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Regional Gravity Modeling in Spherical Radial Basis Functions – Different Types of Observations in a Closed-loop Simulation

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With the increasing number of high-resolution gravity observations, which became available in the recent years, global Earth gravity models can be regionally refined. While global gravity models are usually represented in spherical harmonic basis functions with global support, a very promising option to model the regional refinements is the use of spherical radial basis functions with quasi-compact support.

In regional gravity modeling with spherical radial basis functions, a lot of key parameters, such as the area of investigation, the type of radial basis functions, the number of basis functions or the margin widths, have to be chosen appropriately depending on the signal to be represented. Since we want to model regional refinements, the signal under investigation is a regional difference signal with respect to a given background gravity model. It can be observed by satellite gravity missions like GRACE or GOCE, by airborne gravity campaigns, or by terrestrial gravimetry.

In our approach we use parameter estimation methods to determine the unknown series coefficients of the signal representation in radial basis functions. Most likely, when estimating the parameters, the problem to be solved is singular because of several reasons: First, in most cases a higher number of basis functions is used than minimally needed. Thus, the set of series coefficients is not unique. Second, data gaps may exist such that the corresponding coefficients are not determinable. And third, when using airborne or spaceborne observations, the ill-posed problem of downward continuation of the gravity signal is involved. Amongst the unlimited number of possible solutions to our system of equations, we are looking for a set of coefficients with physically meaningful values.

To study details of the regional modeling procedure and the numerical results, we set up a closed-loop simulation. We use the simulation to compare the estimated gravity representation obtained from different types of observations. Herby, we focus on GRACE- and GOCE-type satellite based observations and terrestrial gravity measurements. The different types of observations have different bandwidths where they are sensitive, what can be taken into account by the appropriate choice of the basis functions.

Furthermore, radial basis functions can be used to effectively combine different types of observations, already on the normal equation level and in one parameter estimation step. We compare the representations for each of the observations and their combination.