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Geodetic monitoring of crustal deformation in Dronning Maud Land, Antarctica

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INTRODUCTION

Finnish Geodetic Institute (FGI) has initialized a program to study crustal motion in Dronning Maud Land, Antarctica. Our program consists of repeated absolute gravity measurements, near-field ice and snow modelling and permanent GPS station. Time series of the permanent GPS station provides information on vertical and horizontal motion, while gravity is sensitive to both vertical motion and changes in density distribution. Combining permanent GPS and repeated absolute gravity one could, in principle, not only determine total vertical motion, but also separate it into the post-glacial rebound signal, and a signal showing present day variation in ice mass.

ABSOLUTE GRAVITY MEASUREMENTS AND NEAR-FIELD SNOW AND ICE MODELLING

The first absolute gravity measurement at the Finnish Antarctic Research Station Aboa (lat = 73 deg 03 min S, long = 13 deg 24 min W) on the nunatak Basen in Western Dronning Maud Land was performed by the FGI in January 1994. The work was part of Finnish Scientific Antarctic Expedition FINNARP1993. The measurement was repeated in January 2001 during the FINNARP2000. The JILAg-5 of the FGI was used. Field campaign for January-February 2004 included the third occupation of the site at Aboa, and measurements at new stations Sanae IV (RSA) and Novolazarevskaya (RU) using the FG5 no. 221 of the FGI. The campaign was organized within the frame of FINNARP2003.

Variation in local ice and snow mass causes a change in gravity through the direct attraction. The effect may be large enough to overshadow other phenomena of interest, i. e. the effects of past and present variation in the ice mass balance. Therefore it must

be separately estimated. Since 1999/2000 we have monitored snow surface heights and glacier motion year-to-year along an accumulation stake line descending from the Aboa absolute gravity station on Basen to the glacier 200 m below.

In 2003-2004 during the FINNARP2003 a new method was applied: the surface is mapped along a large number of quasi-continuous profiles, using RTK GPS in a sledge towed by a snowmobile. More than 35 km of profiles were measured at a sampling interval of 1 m. It is planned to repeat exactly the same tracks during future expeditions. A similar method was used in the same area by IMAU (Institute for Marine and Atmospheric Research, Utrecht University) in 2002. In the modelled area also the density of the top layer of ice/snow was determined using in situ sampling..

PERMANENT GPS STATION

In January 2003 the FGI installed a permanent GPS station at Aboa. The work was part of the Finnish Scientific Antarctic Expedition FINNARP 2002. Aboa is a summer station only, and during the winter the receiver relies on a battery pack, wind mills and solar panels for electricity. Data for the whole year (30 s sampling interval) is stored on the flash memory card of the receiver, and recovered by the next summer's expedition. At least first year's run (to December 2003) was successful without any data gaps. We describe the technical solutions adopted, the experiences with them, and discuss the time series of coordinates.

DISCUSSION

In the near future, CRYOSAT will monitor surface elevation change. GRACE will provide regional estimates of variation in totall mass i.e. the sum of mantle flow of the Glacial Isostatic Adjustment and contemporary ice mass balance. With repeated absolute gravity observations and with the permanent GPS station we strive to detect gravity change and contemporary crustal motion. The program will continue at least until the IPY (International Polar Year).