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Time-wise GOCE gravity field analysis: software architecture and processing strategies

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The dedicated satellite gravity mission GOCE (Gravity field and steady-state Ocean Circulation Explorer), 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. In the framework of the ESA-funded project "GOCE High-level Processing Facility", an operational hardware and software system for the scientific processing (Level 1B to Level 2) of GOCE data is currently set up by the European GOCE Gravity Consortium EGG-C, which is composed of scientists from 10 European institutions with unique expertise in orbit determination and gravity field research. One key component of this software system is the processing of a spherical harmonic Earth's gravity field model from the precise GOCE orbit (GPS satellite-to-satellite tracking; SST) and satellite gravity gradiometry (SGG).

The computation of a high-accuracy, high-resolution spherical harmonic model of the static Earth's gravity field from these complementary data sets is a demanding numerical and computational task, and therefore efficient solution strategies are required to solve the corresponding large normal equation systems. The time-wise approach for the computation of a gravity field model is a combination of several processing strategies for the optimum exploitation of the information content of the GOCE data. It consists of two main components:

(1) Quick-Look Gravity Field Analysis: Computation of fast approximate gravity field solution, with latencies down to 3 hours after the receipt of the input data. These gravity field solutions are used to derive a fast diagnosis of the GOCE system performance

and to monitor the quality of the input data. (2) Core Solver: Rigorous high-precision solution of the very large normal equation systems applying parallel processing strategies on a PC cluster. The Core Solver is composed of the Final Solver, taking the full normal equation matrix into account and thus providing also the full variance covariance matrix of the estimated parameters, and the Tuning Machine, being based on the method of preconditioned conjugate gradients, which will verify and tune the involved software components of the Final Solver in many respects, e.g., concerning the issues of optimum filtering of the SGG time series, regularization and optimum weighting of the normal equations. Concerning the SST component, the energy integral approach is applied.

The presentation gives an overview of the operational software system. On the basis of several numerical simulations, which are based on realistic mission scenarios, the performance of this combined approach is demonstrated, several aspects of the involved functional and stochastic models are presented, and recent developments and upgrades especially concerning the quality assessment and control within the software system are discussed.