

# NEWS BULLETIN OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY



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# News Bulletin of the International Glaciological Society

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Cover picture: Crevasse field, Asgard Range, McMurdo Dry Valleys. Photo: Joel Barker.

Scanning electron micrograph of the ice crystal used in headings by kind permission of William P. Wergin, Agricultural Research Service, US Department of Agriculture

EXCLUSION CLAUSE. While care is taken to provide accurate accounts and information in this Newsletter, neither the editor nor the International Glaciological Society undertakes any liability for omissions or errors.

# From the Editor

# Dear IGS member

When this second issue of *ICE* arrives through your letterbox, online renewal for 2012 membership will have been available for some weeks. You have responded positively and in the first 24 hours we had over 80 members renewing. We need as many of you as possible to renew before we send out the first issue of 2012 at the beginning of next year. We are well advanced with that issue at the time of writing this editorial. As I have mentioned before, it is costing the IGS £10000–£15000 to send out the *Journal* to those that renew late. So please renew promptly.

Another item of great importance which I discussed in the last ICE editorial is 'online only' membership. When we first investigated the possibility of such a membership our accountants informed us that the government considers 'online' to be a service and as such membership would be subject to sales tax, or VAT as it is known in the UK. That information prevented the IGS Council from making any decisions on the issue at its meeting in La Jolla last June. Instead Council agreed to ask a VAT expert to investigate this further, as an increase of 20% on the regular membership for an 'online only' would mean that opting out of receiving a hard copy of the Journal would cost more than receiving one - it simply did not make sense. So we commissioned the VAT experts at our accountants to do a thorough review of the VAT rules. Luckily the verdict was that an online access to IGS publications was a 'benefit' of membership, similar to receiving a discount to an IGS symposium, and as such it was 'outside the scope' of VAT regulations. So we breathed a sigh of relief and now Council has

made a formal decision on 'online only' membership. As expected, it was approved and hence we offer such a membership for 2012. It is about 12% cheaper than a 'combined' membership and hopefully you will appreciate this additional service from the IGS. Council also decided to keep the membership rates unchanged from 2011 as a gesture of goodwill in light of the worldwide economic situation. Normally we follow the 'Retail Price Index' here in Britain, which is running at 5% at the moment. This means that our costs will be going up by 5% over the next year. To help us offset this we would like to ask you again, please renew your membership promptly; as I explained earlier, it will save us a considerable amount of money not having to send out individual copies of the Journal to members who renew late. In addition to saving the IGS some money, you will avoid the inconvenience of losing access to all of our online publications. You are given three months 'grace' but once the three months are up, your online access will be automatically cut off.

Another issue I would like to discuss is that I have received complaints about the pricing of our symposia. In defence of our pricing policy I would like to point out what participants receive with their registration fee. But first I would like to point out that last April I went to the EGU in Vienna. It cost me €380 as an EGU member. And I did not even receive a single cup of coffee in that price! Compare that to what you get at an IGS symposium. You get an icebreaker, a banquet, refreshment throughout the week and sometimes lunch as well (like in La Jolla this year). There is usually another social

evening, e.g. a BBQ with beer and wine. And guite often we include a Wednesday afternoon excursion. You also get an extensive Proceedings volume on a flashdrive and a copy of the Annals of Glaciology. We do not charge you for submitting an abstract either, and you can submit as many as you like. And if you submit a paper to the Annals you do not have to pay page charges on the first four pages. Of course, you only have to pav if your paper is accepted. I hope this will make you appreciate just how much 'value for money' you get when attending an IGS symposium. Not to mention the social aspect and how enjoyable and intimate our meetings are.

Another item I would like to bring to your attention is the fact that the IGS has started a blog. We are anxious to get people blogging, so if you feel you can

Magnús Már Magnússon Secretary General contribute on an intermittent or regular basis please get in touch with us and we will set you up to be a contributor.

