Introducing GRACE Follow-On mock data challenge project

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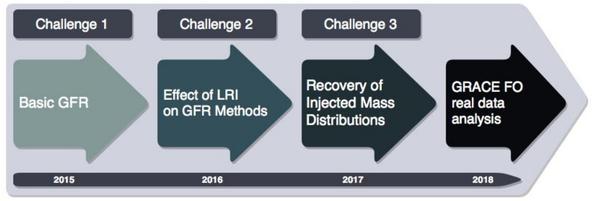
Abstract

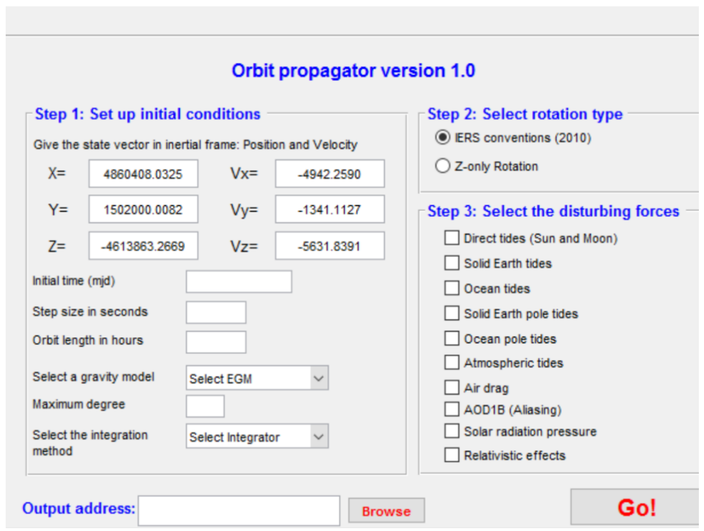
The GRACE Follow-On satellites will be launched in 2018 equipped with a Laser Ranging Instrument (LRI) that will improve the spatial and temporal resolution of Earth's gravity field measurements. Analyzing the complex data set from this mission is a significant challenge that will require a new generation of data analysis algorithms and capabilities. Here we introduce the GRACE Follow-On mock data challenge (MDC) which will release a number of simulated data sets to help research centers around the world develop and test their new tools. The data challenges range from simple gravity field recovery (GFR) to more advanced forms involving the LRI noise models.



Orbit Integrator

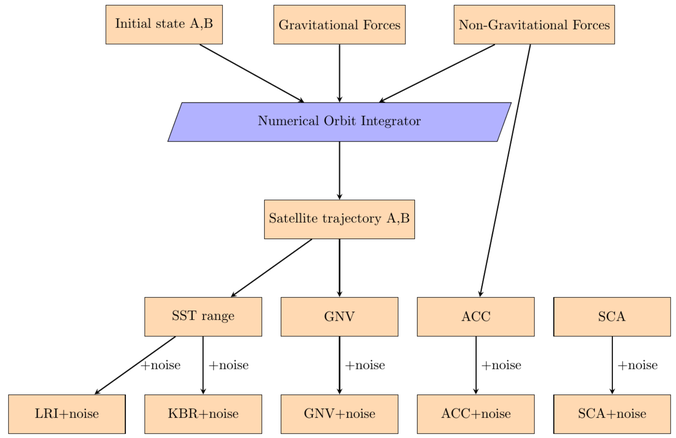
The twin GRACE Follow-On satellites fly a GRACE like polar orbit. In order to simulate the orbit, we used our numerical orbit integrator with the following set up:

Parameter	Description
Numerical integration approach	Gauss-Jackson
Arc length	30 days
Sampling interval	5 seconds



