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GOCE long-wavelength gravity field recovery from high-low satellite-to-satellite-tracking using the acceleration approach

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The restricted sensitivity of the GOCE (Gravity field and steady-state Ocean Circulation Explorer) gradiometer instrument requires satellite gravity gradiometry to be supplemented by orbit analysis in order to resolve long-wavelength features of the geopotential. In this context, the energy conservation method gained particular interest to exploit GPS-based satellite-to-satellite tracking (SST) information. This method has been adopted within official ESA products. On the other hand, various investigations showed the energy conservation principle to be a sub-optimal choice. For this reason, we propose to estimate the low-frequency part of the gravity field by the acceleration approach, which proved to be an efficient and accurate tool in high-low-SST data analysis of former satellite data. This approach balances the gravitational vector with satellite accelerations by means of Newton's law of motion, and hence is characterized by (second-order) numerical differentiation of the kinematic orbit. However, the application of this method to GOCE-SST data, given with a 1s-sampling, showed that serious problems arise due to strong noise amplification of high frequency noise. In order to mitigate this problem, tailored processing strategies with regard to low-pass filtering, variance-covariance information handling, and robust parameter estimation have been adopted. By comparison of our GIWF (Geodetic Institute (GI), Space Research Institute (Institut für Weltraumforschung, IWF)) solutions and the official GOCE models with a state-of-the-art gravity field solution derived from GRACE (Gravity Recovery And Climate Experiment), we conclude that the acceleration approach is better suited for GOCE-only gravity field determination as opposed to the energy conservation method. Comparisons with solutions from other algorithms, e.g. the variational approach, show that the acceleration approach is able to estimate gravity fields of similar quality.