Simulated Multiple Formation Flights for Future Gravity Field Recovery

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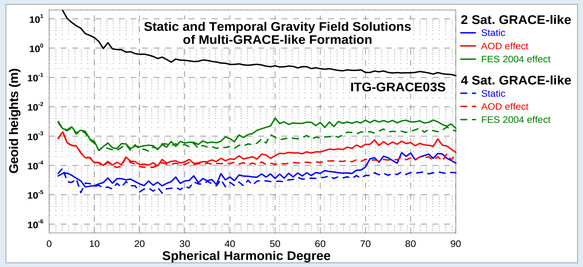
Abstract

A study of the Earth's gravity field recovery from Satellite-to-Satellite Tracking (SST) data of simulated formation flight missions is presented. New scenarios of multiple formation flights with polar and near-circular satellites' orbits will be examined. This is done by the combination of various satellite configurations such as GRACE-type scenarios with another GRACE-type which can be considered for combining one-dimensional (along-track) observations. Also combining GRACE-type with Pendulum-type missions can be accounted for combining multi-dimensional (along-track and cross-track) observations. The main focus of this study is based upon the use of short arcs of the dedicated formation flights, tailored especially to the recovery of Earth's gravity field solutions. The observation equations are set up for each short arc as applied in the calculation of ITG-GRACE03s gravity field model. The numerical simulations are performed with the Gravity Recovery Object Oriented Programming System (GROOPS) software package, which has been developed at the Department of Astronomical, Physical and Mathematical Geodesy, University of Bonn. The results are analyzed in the spatial wavelength spectrum of the static gravity field (up to spherical harmonic degree n= 90). Aliasing effects and ocean tidal models are considered in this study as time-variable gravity field.

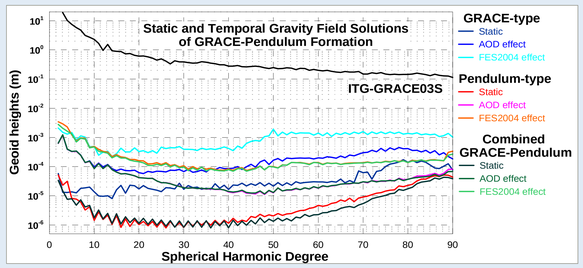
Simulation Scenario 1

As known that the collinear GRACE mission suffers from both under-sampling of temporal signals and a leakage in the spatial sampling due to insufficient and inconsistent coverage of the Earth's surface in short periods. A single gravity satellites mission can not accomplish the temporal resolution globally at such level. For this reason, an alternative mission configuration that is making the use of multi-satellite sensors is highly demanded. **One suggestion is the use of two satellites' orbits (with $\Delta\Omega$ shift= 180°) of GRACE-type flying simultaneously** which can mitigate such these foregoing problems. **The gravity field is recovered for a short period of 11.5 days** for each satellite's orbit.



Simulation Scenario 2

An alternative mission scenario for improving the time sampling with space sampling in the same time is to integrate the satellite formations. This scenario differs from the last one in such a way that it describes the integration of two different one-dimensional observations. **One-dimensional arm (along-track) of GRACE-type with one-dimensional arm (cross-track) of Pendulum-type are integrated with each other forming a GRACE-Pendulum-type formation flying**. An improvement in the gravity field recovery (**here a recovery of 30 days**) is expected on the both scales; the static scale and the temporal one as long as along-track information and cross-track one are incorporated together into the observables.



Keplerian Orbital Elements	Formation Flight Type					
	GRACE-type		GRACE-type		Pendulum-type	
	GRACE 1A	GRACE 1B	GRACE 2A	GRACE 2B	Pend. A	Pend. B
a (m.)	6728137	6728115	6728137	6728115	6728137	6728137
e	0.001	0.001	0.001	0.001	0.001	0.001
i (deg.)	90	90	90	90	90	90
Ω (deg.)	0	0	180	180	0	1.33
ω (deg.)	0	2.48	0	2.48	0	0
M (deg.)	0	-0.77	0	-0.77	0	-1

Discussion and Conclusion

- The idea of this study is how to get improved gravity solutions from formations composed of 3 and 4 satellites.
- All gravity field solutions represents the geoid heights differences between the solution and the truth gravity field model ITG-GRACE03s.
- The error structures in meridian direction seen in the gravity field solutions of the GRACE-type, which are typical of the real GRACE monthly solutions, have been reduced due to the use of additional satellites pair of the same type as in the first scenario and due to the combination of additional (cross-track) information to the observations as in the second scenario at both scales; static and temporal gravity field.