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Gravity Field Recovery from GOCE High-low SST and SGG Data by the Combined Adjustment Method

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ESA's GOCE (Gravity field and steady-state Ocean Circulation Explorer) mission is based on the sensor concepts of high-low satellite-to-satellite tracking (SST-hl) and satellite gravity gradiometry (SGG). The SST-hl data from GPS receiver contains the long wavelengths of gravity field, and the SGG data from gradiometer provides more high-frequency information. Therefore, an optimal GOCE gravity field solution can be derived from the combination processing of these two types of data.

The combination processing is based on the method of least squares combined adjustment, and an Earth gravity field model complete up to degree/order 200 is recovered from 71 days of GOCE precise kinematic orbit and gravity gradient data. The gravity field solution strategies are as following: Firstly, the SST-hl data is processed based on the acceleration approach, which produces the SST-hl normal equations with a maximum degree and order of 100. The satellite accelerations are derived by a 3-points differential scheme, and the colored noises in orbit-derived satellite acceleration data are filtered using a 3-points differential whitening filter. Secondly, the along track of SGG data is processed based on the space-wise least-squares method, which produces the SGG normal equations with a maximum degree and order of 200. Due to the systematic behavior (mainly in 1cpr) and bandwidth limitation (0.005 to 0.1 Hz) of gradiometer measurement, the system errors and colored noises in SGG data are processed by the designed mean filter and ARMA recursive filter, respectively. Thirdly, SST-hl and SGG normal equations are combined for GOCE gravity field model adjustment, and the superposition of normal equation system is solved using Cholesky decomposition. The optimal weight ratio for SST-hl/SGG is obtained from variance component estimate (VCE), and the ill-posed problem caused by polar gaps is treated with Kaula regularization strategy.

The solution is evaluated through comparison with the first released GOCE-only models, and it is also validated by independent GPS/Leveling data in the selected areas of China. The results show that our solution is more accurate than the GOCE time-wise solution, and its total accuracy is most close to the GOCE space-wise solution.

Key words: gravity field recovery, combination adjustment, GOCE

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