University of Bremen

CENTER OF APPLIED SPACE TECHNOLOGY AND MICROGRAVITY
ZARM

Master thesis

Estimation of satellites' optical coefficients for non-gravitational force modeling from accelerometer and orbit data with GRACE/-FO data

The precise non-gravitational force modeling is a perquisite for many tasks related to orbit determination and propagation, mission assessment and performance analysis. Especially for scientific missions (altimetry, geodesy, general physics, as well as GNSS) highly accurate models are very important.

Besides atmospheric drag in low Earth orbits, non-gravitational forces are mainly due to radiation of the Sun (SRP), reflected Sun light at the Earth (Albedo), Earth infra red radiation (IR) and thermal radiation of the satellite itself (TRP), see Fig.1. These forces are determined by the optical coefficients (reflectivity, absorption, emissivity) of the satellite's surfaces. For many satellites these parameters are just known roughly and might be subject to change due to material degradation over time.

Therefore an estimation of these coefficients from satellite orbit ano/ or accelerometer data would be very beneficial.

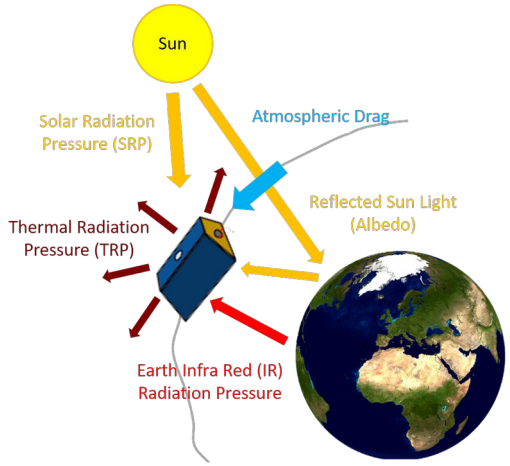

Figure 1: Non-gravitational accelerations acting on a satellite.

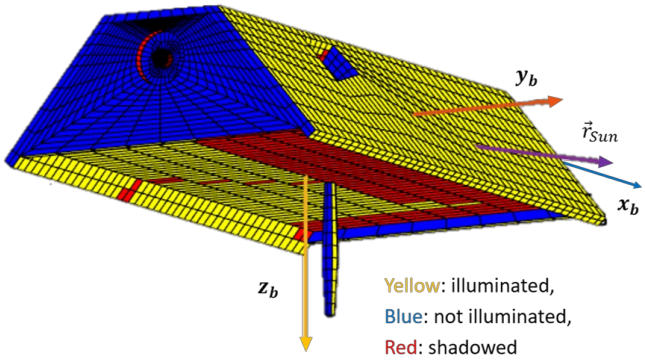

Figure 2: Finite element model of a GRACE-FO satellite for the radiative non-gravitational force computation.

The main scientific purpose of the GRACE and GRACE-FO missions is the mapping of the gravitational field of the Earth and especially its changes. For this purpose the knowledge of the non-gravitational forces is fundamental and the satellites carry accelerometers to measure these forces. Furthermore, the orbit and attitude of the satellites is well known, making the mission a perfect candidate for this project.

Besides the need to calibrate the accelerometers due to bias, drifts and scale factors, on one GRACE-FO satellite the accelerometer broke down shortly after launch, making precise non-gravitational force modeling even more precious for the mission. This is one research project in our working group. A further project is the estimation of atmospheric density from satellite orbit data, where the

modeling of non-gravitational accelerations is also fundamental, and where this development could be utilized.

The modeling of the forces is implemented in our MATLAB/Simulink orbit and satellite simulation toolbox XHPS (eXtended Hybrid simulation Platform for Space systems).

The exact work schedule can be discussed in a personal meeting, depending on preferences and type of the thesis.

We are looking for students with:

- Background in physics or space engineering, preferably with programming skills and basic knowledge of orbital mechanics
- Interested in satellite data evaluation, processing and simulation

We can offer:

- Interesting topics in the field of satellite simulation, force modeling, orbit and gravitational field determination and analysis of satellite data
- Close scientific supervision and integration in our research group (Space Science, MSAMM, Benny Rievers)

A thesis is possible in **English** or **German**. If you are interested you are welcome to contact us for further information and/ or send us an application.

This topic could also be adapted to a Master project with a few people.

Contact:

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