Comparison of topographic data-sets along proposed flight routes in Dronning Maud Land and adjacent areas

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Motivation

The Alfred Wegener Institute for Polar and Marine Research (AWI) provides logistic support for research activities in polar regions and carries out various own research programmes. Its main facilities in Antarctica are the research icebreaker RV Polarstern, the German wintering base Neumayer on Ekströmisen and the summer base Kohnen on Amundsenisen. Mobility of research personnel within Antarctica is granted by a fleet of small and large snow vehicles as well as by ski equipped aircraft (Dornier 228-101). Usually all supplies and scientific equipment are shipped to Neumayer, while for the personnel the recently by the DROMLAN (Dronning Maud Land Air Network) consortium established air connection from Cape Town, South Africa, to Dronning Maud Land (DML), Antarctica, is used.

Within DROMLAN, a consortium of 11 national COMNAP organizations, intercontinental flights are organized to two airfields in DML: to the Russian station Novolazarevskaya (011.6°E/70.8°S) and to the Norwegian station Troll (002.4°E/72°S). In addition, feeder flights connect the various stations and summer bases. While for the intercontinental flights large Iljushin 76 and Hercules C130 aircraft are used, the feeder flights are carried out with small non-pressurized ski equipped aircraft, e.g. Basler BT67, Do228-101, or TwinOtter. The feeder flights cover entire DML, from Halley in the west to Syowa/S17 in the east and up to Dome Fuji in the south.

Maps

In order to ease the communication between the operators at the various stations and the pilots as well as to increase safety on the feeder flights a set of topographic maps (see figures 7 and 8) has been compiled using the freely available surface topography data set of the Antarctic Digital Database V4 (ADD4)(SCAR, 2003). In order to visualize surface structures, the Radarsat image mosaic 1997 (Byrd Polar Research Center, 1998, Canadian Space Agency, 1997) has been used as background image. The flight routes are connecting the research stations and bases within DML on great circles. Along all flight routes reporting points with a spacing of 60 nautical miles for flight following have been defined. These standardized reporting points make it easy for the radio operators in duty to track the aircraft. Keeping in mind that many different nationalities and therefore also languages are involved in the DROMLAN operation, this helps to reduce misunderstandings and increases flight safety.

Topographic data sets

Because there is no approved surface topography data set set of Antarctica, we have compared the elevations of the ADD4 with data sets compiled by Bamber & Huybrechts, 1996, and Liu et al., 1999 (Ramp V2) to get an estimation on the reliability of the map. The result is shown in figures 1-6 for several selected profiles in DML for ADD4 (red), Bamber (blue), and Ramp V2 (bold black - grid size 5 km, thin black - grid size 200 m). Differences between the Ramp V2 and the ADD4 (dashed black-red) and Ramp V2 and Bamber (dashed black-blue) are shown in order to emphasize the deviation within the data sets. Please note the different scales on the vertical axis. The data sets show good agreement along the ice shelves and the plateau of the ice sheet, there are differences of up to several hundred meters in the region between the flat parts of the polar plateau and the ice shelves as well as above ice rises.

On top of each figure the landscape type (ocean, ice shelf, grounded ice, bare rock) of the surface according to the ADD4 is indicated. The blue graph in the lower part of each figure shows the magnetic variation (IAGA, 2005 (IGRF10)) for January 2007 along each route.

Summary

The feedback on the proposed new flight routes in DML and maps received after their introduction in field season 2005/06 led us to check the reliability of the used surface data set. The comparison of three different available surface elevation data sets along the new proposed flight routes in DML shows, that the surface topography in areas with large surface gradients is still not known with sufficient accuracy, despite satellite based remote sensing. As feeder flights are usually flown at a flight level of 10000 ft (3050 m) and the regions with steep surface slopes are at elevations between sea level and approximately 2500 m, the usage of the ADD4 data set in combination with the RAMP radarsat image for overview maps (scale 1:1500000) is acceptable, but for detailed reliable navigation the existing data sets have to be improved.

Currently, new data sets from Icesat laser altimetry, SAR interferometry, and airborne altimeter data are under preparation.

Literature/data sources

Bamber, J.L. and P. Huybrechts, 1996: Geometric boundary conditions for modelling the velocity field of the Antarctic ice sheet. Annals of Glaciology, vol 23, pp. 364-373.

IAGA , 2005: 10th generation of IGRF, released 2005 (http://www.ngdc.noaa.gov/IAGA/vmod).

Liu, H., Jezek, K.C. and Li, B., 1999: Development of an Antarctic digital elevation model by integrating catographic and remotely sensed data: A geographic information system based approach. Journal of Geophysical Research, Vol 104, No B10, pp. 23199-23213.

SCAR, 2003: Antarctic Digital Database V4 (http://www.add.scar.org).

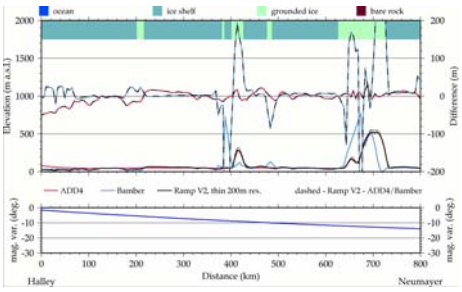

Fig. 1: Surface elevation and magnetic variation along flight track Halley – Neumayer.

