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Regional gravity field modeling by the free-positioned point mass method

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The remove-compute-restore technique can be regarded as a state-of-the-art procedure for regional gravity field modeling, in which the long and short wavelength contributions from a spherical harmonic model and a DTM are first removed from the observations, then gravity field modeling techniques are applied to the residuals, and finally the corresponding long and short wavelength contributions are restored back. In this contribution the emphasis is on the second step, i.e. the compute or modeling step. Besides the classical integral and least-squares collocation (LSC) methods, the estimation based on radial basis functions is another interesting approach for regional gravity field modeling. The point mass method belongs to the latter category, where the basis functions with respect to the disturbing potential are the reciprocal distances between the function and observation locations. The choice of the positions and number of the point masses plays a crucial role in this method, and even in other related estimation methods. In order to solve this problem, the concept of the free-positioned point masses proposed by Barthelmes (1986) seems to be a good choice, in which the point masses are searched stepwise with simultaneous determination of the corresponding point mass positions and magnitudes within an iterative nonlinear least-squares approach.

In this study, four different nonlinear iterative algorithms (Levenberg-Marquardt, L-BFGS, L-BFGS-B, and NLCG) have been implemented for regional gravity field modeling. The applicability and performance of each algorithm is demonstrated by two numerical tests with simulated and real data, respectively. In each test, different aspects (e.g., the use of original or reduced basis functions, the use of 2 or 4 parameters for each point mass), affecting the quality of the solutions, are discussed. Furthermore, the results are compared to the classical LSC solutions.