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Regional gravity field modeling via multi-resolution representation and the combination of various observation techniques

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In the last few years Multi-Resolution Representation (MRR) plays more and more a prominent role in global and regional gravity field modeling. The main feature of this mathematical approach is that the target function is split into multiple detail signals each related to a specific frequency band. Applying this method to gravity field modeling, the spectral decomposition produces band-pass filtered signals which allow for data compression and filtering.

Complementary to this theoretical development, recent satellite missions such as GRACE and GOCE deliver very accurate gravity measurements which can be combined with terrestrial and airborne data as well as observations from satellite altimetry. Since these heterogeneous data sets are sensitive to different parts of the frequency spectrum, a spectral combination can be performed within the MRR: the detail signals of the high levels are estimated from a combination of terrestrial data and satellite altimetry measurements, the detail signals of the medium levels are computable from GOCE and airborne data, whereas the lower levels are mainly determined from GRACE measurements. The connection of all these detail signals can be realized mathematically by using a pyramidal algorithm. This presented approach enables to exploit the highest degree of information out of these different measurement techniques.

For the determination of the various detail signals parameter estimation techniques are implemented. We apply the method to specific regions and represent the gravity field by a series expansion in terms of localizing quasi-compact scaling and wavelet (base) functions. The corresponding series coefficients can be estimated, e. g. by least-squares or by variance components. One of the main advantages of this method is not only to solve for the unknown coefficients but also for the necessary stochastic information. Especially the influence of correlations between different detail signals (e. g. in overlapping frequency spectra) has to be studied.

In the presentation basic principles will be shown and open issues will be discussed. Examples of regional gravity field models are given with an outlook on geophysical applications.