Using spherical scaling functions in scalar and vector airborne gravimetry

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Airborne gravimetry is capable to provide Earth’s gravity data of high accuracy and spatial resolution for any area of interest, in particular for hard-to-reach areas. An airborne gravimetry measuring system consists of a stable-platform or strapdown gravimeter, and GNSS receivers. In traditional (scalar) airborne gravimetry, the vertical component of the gravity disturbance vector is measured. In actively developing vector gravimetry, all three components of the gravity disturbance vector are measured.

In this research, we aim at developing new postprocessing algorithms for estimating gravity from airborne data taking into account a priori information about spatial behavior of the gravity field in the survey area. We propose two algorithms for solving the following two problems:

1) **In scalar gravimetry:** Mapping gravity at the flight height using the gravity disturbances estimated along the flight lines (via low-pass or Kalman filtering), taking into account spatial correlation of the gravity field in the survey area and statistical information on the along-line gravity estimate errors.

2) **In vector gravimetry:** Simultaneous determination of three components of the gravity disturbance vector from airborne measurements at the flight path.

Both developed algorithms use an a priori spatial gravity model based on parameterizing the disturbing potential in the survey area by three-dimensional harmonic spherical scaling functions (SSFs). The algorithm developed for solving Problem 1 provides estimates of the unknown coefficients of the a priori gravity model using a least squares technique. Due to the assumption that the along-line gravity estimate errors at any two lines are not correlated, the algorithm has a recursive (line-by-line) implementation. At the last step of the recursion, regularization is applied due to ill-conditioning of the least squares problem. Numerical results of processing the GT-2A airborne gravimeter data are presented and discussed.

To solve Problem 2, one need to separate the gravity horizontal component estimates from systematic errors of the inertial navigation system (INS) of a gravimeter (attitude errors, inertial sensor bias). The standard method of gravity estimation based on gravity modelling over time is not capable to provide accurate results, and additional corrections should be applied. The developed algorithm uses a spatial gravity model based on the SSFs. The coefficients of the gravity
model and the INS systematic errors are estimated simultaneously from airborne measurements at the flight path via Kalman filtering with regularization at the last time moment. Results of simulation tests show a significant increase in accuracy of gravity vector estimation compared to the standard method.

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