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What have we gained from GOCE, and what is still to be expected?

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So far three releases of GOCE-only gravity field models applying the time-wise method have been computed in the frame of the ESA project "GOCE High-Level Processing Facility". They have been complemented by satellite-only combination models generated by the GOCO ("Gravity Observation Combination") consortium. Due to the fact that the processing strategy has remained practically unchanged for all releases, the continuous improvement by including more and more GOCE data can be analyzed.

One of the basic features of the time-wise gravity field models (GOCE_TIM) is the fact, that no gravity field prior information is used, neither as reference model nor for constraining the solution. Therefore, the gain of knowledge on the Earth's gravity field derived purely from the GOCE mission can be evaluated. The idea of the complementary GOCO models is to improve the long to medium wavelengths of the gravity field solutions, which are rather weakly defined by GOCE orbit information, by inclusion of additional data from satellite sources such as GRACE, CHAMP and SLR, taking benefit from the individual strengths and favourable features of the individual data types.

In this contribution, we will review which impact GOCE has achieved so far on global and regional gravity field modelling. Besides the gravity field modelling itself, the contributions of GOCE to several application fields, such as the computation of geodetic mean dynamic topography (MDT), and also for geophysical modelling of the lithosphere, will be highlighted. Special emphasis shall be given to the discussion to what extent the full variance-covariance information, representing very realistic error estimates of the gravity field accuracy, can be utilized.

Finally, also a GOCE performance prediction shall be given. After the end of the extended mission phase by December 2012, currently several mission scenarios are discussed, such as either extending the mission period further as long as possible at the same altitude, or lowering the satellite by 10-20 km for a shorter period. Based on numerical simulation studies the pros and cons of several scenarios regarding the achievable gravity field accuracy shall be evaluated and quantified.