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Towards a Multi-Resolution Analysis in Geodetic Applications

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The multi-resolution analysis (MRA) provides a simple hierarchical framework for identifying the properties of a signal. The procedure starts from the measurements, performs the decomposition into frequency-dependent detail signals by applying a pyramidal algorithm and allows for data compression and filtering, i.e. data manipulations. The MRA means a tool for representing and reconstructing signals and finally for interpretation. A key aspect of this framework is its hierarchical structure. At different resolution levels the details of a signal generally characterize different physical aspects. At coarse resolution these details correspond to the larger overall aspects. At fine resolution the details correspond to its characteristic features.

Nowadays many fields of interest, e.g., in geosciences require modern strategies for representation and interpretation. MRAs may be defined on various manifolds such as sphere, ellipsoids or multi-dimensional Euclidean domains; often tensor products are introduced for combining different sets of base functions. A MRA is usually generated by scaling functions, from which so-called wavelet functions are derived. These functions span the sequence of scaling and detail spaces of the MRA.

Since different geodetic measurement types (terrestrial, airborne, spaceborne) cover different part of the frequency spectrum, it seems reasonable to calculate the detail signals of the lower levels mainly from satellite data, the detail signals of medium levels mainly from airborne and the detail signals of the higher levels mainly from terrestrial data. A concept is presented how these different measurement types can be combined within the MRA. Furthermore, in many applications huge data sets have to be handled; data transmission requires the extraction of the relevant information in a preprocessing step. Thus, data compression techniques play an important role. In this paper the basic principles on strategies and concepts for the generation of MRAs will be shown. Examples of gravity field determination and atmosphere modeling are presented.