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Geodetic and geophysical results from a Taiwan airborne gravity survey: Data reduction and accuracy assessment

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[1] An airborne gravity survey was conducted over Taiwan using a LaCoste and Romberg (LCR) System II air-sea gravimeter with gravity and global positioning system (GPS) data sampled at 1 Hz. The aircraft trajectories were determined using a GPS network kinematic adjustment relative to eight GPS tracking stations. Long-wavelength errors in position are reduced when doing numerical differentiations for velocity and acceleration. A procedure for computing resolvable wavelength of error-free airborne gravimetry is derived. The accuracy requirements of position, velocity, and accelerations for a 1-mgal accuracy in gravity anomaly are derived. GPS will fulfill these requirements except for vertical acceleration. An iterative Gaussian filter is used to reduce errors in vertical acceleration. A compromising filter width for noise reduction and gravity detail is 150 s. The airborne gravity anomalies are compared with surface values, and large differences are found over high mountains where the gravity field is rough and surface data density is low. The root mean square (RMS) crossover differences before and after a bias-only adjustment are 4.92 and 2.88 mgal, the latter corresponding to a 2-mgal standard error in gravity anomaly. Repeatability analyses at two survey lines suggest that GPS is the dominating factor affecting the repeatability. Fourier transform and least-squares collocation are used for downward continuation, and the latter produces a better result. Two geoid models are computed, one using airborne and surface gravity data and the other using surface data only, and the former yields a better agreement with the GPS-derived geoidal heights. Bouguer anomalies derived from airborne gravity by a rigorous numerical integration reveal important tectonic features.

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1. Introduction

[2] Taiwan's terrain is complex and mostly inaccessible for gravity survey. Over 75% of Taiwan's terrain is covered with hills and high mountains, with the highest point being nearly 4000 m (Figure 1). The variation of gravity anomaly over the region is large, ranging from about −400 mgal over the trench east of Taiwan to 400 mgal over the Central Range of Taiwan. Here the existing gravity data are sparsely distributed, and there are uncertainties in the gravity datum and the coordinate system associated with point gravity data [*Hwang*, 1997]. For such applications as geoid modeling, vertical datum determination, geological study, and ocean current determination, a dense, accurate gravity data set is needed. To this end, Ministry of the Interior (MOI) of Taiwan sponsored an airborne gravity survey over the period of May 2004 to May 2005. The field work and data reduction were carried out by the National Chiao Tung University (NCTU), Taiwan, and the National Survey and Cadastre (KMS), Denmark. The survey area covers the entire Taiwan Island and its offshore waters.

[3] There are many regions in the world where airborne gravity surveys have been carried out [see, e.g., *Wei and Schwarz*, 1998; *Bell et al.*, 1999; *Olesen et al.*, 2000; *Forsberg and Solheim*, 2000; *Childers et al.*, 2001; *Forsberg et al.*, 2003; *Verdun et al.*, 2003]. The Taiwan airborne gravity survey described in this paper will be just one such survey. However, for a best result from an airborne gravity survey, many issues need to be investigated [*Schwarz and Li*, 1997]. These issues are largely related to the kinematic positioning of aircraft by global positioning system (GPS), error models of measurement system, filtering, downward continuation, and methods for geoidal and geophysical models using airborne and other gravity data. These issues are still under extensive investigations today, and the ultimate

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