I would again like to ask all of you to encourage your colleagues and students to join the IGS. In 2011 our membership rose by 50 and was the highest since 2002. We do hope that the new 'online only' membership will encourage new members to join, as we have heard that actually receiving hard copies was a reason not to join because people felt a hard copy was only taking up space and was never read anyway. So we listened and have done what you asked us to do. Now is your opportunity to join, we need to continue the trend of increased membership every year. Hopefully we can break the record for the number of members, which was set in 2001



# Norway

# ICE CORES, GLACIOCHEMISTRY, BLACK CARBON

# NSINK: Nitrogen dynamics in the winter snowpack

Mats Björkman (NPI); Johan Ström (MISU); Tjarda Roberts, Rafael Kühnel, Elisabeth Isaksson (NPI) We investigat the role of Svalbard snowpack's as a reservoir for nitrogen compounds and the snowpack's role for the lower atmospheric conditions as well as for biological impacts within snow, glacier and downstream ecosystems. Work also involves implications for ice core analysis and processes important for ice core signals. Email: mats.bjorkman@npolar.no

# NSINK: Atmospheric chemistry and climatology

Rafael Kühnel (NPI); Johan Ström (MISU); Tjarda Roberts, Mats Björkman, Elisabeth Isaksson (NPI) We investigate climatological data and atmospheric composition during the last 20 years, with focus on nitrogen deposition events and air transport patterns to Svalbard.

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# Prodex – black carbon

Carl Egede Bøggild (UNIS); Rune Solberg (NR) The objective of the project has been to determine whether the black carbon content of snow and ice can be retrieved from satellite information and to outline concepts for algorithms for BC retrieval. Since 2008 detailed field sampling has taken place on selected glaciers on Svalbard where measurement of surface albedo have been made together with the quantification of impurities on the melting glacier surfaces. The preliminary outcome has been derivation of algorithms quantifying the relation between glacier surface impurities and the resulting albedo.

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# Black carbon in Svalbard snow

S. Forsström, S. Gerland, E. Isaksson, C. Pedersen (NPI); J. Ström (MISU)

Since the spring of 2007 we have collected snow samples for black carbon (BC) analyses on various Svalbard glaciers. The atmospheric transport of black carbon to Svalbard is studied by connecting atmospheric soot measurements to back-trajectory calculations, in order to understand the observed regional (100 km) scale variability in the snow pack. The samples at the eastern side present statistically significantly higher values than those at the western side. Linking the observed atmospheric equivalent black carbon BC concentration at the Zeppelin station, Ny-Ålesund with air mass trajectories, shows that generally higher concentrations are observed when the air comes from the east than from west. This could be one factor to explain why the measured black carbon content in snow in east Svalbard presented systematically higher values compared to the western side. Email: elisabeth.isaksson@npolar.no

A new Svalbard ice core from Lomonosovfonna

E. Isaksson (NPI); M. Schwikowski (PSI & UB); V. Pohjola (UU)

In March 2009 we drilled two new ice cores of 149 m and 37 m depth, respectively, at the Lomonosovfonna (1202 m asl,  $78^{\circ}49'24.4'$ N;17°25'59.2'E). At 149 m the drill got stuck and was released by applying antifreeze. According to the radar measurements at the drill site the ice depth is about 190.0 +/ 5.1 m. The main goal with these core is to reconstruct the development of black carbon in this part of the Arctic.

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# Svalbard ice cores and climate variability

E. Isaksson (NPI); D. Divine (UiT); T. Martma (IG TUT); J. Moore (AC); V. Pohjola (UU); R. V de Wal (IMAU)

Over the last 10 years Norwegian scientists together with colleagues from several other nations have retrieved ice cores, spanning several hundreds of years, from three major glacier-ice caps in Svalbard; Lomonosovfonna, Austfonna and Holtedahlfonna. Thus these cores are providing information on both the spatial variability component in addition to the temporal record. The main scientific goal of the project is to investigate the present and the recent past climate and the input of long-range contaminants to Svalbard. For example, we have used the 18O records from two of these ice cores to calibrate against available instrumental surface air temperature series and reconstruct the winter surface air temperatures (SAT) on Svalbard back more than 1000 years. To our knowledge this is the first attempt to date to quantify in detail past temperature changes in Svalbard from isotopic ice core records.

