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The role of a priori information in gravity field determination

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Gravity field estimation using observations of the recent space missions CHAMP, GRACE, and GOCE is a non-linear parameter estimation problem. The problem must be solved by linearization, implying that the terms of higher than the first order in the estimated parameters are neglected.

In principle, an iteration process using the previously determined parameters as new a priori values must be performed. The process leads to the "true" answer, provided the linearization errors are small (from some point in the iteration process onwards) and provided all parameters of the physical model of the observables are solved in one parameter estimation problem in each iteration step.

Using the Celestial Mechanics Approach (CMA) as a tool we show how a priori information can be introduced unwittingly into the estimated gravity field parameters, if the above principles are breached. We show explicitly that attempts based on the separation of the orbit determination problem from the gravity field determination problem may end up in using a priori information without being aware of it.

The mechanisms are illustrated using the observations of the GRACE mission, where the cases GPS-only and GPS/K-Band combined are studied. The introduction of a priori information can be avoided – at least if gravity field determination is considered as a generalized orbit determination process – as in the CMA.