GOCE GRAVITY FIELD ANALYSIS IN THE FRAMEWORK OF HPF: OPERATIONAL SOFTWARE SYSTEM AND SIMULATION RESULTS

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ABSTRACT

In the framework of the ESA-funded project "GOCE High-level Processing Facility" (HPF), an operational hardware and software system for the scientific processing (Level 1b to Level 2) of GOCE data has been set up by the European GOCE Gravity Consortium EGG-C. One key component of this software system is the processing of a spherical harmonic Earth's gravity field model and the corresponding full variance-covariance matrix from the precise GOCE orbit and satellite gravity gradiometry (SGG) data. In parallel to two other HPF teams, this key component is performed by the "Sub-processing Facility (SPF) 6000". The second main task of SPF6000 is the production of quick-look gravity field products in parallel to the GOCE mission for system diagnosis purposes. The paper gives an overview of the operational software system. On the basis of a numerical case study, which is based on the data of an ESA GOCE end-to-end simulation, the processing architecture is presented, and several aspects of the involved functional and stochastic models are addressed.

1. INTRODUCTION

The dedicated satellite gravity mission GOCE (Gravity field and steady-state Ocean Circulation Explorer; [6]), the first Earth Explorer Core Mission, in the context of ESA's Living Planet programme, strives for a high-accuracy, high-resolution global model of the Earth's static gravity field. GOCE is based on a sensor fusion concept: satellite-to-satellite tracking in the high-low mode (hl-SST) using GPS, and satellite gravity gradiometry (SGG). The GOCE mission, when successfully completed, will provide a huge data set consisting of several hundred million orbit data plus very precise gravity gradiometry data, which contains abundant information about the gravity field of the Earth on a near-global scale, from very low (derived mostly from hl-SST) to high (derived mostly from SGG) frequencies.

The scientific data processing (Level 1b to Level 2) is performed by the "European GOCE Gravity Consortium" (EGG-C), a consortium of 10 European university and research institutes, in the framework of the ESA-funded project " GOCE High-Level Processing Facility" (HPF; [23]). In the frame of this contract, the "Sub-processing Facility (SPF) 6000", a co-operation of TU Graz, Austrian Academy of Sciences, University of Bonn, and TU Munich, under the lead of TU Graz, is responsible for the processing of a spherical harmonic Earth's gravity field model and the corresponding full variance-covariance matrix from the precise GOCE orbit and SGG data, and the production of quick-look gravity field products in parallel to the GOCE mission for the purpose of a fast system diagnosis.

The mathematical model for the parameterization of the Earth's gravity field is based on a series expansion into spherical harmonics. In the case of a model resolution complete to degree and order 250, this yields approximately 63000 unknown spherical harmonic coefficients. The determination of these coefficients from the complementary hl-SST and SGG data sets is a demanding numerical and computational task, and therefore efficient solution strategies are required to solve the corresponding large normal equation systems. During the last decade, several approaches have been developed to perform this task (e.g., [22], [24], [8], [16], [14]). In [16], [17], the rigorous solution of the large normal equation matrix by means of a parallel processing strategy implemented on a Linux-PC cluster was proposed. While direct methods perform an epoch-wise processing of the gravity field observations, the semianalytic approach considers the observations along a satellite track as a time-series ([22], [16], [29], [19]).

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