

A Test of Precise Gravity Measurements on Ice Sheet, Antarctica.

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Satellite gravity missions in the 21st Century are expected to be beneficial to multi-disciplinary scientific objectives. Especially, Gravity Recovery And Climate Experiment (GRACE) and its follow-on missions will provide not only data for precise gravity mapping but also time series of global gravity fields coefficients. These data are precise enough to reveal the temporal variations of the gravity fields due to mass redistribution in and on the Earth. Of particular importance in the Antarctic region is the studies of ice sheet mass balance and/or postglacial rebound related to sea level changes and global water circulation. Besides these, a challenging study is the detection of regional to local scale ice sheet movements. The ice sheet thinning rate of the Shirase Glacier drainage basin in the Japanese Antarctic Research Expedition area is estimated about 10-20 cm/year, and the induced gravity signals will contribute not only for glaciological studies but also for the CAL/VAL purpose of the gravity mission data.

For these studies, we proposed an effective configuration of in-situ precise gravity measurements, which consists of one absolute gravity point and several surrounding relative gravity points. In each site, absolute gravity measurements and precise GPS measurements should be conducted at the absolute gravity point; meanwhile, precise relative gravity measurements can be carried out to determine the local gravity anomalies at the site using a spring type gravimeter with a kinematic GPS positioning system.

As a feasibility study, we conducted precise gravity measurements on ice sheet near Syowa station during the 45th Japanese Antarctic Research Expedition (JARE-45). We established a set of 5 by 5, in total 25 gravity points with a 10m interval, and another set of 4 by 4, in total 16 gravity points in between each of the first set of gravity points. Because we do not possess the field type absolute gravimeter, we only employed two LaCoste & Romberg (G-type) gravimeters to measure relative gravity differences from a base point. Using the gravity differences as well as precise positions of the points measured by the kinematic GPS positioning system, we made a test whether the gravity values of the second set (16 gravity points) can be estimated from the data of the first set (25 points). The result suggests that those measurements with an appropriate data processing enable a 10 micro Gal accuracy even on the moving ice sheet.