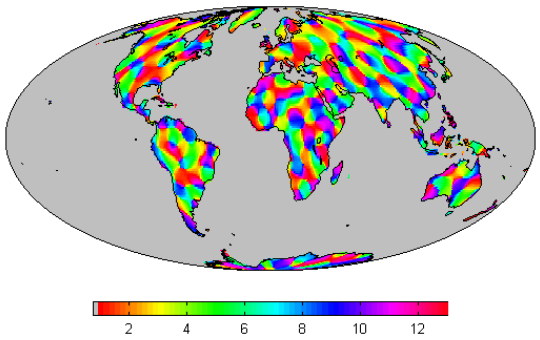
Swarm A-B

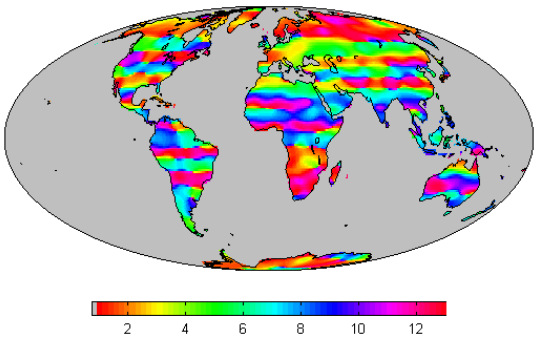






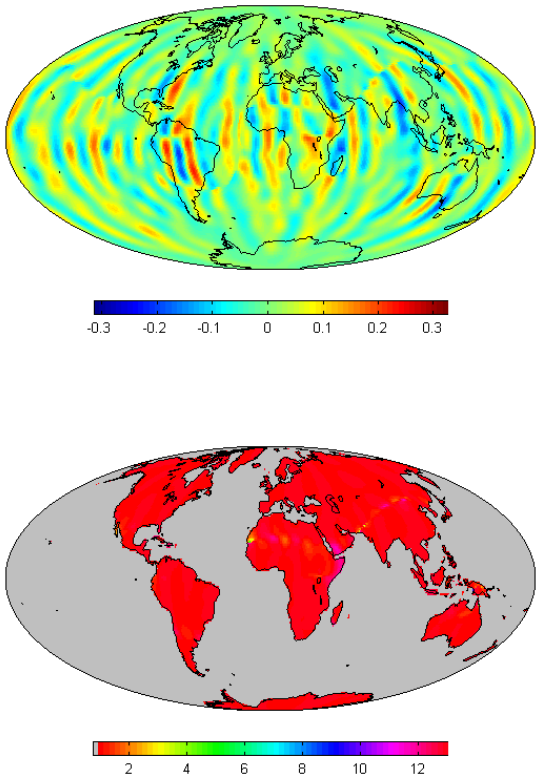




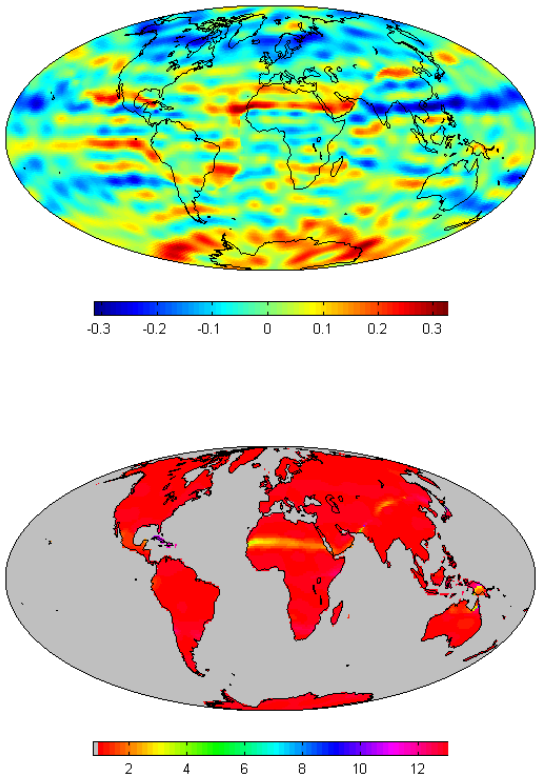


Differences to LaD model (constellations with K-band, d/o 30, in [mm])