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# Contaminants in Svalbard snow and ice

M. Hermanson (UNIS); Elisabeth Isaksson (NPI); D. Muir (EC)

Since 2000 we have been investigating contaminants in ice cores and snow pits from sites on Svalbard, mainly Austfonna, Lomonosovfonna, and Holtedahlfonna. Among the analysed substances are PCB, DDT, brominated flame retardants and various pesticides. Our research is showing us that the atmosphere can deliver contaminants over long distances as gases or attached to particles suspended in air. Most of the contaminants are being transported to Svalbard by fast-moving winds from agricultural areas in Europe and Asia. We are also finding that there are differences in amounts and numbers of contaminants reaching different parts of Svalbard. Studying the contaminants has given us insight into atmospheric transport, deposition and preservation in the snow pack thus also highly relevant for climate variability studies. Email: elisabeth.isaksson@npolar.no

# Long range transport of black carbon and the effect on snow albedo in north-east China and in the Arctic (LOTUS)

Christina A. Pedersen, Sebastian Gerland, Jean-Charles Gallet (NPI); Johan Ström (MISU); Gunnar Myhre (Cicero); Terje K. Berntsen (UiO); Xiaoshan Zhang, Zhangwei Wang, Meigen Zhang (CAS); Jie Tang, Peng Yan (CMA)

The Lotus project aims to perform measurements of black carbon (BC) content in the snow and in the air in parallel with high quality measurements on the ground of snow albedo and snow physical properties at two locations: Zeppelin Station (N78° 54' E11° 53') near Ny-Ålesund in Svalbard, Norway and Tongyu Station (N44°25' E122° 52') at 184 m a.s.l. in north-eastern China. The objectives are to quantify the impact of BC on the snow albedo but also the contribution from different sources, regions and seasons to the BC concentration in the snow and in the air between the source regions and the Arctic. It has also for objective the exchange and development of experience and knowhow between Norway and China.

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# Tracing the fate of nitrogen deposited to an Arctic glacier

T.J. Roberts (NPI); A. Hodson (Ushef); C.D. Evans (CEH); K. Holmén (NPI); A-C. Engvall (NILU)

Observations of meltwater ion chemistry have traced the fate of a polluted rain-on-snow event through an Arctic glacier during the meltseason in 1999 (Hodson et al., 2010). New time-resolved analysis and modelling of the meltwater ion chemistry indicates significant glacial biogeochemical impacts of such episodic nitrogen deposition to the Arctic, following pollutant transport from lower latitudes (Roberts et al., accepted).

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## **Biogeochemical studies of glacial ecosystems**

J.C. Yde (HSF); K.W. Finster (AU); T.G. Bárcena (UoC)

This multidisciplinary study investigates the interactions between microbial communities and biogeochemical fluxes at the margin of the Greenland Ice Sheet in West Greenland and at Mittivakkat Gletscher on Ammassalik Island in Southeast Greenland. Various microbiological methods have been applied to quantify aspects of the nitrogen, carbon and sulphur cycles in basal ice, glacial meltwater and proglacial sediments. Flux chambers were employed to measure methane consumption and production rates along proglacial transects. The microbiological assays were coupled with glaciological, hydrological and geological analyses to obtain knowledge on the role of microorganisms in basal ice facies and subglacial sediments, their importance for glacial geochemical weathering rates, and their diversity in tills and glaciofluvial deposits on the proglacial foreland as a function of time since deglaciation. The first results of this study will be published in Annals of Glaciology, 51(56), and Arctic, Antarctic, and Alpine Research.

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# CALVING

### Calving and the dynamics of calving glaciers

Doug Benn (UNÍS); Jack Kohler (NPI); Adrian Luckman, Tavi Murray & Ian Rutt (Swansea); Faezeh Nick (Université Libre de Bruxelles); Thomas Zwinger (CSC – IT Center for Science, Finland).

This work aims to test and develop the crevassedepth calving model of Benn et al. (2007a, b). Current work focuses on coupling the calving model with 3-D flow models with higher-order physics, and testing model output against observations on a sample of calving glaciers in Svalbard, Iceland and Greenland. This project is part of the SVALI project. Email: Doug.Benn@unis.no

# Monitoring of iceberg calving at Kronebreen, Svalbard

Anne Chapuis, Cecilie Rolstad, Mari Svanem (Norwegian University of Life Sciences); Etienne Berhier (LEGOS); Andreas Köhler, Chris Nuth, Christian Weidle (UiO)

In this project we have developed an array of methods to monitor the iceberg calving activity at Kronebreen, Svalbard. Instrumental methods include ground-based radar, seismic monitoring, acoustic monitoring, time-lapse cameras, photogrammetry and optical remote sensing. We

have also build time-series of iceberg calving activity based on direct visual observations as calibrating and validating datasets. The outputs of this project are a better understanding of the calving process and a dataset of observations that can be used to test calving models.

