Validation of GOCE Simulation[1]

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Abstract

The gradiometer mission GOCE (Gravity Field and Steady-State Ocean Circulation Explorer) is simulated by using simplified assumptions. Taking into account the couplings between the different sensors (e.g. GPS, accelerometers) and control systems (e.g for drag-free control), we investigate the effects of different error sources on the scientific end-products like gravity gradients (or spherical harmonics at a further processing level).

We try to simulate the total mission (i.e. considering all important effects from misalignment of gradiometer axes up to instabilities of the contol loops) by using the standard mathematical software package SIMULINK.

We control our simulation results by linear control theory; that means, we extract single parts of the complex mission (e.g. drag-free control or the coupling of misalignments) and compute their effects separately.

Although the possibilities of SIMULINK are limited good results have been obtained. Our preliminary results show that the aspired accuracy level for GOCE (10^{-3} Eötvös/$\sqrt{\text{Hz}}$) can be achieved which enables to derive a gravity field up to degree and order 250.

1 Introduction

GOCE is one of the dedicated gravity field mission currently under investigation in the context of the ESA explorer program. Its main objective is the determination of the Earth's gravity field with high spatial resolution and with high homogeneous accuracy by using: Satellite-to-Satellite Tracking (SST) in high-low mode for the orbit determination and for the retrieval of the long-wavelength part of the gravity field, and Satellite Gravity Gradiometry (SGG) for the derivation of the medium/short-wavelength parts.

The GOCE orbit will be near circular and sun-synchronous ($i \approx 97^{\circ}$) at an altitude of 250 km. The mission duration is planned to be about 8 months. During this period the satellite shall be kept drag-free. The orbit will be determined by GPS with an accuracy of about 1 cm RMS. The measurement precision of the 3-axis gradiometer that is aimed for, is at the 10^{-3} Eötvös/$\sqrt{\text{Hz}}$ level.

Beside a GPS receiver and an ensemble of 3-axis accelerometers, further instruments are needed; e.g. star trackers to determine the orientation of the spacecraft or thrusters for attitude and drag-free control. Each instrument has its own error behaviour which affects the measurements and the final products in some typical manner.

For a realistic simulation, the various errors (e.g. misalignments, drag coupling or S/C rotation) as well as the interactions between the sensors/actuators (e.g. for attitude control) have to be considered and their effect on the scientific end-products (e.g. spherical harmonics, geoid heights or gravity anomalies) has to be investigated.

The different parts of the GOCE simulation are performed by the SID consortium consisting of SRON[2], IAPG and DEOS[3]. The division of the different tasks within SID is shown in Fig. 1. Additionally, IAPG is responsible for the validation of the gradiometer simulation.

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[1] This article is published in similar form in the journal *Artificial Satellites*.

[2] Space Research Organisation Netherlands, NL-3584 CA Utrecht, NL.

[3] Delft Institute for Earth Oriented Space Research, Delft University of Technology, NL-2629 JA Delft, NL.