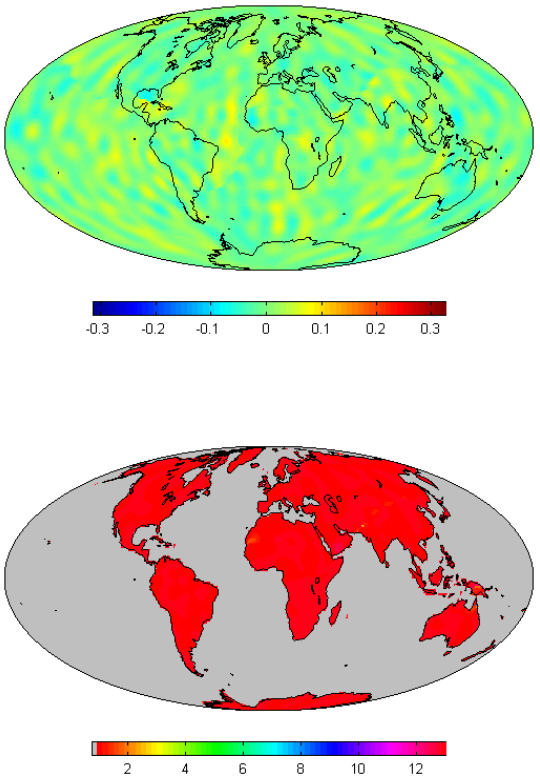
GRACE



Swarm K-band



GRACE-Swarm

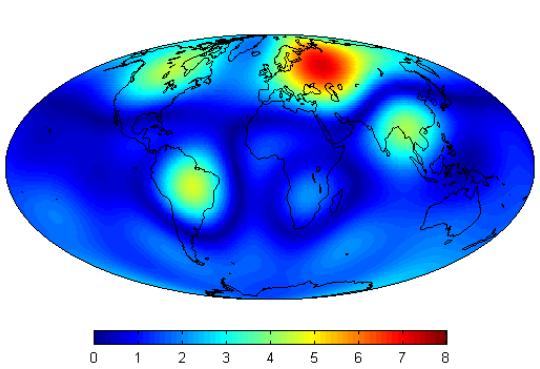


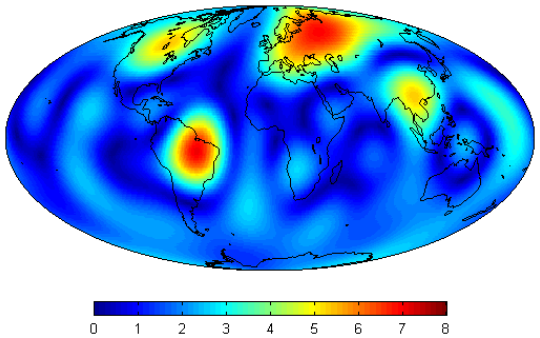
Recovery of the annual component to d/o 6 (GPS only, in [mm])

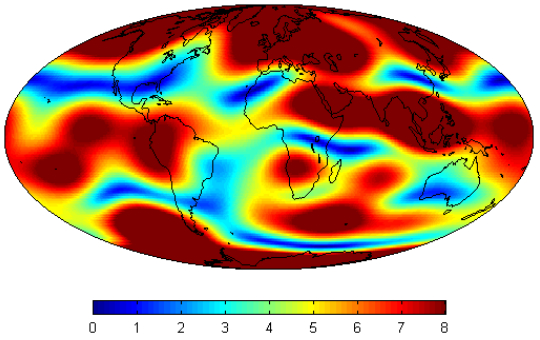
LaD model
(annual component)

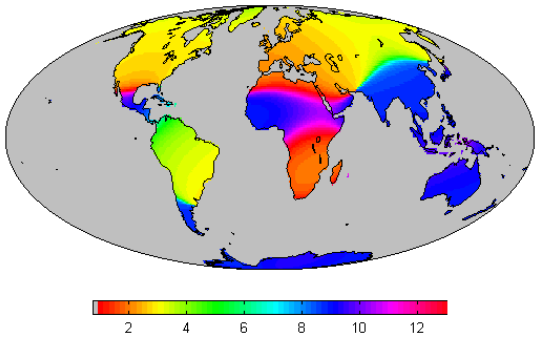
Swarm A

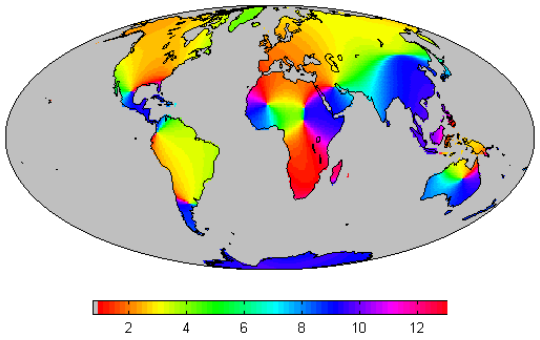
Swarm A-B

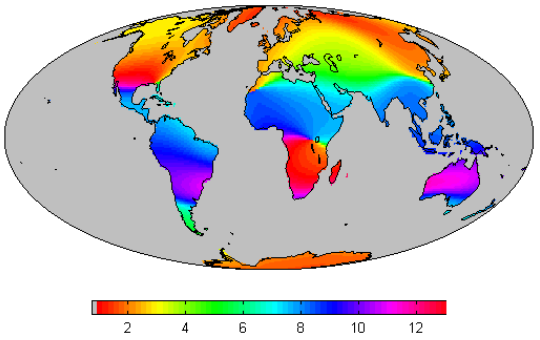












Conclusion

- 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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