Simulation procedure

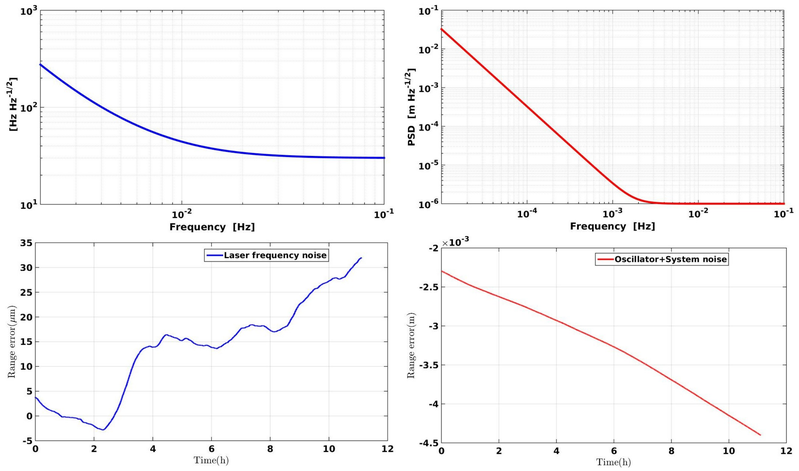
The primary step of the MDC is generating GRACE Follow-On type data. The simulation procedure started with generating simulated orbit using an orbit integrator with the truth dynamic models (gravitational and non-gravitational forces). Noise free GPS position and velocity and KBR measurements are the output of the orbit integrator.



Generation of the instrument noise

GRACE Follow-On design and instruments will be very similar to GRACE. Accordingly we used the same noise models proposed by Kim (2000) for GRACE instruments. For new LRI addition, we used noise models suggested by (Heinzel et al. 2012). With a given power spectral density (PSD) of the noise, a time series of the noise was generated with LISA Technology Package Data Analysis (LTPDA) MATLAB toolbox. Here is a comparison between LRI and KBR noise models.

LRI noise model	KBR noise model
Frequency Noise	Oscillator and System Noise
$30 \times \sqrt{1+\left(\frac{0.003}{f}\right)^2} \times \sqrt{1+\left(\frac{0.01}{f}\right)^2} \frac{Hz}{\sqrt{Hz}}$	$10^{-6} \times \sqrt{1+\left(\frac{0.0018}{f}\right)^4} \frac{m}{\sqrt{Hz}}$

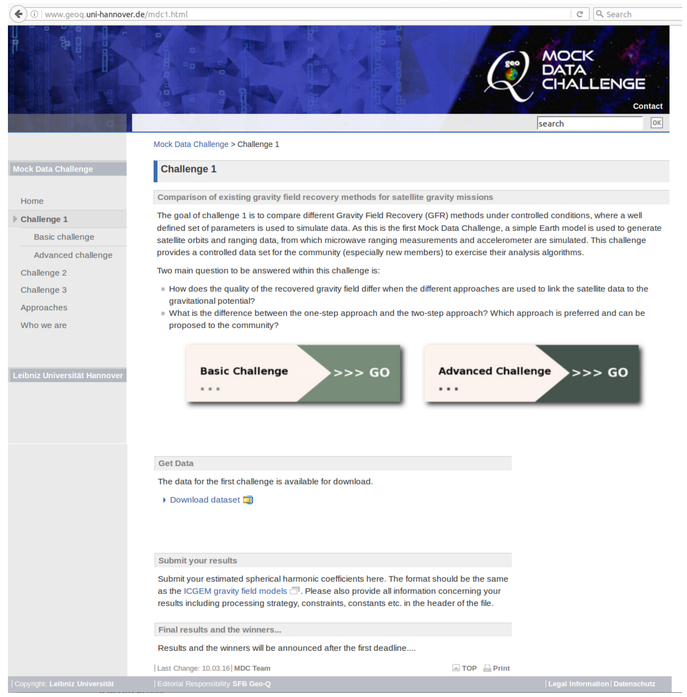


Using the GRACE Follow-On MDC

The MDCs are available via the website:

- **www.geoq.uni-hannover.de/mock**

Here is a snap shot of the website, where the users can download the data and upload the result. Each challenge will be announced for a certain period of the time, and the result will be compared and published in a peer reviewed journal.



References

- Kim J (2000) Simulation Study of A Low-Low Satellite-to-Satellite Tracking Mission
- Heinzel G, Sheard B, Brause N, Danzmann K, Dehne M, Gerberding O, Mahrdt C, Müller V, Schütze D, G Stede, Klipstein W, Folkner W, Spero R, Nicklaus K, Gath P, Shaddock D (2012) Laser Ranging Interferometer for GRACE follow-on, Proceedings of the ICSO (International Conference on Space Optics), Ajaccio, Corse, France, Oct. 9-12

Acknowledgments

The authors would like to thank the DFG Sonderforschungsbereich (SFB) 1128 Relativistic Geodesy and Gravimetry with Quantum Sensors (geo-Q) for financial support. Special thanks to Axel Schnitger for designing MDC website and Vitali Müller for all the scientific discussions.

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