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A case study on the potential of robust decorrelation filter design for a reprocessing of a gravity field model from GOCE data

Jan Martin Brockmann, Wolf-Dieter Schuh, and Boris Kargoll

Institute of Geodesy and Geoinformation, Department of Theoretical Geodesy, University of Bonn, Bonn, Germany (brockmann@geod.uni-bonn.de)

Gravity gradients measured by the gradiometer on board the GOCE (Gravity field and steady-state Ocean Circulation Explorer) satellite are highly correlated. To account for the correlations in the observations within gravity field determination, digital Auto-regressive-Moving Average (ARMA) filters estimated from observation residuals are used as whitening filters.
After a full scale gravity field recovery, gravity gradient residuals are analyzed and ARMA filters are adjusted. Within the chosen processing method, which follows the so called time-wise approach, individual filters are adjusted for the different gravity gradient components and for different coherent gap-less parts of the time series (segments).
Due to satellite maneuvers, instrumental effects, or an imperfect calibration, the noise of the observations becomes non-stationary and outliers become visible. Both significantly affect the design of decorrelation filters. An alternative to the state-of-the-art approach of adjusting decorrelation filters to outlier-free parts of a segment is investigated. A robust approach is used to estimate the decorrelation filter coefficients. In addition to the coefficients, outlier information is an output from filter design, which can be used for gravity field determination.
As the chosen approach identifies non-stationary parts of the time-series and outliers, the decorrelation filters are estimated from clean data only. Outliers and non-stationary parts do not degrade the overall characteristics of a segment. Consequently, the accuracy of the spherical harmonic coefficients increases and gets more realistic, although less data is used in the adjustment.
Within this contribution, both the proposed and the state-of-the-art filter type is for gravity field recovery from GOCE gravity gradients from the lower orbit operation campaign. The effect of the alternative filter design on gravity field solutions and their accuracies is shown. In comparison to more accurate reference models, it is shown that individual segment- and component-wise solutions do not significantly change but the estimated accuracy gets more realistic (especially for the YY component). Consequently, solutions which combine different components and segments become better and more accurate, as the relative (spectral) weighting of components and segments improves.