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Regularization method for the downward continuation of airborne gravity data

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Airborne gravimetry is an effective method for surveying the gravity in space near the earth by use of gravity sensors, attitude sensors, GPS, altitude sensors and other sensors mounted on an aircraft. The gravity disturbances or gravity anomalies on surveying lines are evaluated by airborne gravimetry. We know, gravity anomalies on the geoid or the earth surface are generally needed for many geodetic actual applications, so that downward continuation is needed. The downward continuation of airborne gravimetry data is instable, because the observation noise is extremely enlarged in the process, so that the large error is introduced in the unknowns by a small observations noise. Fortunately, this problem can be solved by regularization method. Considering the actual situations in airborne gravimetry, a downward continuation model, in which the known terrestrial gravity values serve as control values and the outer zone effect are taken into account, is presented in this paper. And the spectral decomposition formulae of downward continuation model are derived, moreover, the reasons causing instability of the downward continuation are analyzed in spectral domain. By analysis, we find out that the main reason causing instability is that the observation errors in high-band are extremely enlarged by the singular value in normal matrix. This problem can be solved by regularization method. But how to select an appropriate regularization parameter is a key to the regularization method. For a too small parameter, the high-band observation errors cannot be effectively reduced, while for a large parameter, the contribution to the unknowns from observations is limited extremely. In this paper, a simple and convenient method to determine a regularization parameter is given, which has called figure-analysis numerical iteration scheme based

on the criteria of the trace of root mean square matrix of parameters being smallest. Chinese first airborne gravimetry test results indicate that the accuracy of downward continuation results is 4.25mGal by use of the regularization method in the case that accuracy of the aero-gravity mean anomalies is 3.68mGal.