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Gravity Field Determination at AIUB: From CHAMP and GRACE to GOCE

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Gravity field recovery at the Astronomical Institute of the University of Bern (AIUB) is rigorously treated as an extended orbit determination problem, which avoids the introduction of any a priori gravity field information from the CHAMP-, GRACE-, or GOCE-era. The so-called Celestial Mechanics Approach is applied to GPS high-low satellite-to-satellite tracking (hl-SST) data of low Earth orbiters (LEOs), via the use of previously established kinematic LEO positions, to K-band low-low satellite-to-satellite tracking (ll-SST) data of the GRACE mission, and to gradiometer data of the GOCE mission. Mathematical or empirical covariances of all observations may be taken into account on request.

We use CHAMP and GOCE hl-SST data to fully exploit the long wavelength part of the Earth's gravity field. We validate the derived gravity field models by performing LAGEOS orbit determination using Satellite Laser Ranging (SLR) measurements and demonstrate that GPS hl-SST gives access to high-quality estimates of the lowest degree coefficients. We also assess the contribution of GPS hl-SST to the recovery of time variable gravity signals and show that large-scale variations may be captured.

We present the new release AIUB-GRACE03S based on 7 years of K-band ll-SST and GPS hl-SST data, consisting of a static gravity field resolved up to degree 160 and a series of monthly gravity field models resolved up to degree 60. We compare the AIUB-GRACE03S release with results from other research groups and assess the differences between a simultaneous estimation of annual, semi-annual and trend signals with the static field and the estimation of a static field only.

As opposed to the commonly applied filtering techniques for GOCE gravity field recovery based on gradiometer data, empirical parameters are set up in addition to the gravity field coefficients to absorb the non-physical part of the gradiometer measurements. First results of this appraoch are presented, which is by construction independent of the a priori gravity field information.

The Celestial Mechanics Approach was generalized to take empirically derived covariance information into account, e.g., derived from the analysis of residuals. We study the impact of empirical covariance information on the GOCE gradiometer solutions and on the monthly GRACE solutions. We discuss in particular the important issue, whether information may be introduced from the gravity field model underlying the residuals used for the establishment of the empirical covariances.