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Different radial basis functions and their applicability for regional gravity representation on the sphere

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Satellite data provide very valuable contributions to global Earth gravity models. Commonly, these global gravity models are represented in spherical harmonic basis functions. Since spherical harmonics are basis functions with global support, they do not necessarily represent a small regional signal in an optimal way. Regional gravity field refinements are obtained for example from airborne or terrestrial measurements. To represent this additional regional information appropriately, one option is to use spherical radial basis functions.

In contrast to spherical harmonics, spherical radial basis functions have quasi-compact support. Their influence decreases rapidly with distance from their location. Thus, they are much more suitable than spherical harmonics to model local effects on the sphere.

We investigate different types of radial basis functions and their applicability to represent a regional gravity signal on the sphere. Some radial basis functions, like the Shannon, Blackman, or Poisson-multipole wavelets, have band-pass filtering characteristics. They can be adapted to the bandwidth of the signal under consideration. This characteristic can be beneficial for example for modeling data from the satellite mission GOCE, where reliable observations are limited to a certain spectral bandwidth. Other radial basis functions, like the Abel-Poisson wavelet, have better space localizing properties. We compare different types of radial basis functions and their performance in the representation of a simulated regional gravity potential signal on the sphere. The determination of the coefficients of the representation in radial basis functions requires solving an ill-posed problem. We propose parameter estimation methods, instead of the often-used numerical integration, to determine the coefficients. Thereby, we use a pseudo inverse and variance component estimation.

The quality of the representation of a signal on the sphere in radial basis functions depends not only on the choice of the radial basis function, but also on the number of basis functions in use, their location, and the method, which is used to estimate the parameters of the representation. All of these aspects have to be taken into account.