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# Calving at Kronebreen glacier, Svalbard

Cecilie Rolstad Denby, Anne Chapuis (UMB); Richard Norland (ISPAS)

A ground-based high-range resolution interferometric radar measures calving events and flow velocities at a high temporal rate (2 Hz) of Kronebreen, Svalbard. The radar, operating at 5.75 GHz, is placed about 4 km from the calving front. The radar measures a horizontal width of about 700m of the front, and a range of 300 m. The latter includes the calving front and 250m upglacier. We find that the glacier surface provides permanent scatterers, so spatially continuous movements at the front and at locations further upglacier can be tracked. The method is promising for carrying out studies of processes at a calving front, as it provides spatially continuous, highfrequency accurate velocities from a safe distance to the glacier.

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# Dynamics of calving and surging glaciers

Monica Sund, UiO (formerly also UNIS)

The project aims to increase understanding of the mechanisms of calving and surging glaciers and its implications to glacier climate change response. For calving studies mainly data from Kronebreen are used, while Blomstrandbreen, Comfortlessbreen and Nathorstbreen are studied with regard to surge dynamics.

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# GLACIAL HYDROLOGY

# Speleological investigation of glacial drainage systems

Doug Benn (UNIS); Jacek Jania (University of Silesia, Poland); Jason Gulley (University of Texas & UNIS); Ian Willis, Alison Banwell (SPRI); Tavi Murray (Swansea).

Glacio-speleological research is now recognized as an important source of information on the geometry and characteristics of glacial drainage systems. Published work to date has focused on processes of conduit formation and their environmetla controls (e.g. Gulley et al., 2009). Work in progress uses speleological techniques in conjunction with other methods, such as GPR, dye tracing, and and ice deformation measurement, to investigate the dynamic behaviour of glacial drainages.

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# løkulhlaup/GLOF

Miriam Jackson, Hallgeir Elvehøy, Bjarne Kjøllmoen, Rune Engeset (NVE)

Jøkulhlaups or Glacier Lake Outburst Floods are a recurring feature of Norwegian glaciers and these events are monitored by NVE. In recent years many glaciers in Norway have thinned and glacier-dammed lakes have increased in size and number. A glacier-dammed lake at Blåmannsisen in northern Norway has drained under the glacier five times in the last decade, with the most recent event occurring in 2010. Up to 40 million cubic metres of water drained in each event, raising the water level in a hydropower reservoir downstream by up to 2.5 m. Previously the glacier drained in the opposite direction over a rock sill.

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# MASS BALANCE

# Response of Himalayan glaciers to climate change

Doug Benn (UNIS); Tobias Bolch (Dresden); Kimberly Casey (Oslo); Jason Gulley (University of Texas & UNIS); Adrian Luckman, Bernd Kulessa & Sarah Thompson (Swansea); Lindsey Nicholson (Innsbruck).

Work continues on downwasting debris-covered glaciers in the Mount Everest region, including volume and velocity changes, mass balance, debris-layer properties, hydrology, lake formation and outburst flood hazards. Work in progress aims to understand evolving flood risks in the region, using a combination of field and remote sensing techniques.

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# Glacier length change measurements

Hallgeir Elvehøy (NVE)

Length change observations started in 1899, and were performed at 31 glaciers in mainland Norway in 2010. Three glaciers have more than 100 observations, and another 18 glaciers have more than 50 observations. Norwegian glaciers have had a rapid retreat since 2000. Details on the monitoring programme are reported in annual reports from NVE, on www.nve.no/glacier and reported to WGMS.

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# Surface mass balance observations

Liss M. Andreassen, Hallgeir Elvehøy, Bjarne Kjøllmoen (NVE)

Surface mass balance has been measured for 44 glaciers in mainland Norway since measurements began on Storbreen in 1949. Currently (2011) mass balance is measured on 16 glaciers. Accumulated snow is measured at the end of the winter season, and snow and ice removed by ablation is measured at the end of the summer season. Details on observation programme, methods and results are reported annually in the Glaciological investigations in Norway published by NVE (www. nve.no/glacier) and reported to WGMS. Email: Ima@nve.no

## Laserscanning and geodetic mass balance

Liss M. Andreassen, Hallgeir Elvehøy, Bjarne Kjøllmoen (NVE)

The goal of the project is to produce accurate digital terrain models (DTMs) by laser scanning of selected glaciers in mainland Norway and to assess the geodetic mass changes of the glaciers using older maps. Since 2007 annual laser scanning campaigns have been conducted. For glaciers with long term surface mass balance series geodetic and direct observations are compared and will be used for bias correction of annual mass balance measurements. The new accurate DTMs will also provide a baseline for future ice volume changes.

