Austfonna (Svalbard, Norway) during IPY

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Due to the substantial total ice volume of Arctic ice caps and glaciers and their relatively short response time to climatic changes (unlike the Greenland and Antarctic ice sheets), mass losses from these glaciers are expected to make a considerable contribution to the eustatic sea level-rise over the next century (IPCC, 2007). However, future evolution of these ice masses is uncertain. Surprisingly, the results of repeated airborne altimetry (Bamber *et al.*, 2004) indicates a growth of the Austfonna ice cap (centred at 79.7° N - 24.0° E) in NE-Svalbard. Previous estimates (Hagen *et al.*, 2003; Pinglot *et al.*, 2001) indicated that Austfonna was in equilibrium, whereas most other Svalbard glaciers were retreating. Questions arose as to whether the observed elevation increase was caused by ice dynamics or whether it represented a climatic signal; the accuracy and representativeness of the remotely sensed data was questioned. This discussion sheds light on the problem of how the future evolution of arctic ice masses can be estimated if the present state of balance already is subject to large uncertainties.

Methods used to determine the mass balance of glaciers were originally developed for mountain glaciers, and their applicability to ice caps is limited. In contrast to mountain glaciers, where the mass balance is usually (linearly) distributed with elevation, the mass balance pattern across ice caps is often asymmetrical, thereby complicating the extrapolation of point measurements. The remoteness of Austfonna calls for the use of remote sensing techniques; the measurements by Dowdeswell *et al.* (1986), for example, provide important information on the geometry and flow of the ice cap. However, the size of ice caps like Austfonna (~8120 km^2) makes total altimetry coverage impractical. In addition, there is a lack of reliable ground-control points in completely glaciated, central parts of the ice cap. Additional control points are required to correctly interpret the remotely sensed data.

Austfonna was selected by the European Space Agency as a calibration-validation site for the upcoming CRYOSAT-2-mission. Since 2004, the University in Oslo and the Norwegian Polar Institute have conducted annual expeditions to Austfonna. These expeditions discovered that the snow distribution is highly asymmetrical (Taurisano *et al.*, 2007), thereby introducing complexity into the pattern of surface mass balance (Schuler *et al.*, in press). Most of the ice cap consists

AUSTFONNA
- Area ~**8120 km^2**
- Maximum elevation ~800 m a.s.l., max. ice **thickness 560 m** (Dowdeswell, 1986)
- **Polythermal** and situated below the percolation-zone
- Large part of the boundary is **calving**
- Simple **dome-shape** topography
- A number of drainage basins, several of which are of **surge-type** (Hagen *et al.*, 1993)

Photos: A. Taurisano, T.V. Schuler

of cold ice, i.e. the temperature of which is well below 0˚ C. Records of ice temperature at several levels exhibited the importance of this cold content for the mass balance, since a considerable amount of energy is consumed by warming the ice to the melting point (Loe, 2005). These results help to assess the surface mass balance of Austfonna, and so to determine the direct atmospheric influence on its elevation changes. The degree to which observed elevation changes are related to glacier dynamics will be investigated during the IPY-project GLACIODYN from March 2007 onwards. Special focus will be on interactions between surface processes and dynamics (e.g. the influence of melt water supply on ice velocities) and calving glacier dynamics. These issues will be addressed in a set of complementary glacier observation and modelling programs. In an international project consortium, scientists from Norway (Univ. Oslo, Norwegian Polar Institute, UNIS, Univ. Ås, NORUT-IT and NVE) are cooperating with colleagues from, amongst others, U.K., USA, Canada, Russia, Netherlands, Sweden, Finland and Denmark. A compilation of field measurements, satellite data and modelling results will draw a comprehensive picture of the present state of balance of Austfonna and help to understand the mechanisms determining the future evolution of such ice caps.

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News from Norway: the CRYONOR network

The main purpose of CRYONOR <www.cryonor.org> is to facilitate cooperation and exchange of data relating to research and education on all cryospheric themes in Norway. CRYONOR is led by four representatives from the main Norwegian universities and represents a network of about 30 cryosphere scientists working in Norwegian universities. CRYONOR is a member of the International Permafrost Association <www.geo.uio.no/IPA>.

CRYONOR organises a field workshop in the Norwegian mountains every fall. The 2005 workshop was held at the Finse Research station, Southern Norway; the 2006 one at Folldal, Hedmark, on the theme of Weichselian glaciation and permafrost in Norway. On March 27, 2007, CRYONOR hold a seminar at the University of Oslo on the theme: *Climate Change and the Terrestrial Cryosphere of Mountainous and Arctic Regions*. The seminar was attended by 28 persons. The presentation by Wilfried Haeberli (Univ. of Zurich, Switzerland) on anticipating climate-driven geosystem changes in high mountain areas was illustrated by case studies from the Upper Engadine, in the Eastern Swiss Alps. Christopher Burn (NSERC, Carleton Univ., Canada) talked about permafrost along the western Arctic coast of Canada, and stressed the modifications of its thermal conditions and terrain features under a changing climate. Ketil Isaksen (met.no, Norway) reviewed recent trends in permafrost temperature in Norway and Svalbard. Ole Humlum (Univ. of Oslo) revisited the Longyearbyen debris flow event of July 10th, 1972. Thomas V. Schuler (Univ. of Oslo) presented the last results of the mass balance modelling of Austfonna, Svalbard (pg 6).

The CRYONOR scientific network developed the IPY project *TSP NORWAY: Thermal State of Permafrost in Norway and Svalbard*, coordinated by Hanne H. Christiansen (University Centre in Svalbard UNIS). The main objective of TSP NORWAY is to measure and model the permafrost distribution in Norway and Svalbard, including its thermal state, thickness and influence on periglacial landscape-forming processes. The project focuses on empirical and numerical modelling of permafrost distribution and thermal heat fluxes in the ground, to study the impacts of past and future climate variability on permafrost distribution as demonstrated by permafrost landform activity. More information at: <www.tspnorway.com>.