UDC 681.2

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Characteristics of an airborn measuring complex

The indication of gravity anomalies from aircraft requires a combination of several instrumentation components, each of which is designed for the role of measurement. The aggregate assemblage of these components constitutes an airborne measuring complex. The present task is therefore to determine the number, function, and accuracy of the subsystems which make up an airborne gravimetry system

Airborne gravimetry system.

The indication of gravity anomalies from aircraft requires a combination of several instrumentation components, each of which is designed for the role of measurement or signal processing. The aggregate assemblage of these components constitutes an airborne measuring complex. Subsets of this assemblage of components which relate system outputs to inputs will be termed the subsystems of the airborne gravimetry system. The present task is therefore to determine the number, function, and accuracy of the subsystems which make up an airborne gravimetry system.

A system for airborne gravimetry must consist of five functional subsystems for 1) specific force measurement, 2) geometric stabilization, 3) terrestrial navigation, 4) altimetry, and 5) computation. In determining the accuracy required of such a system we must recall that the only use for global gravity data is the computation of geoid heights and deflections of the vertical. Overall system accuracy should then be evaluated in terms of the resulting accuracy in these computations. Measurement accuracies on the order of ±1 to 3 mgl may ultimately be required.

In order to carry out a gravity survey from a moving vehicle, some means of stabilizing the gravimeter along a reference direction is required. Since it is ultimately necessary to deduce the specific force in the direction of the local geographic vertical, the direct instrumentation of the vertical provides the most desirable measurement environment. Instrumentation of the vertical on a moving base requires however, a rather complex subsystem using grade inertial components, and involves real time computation using precise navigation data. The drawbacks of complexity are reduced somewhat by the fact that such a stabilization system can also serve as the heart of a geographic inertial navigator.

As an alternate to stabilization along the vertical, the gravimeter may be allowed to track the apparent vertical, provided the proper compensation term is added to' the gravimeter output. This term, known as the Browne correction, has not been applied completly in the airborne measurements reported to date. Stabilization along the apparent vertical also places a greater load on any gravimeter output filtering scheme due to the presence of components of short term horizontal acceleration in the gravimeter output.

An airborne gravimetry system may be thought of as the instrumentation of a single dynamic equation, relating the outputs of the required subsystem to the indicated gravity anomaly. As this equation shows, the indicated gravity anomalies are obtained by compensating the output of a specific force sensor (gravimeter) which is stabilized along a vertical or apparent vertical axis. Four types of compensation term appear in equation, 1) vertical accelerations of the aircraft, 2) Coriolis and centrifugal force corrections, sometimes called Eotvos corrections, 3) free air gravity reduction terms, and 4) the computed reference value of gravity at sea level. If an apparent vertical stabilization system is used, the Browne correction must also be applied. All but the first of these compensation terms can be easily computed from the outputs of the previously specified subsystems. The first term, aircraft vertical acceleration, is more difficult to deal with, because it cannot be measured directly due to the indicting - usability of gravitational and inertial accelerations. There remains the possibility of double differentiation of altitude data, separation by filtering and combination of these techniques, all of which will be considered.

Fig. 1 presents the functional scheme of airborne measuring complex [1-6]. Airborne measuring complex for measuring *g*-force acceleration anomalies contains system (1) of navigation parameters identification, the height meter (2) and gravimeter (3) mounted on girostabilized platform, the outputs of which are connected to on-board computer inputs (4).

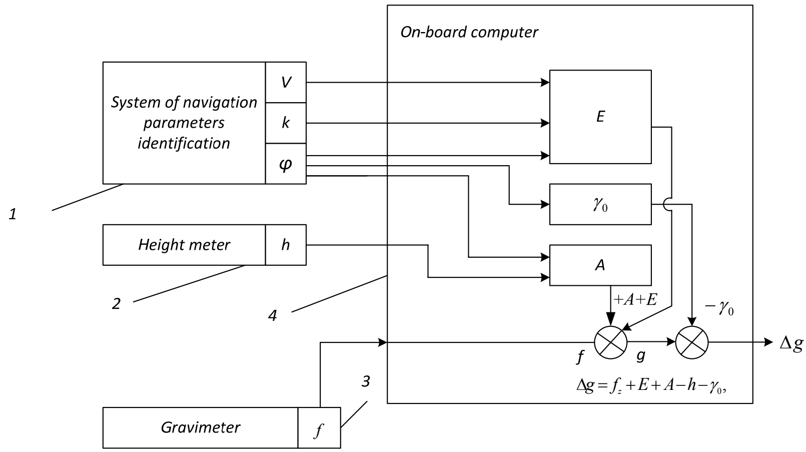

Fig. 1. Airborne measuring complex

Compensation error due a given velocity measurement error varies with both aircraft heading and latitude, the minimum sensitivity for any latitude occurring on a due west heading.

For a given specific force sensor uncertainty, the minimum system uncertainty results when the sensor is physically stabilized along the z axis (vertical axis) of an instrumented local geographic coordinate frame. Errors in the 2 axis alignment of such a frame result in 1.20 mgl error for each arc minute of misalignment due to projection of horizontal Coriolis forces along the measurement axis, and a smaller second order error which reaches 0,4 mgl at 3 arc-minutes verticality error.

We see that an airborne gravimetry system capable of measurement accuracy of the order 3 mgl, must be capable of nominal subsystem accuracies as follows in table 1.

Table 1.

Nominal subsystem accuracies

vi1ocity		
no heading restriction	0,18	knot
no westerly headings	0,4	knot
latitude	0,5	mile
verticality	1	arc minute
sea-level altitude	10	feet
specific force measurement	1	mgl

Conclusions

Aairborne gravimetry system capable of measurement accuracy of the order 3 mgl, should provide the calculated accuracy of the subsystems, as indicated above.

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