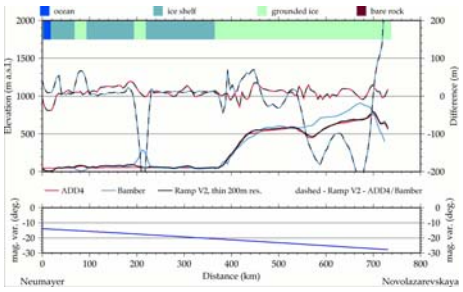

Fig. 2: Surface elevation and magnetic variation along flight track Neumayer – Novolazarevskaya.

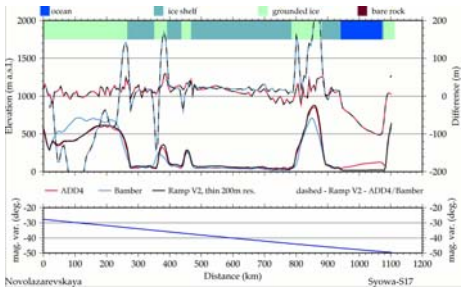

Fig. 3: Surface elevation and magnetic variation along flight track Novolazarevskaya – Syowa/S17.

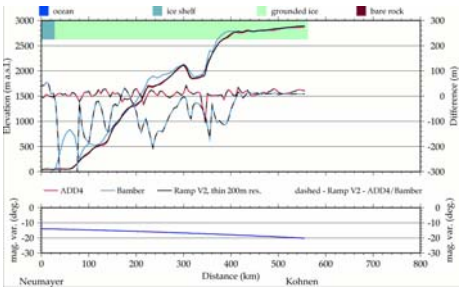

Fig. 4: Surface elevation and magnetic variation along flight track Neumayer – Kohnen.

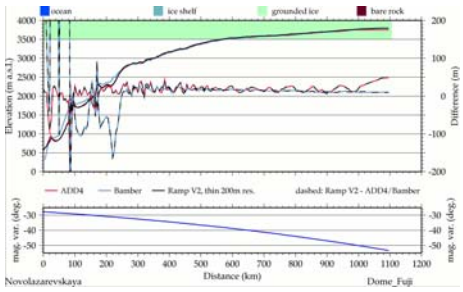

Fig. 5: Surface elevation and magnetic variation along flight track Novolazarevskaya – Dome Fuji.

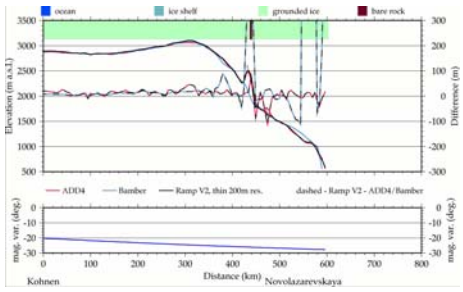

Fig. 6: Surface elevation and magnetic variation along flight track Kohnen – Novolazarevskaya.

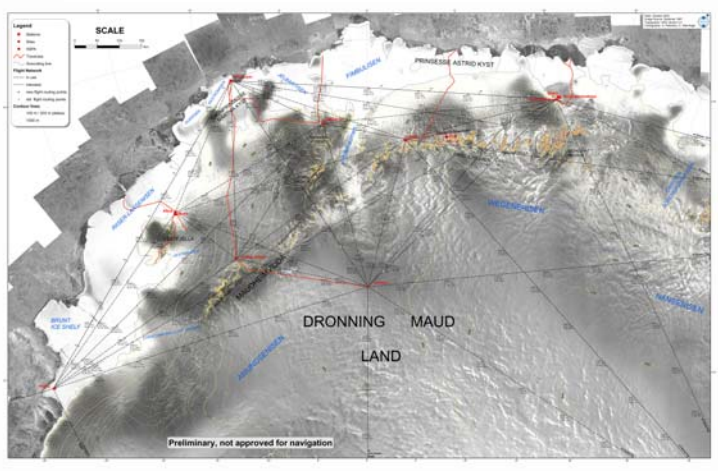

Fig. 7: Suggested flight routes in west and central Dronning Maud Land.

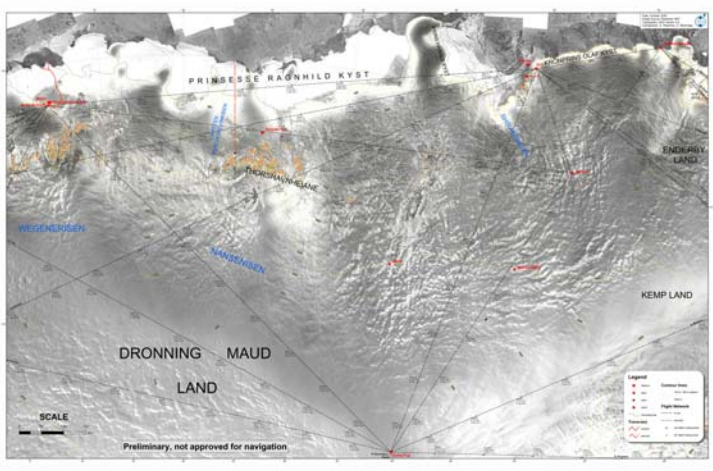

Fig. 8: Suggested flight routes in east Dronning Maud Land.