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On the problem of combining time-variable spherical harmonic potential field data with time series of point-wise, broad-band, data

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A common problem in modern geodesy and geodynamics is to combine potential field data, provided in the form of spherical harmonics and derived typically from spaceborne observing systems, with terrestrial, point-wise, broad-band data. Examples include the validation and possibly combination of GRACE time-variable gravity field models with time series from superconducting or absolute gravity meters, or the joint inversion of time-variable gravity fields with time series of GPS station displacements through a loading theory and with in-situ ocean bottom pressure data.

This task is recognized as one of the most challenging problems in geodetic data analysis, since a) potential field data given in spherical harmonic sets are by nature band-limited, possibly affected by noise propagation through downward continuation, characterized by correlated noise pattern, and mostly provide a mean quantity in the temporal sense, whereas b) in-situ data typically samples the non-bandlimited spatial field in heterogeneous point configurations, with high temporal resolution but sparse over either land or oceans. In addition, different functionals of the gravity field (potential vs. gravity changes at the Earth surface) or of the surface mass distribution (gravity potential harmonics vs. deformation vs. bottom pressure) are to be combined.

In this contribution, we will outline the specific problem areas, summarize and compare some of the methods that may be employed in a common mathematical setup, identify their benefits, discuss their transition into discrete least-squares problems, and provide some numerical examples.