Stochastic model validation of satellite gravity data: a test with 2 years of CHAMP data

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With the present CHAMP and GRACE missions and the upcoming GOCE mission, millions of gravity related observations will be released to the scientific world. To derive a model of the Earth's gravity field, one needs to know both functional and stochastic model. This study aims at the estimation, validation and improvement of the stochastic model using the technique of Variance Components Estimation (VCE). A comparison is made between the Minimum Norm Quadratic Unbiased Estimator (MINQUE) and the Almost Unbiased Estimator (AUE). Monte Carlo techniques are used to speed up the computations. Outliers are detected with an approximation of the Pope's test. With the knowledge of the variance-covariance matrix of the data sets, one should be able to combine several heterogeneous data sets including existing gravity models and have a more reliable estimate of the quality of the derived model.
As a test, two years of CHAMP data (GPS, accelerometer and attitude information) have been evaluated. The data is used to compute pseudo-observations according to the energy balance approach. The spherical harmonic coefficients of the gravity model were estimated simultaneously with polynomial coefficients (for each data set) to account for the energy constant and bias of the accelerometer, and the variance components for the in-situ potential values. Arcs showing spurious behaviour were effectively downweighted, which improved the gravity model significantly. After the combination of the satellite data (satellite-only solution), the normal equations were stabilized by combining them with the EGM96 model, again with the use of Monte Carlo VCE.
Variance Components Estimation in combination with Monte Carlo techniques appears to be a promising technique to combine data sets of varying quality and / or different sensors with each other, such as the SGG and the SST data in case of the GOCE mission.