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### New glacier inventory of Norway

Liss M. Andreassen, Solveig H. Winsvold (NVE); Frank Paul (GIUZ)

A detailed survey of the total glacier area in mainland Norway has not been performed since the compilation of glacier inventories in the mid 1980s for southern Norway and the early 1970s for northern Norway. A new glacier inventory is now being derived from Landsat imagery using 12 Landsat scenes over the period 1999-2006. The new glacier outlines will be available from the GLIMS and CryoClim web portals. The outlines are also linked to previous inventories and outlines available from historic maps to derive changes in area in several regions. Email: Ima@nve.no

Ice volume mapping

Kjetil Melvold, Hallgeir Elvehøy (NVE)

A number of ice caps were mapped with ground penetrating radar in the 1980s and 1990s to define drainage divides between river catchments. Recently, the focus has turned to assessments of ice volumes as baseline for studies on response to climate change. New campaigns are now conducted with the aim to map all glaciers where mass balance measurements are performed. Ice thickness data are also used as baseline data for glacier modelling and prediction of ice-volume and runoff changes from glaciated catchments for different climate projections.

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# Dynamical modelling

Kjetil Melvold (NVE)

Glacier runoff affects and is a large component in the water budget of several hydropower plants in

Norway. Substantial changes in ice volume will, therefore, lead to large changes in the hydrology of glacier rivers with important implications for the hydropower industry and many other social sectors such as transportation and tourism. Changes in glacier mass balance and glacier geometry for several ice caps and glaciers will be modelled with mass balance and dynamic models within SVALI project to estimate future response of glaciers to climate change. The goal of the project is to produce estimates of melt water runoff and change in glacier volume from initially ice-covered areas in long integrations for a warming climate.

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### Energy balance and mass balance modelling

Liss M. Andreassen (NVE); Rianne H. Giesen, Johannes Oerlemans and Michiel Van den Broeke (IMAU)

Three automatic weather stations (AWS) have been operated in the ablation zones of Midtdalsbreen (2000-), Storbreen (2001-) and Langfjordjøkelen (2007-2010). The stations are part of the Institute of Marine and Atmospheric research Utrecht (IMAU, NL) network of AWS on glaciers. Data from the glaciers are used to study and compare the meteorology and surface energy balance. Furthermore, data are used to calibrate and validate mass balance models for climate sensitivity analyses and to reconstruct mass balance series.

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### Glacier mass balance of Jan Mayen

John Hulth (UMB), Anna Sinisalo (UiO), Cecilia Rolstad Denby (UMB), Jon Ove Hagen (UiO), Emilie Beaudon (AC)

Jan Mayen is the most northerly island on the Mid-Atlantic ridge. It has a climatically interesting location as it lies in the boundary between warm and cold currents in the North Atlantic Ocean. A glacier mass balance field program was initiated in 2007. Ablation sensors and snow radar measurements are complementing the traditional measurements to improve the temporal and spatial distribution of the calculated surface mass balance. We also map ice thickness, and thermal structure of glaciers with a ground penetrating radar. Numerical models are applied to compute snow and ice melt and resulting runoff on hourly to annual time scales, using both energy balance and temperature index methods. The models are driven by weather station data from the glacier, recorded meteorological data off the glacier and predicted regional climate model data. Combining field data and modeling allows us to estimate how and to which extend the glaciers respond to recent climatic change. Email: john.hulth@umb.no

# Mass balance Kongsfjord glaciers

Jack Kohler (NPI)

NP measures mass balance on four glaciers in the Kongsfjorden area of north-western Spitsbergen, Svalbard: Austre Brøggerbreen (1967-present); Midtre Lovénbreen (1968-present); Kongsvegen (1987-present); and the glacier system Kronebreen-Holtedahlfona (2003-present). The first two are among the longest continuous high arctic glacier mass balance time-series. In cooperation with UiO, mass balance has been measured on Etonbreen, Austfonna, since 2004. Email: jack@npolar.no

# Kronebreen/Holtedahlfonna

Jack Kohler (NPI); Chris Nuth (UiO)

Mass balance has been measured annually since 2003. Automatic Weather Stations have been operating since 2007. Mass balance models are being employed to distribute the measurements and extrapolate back in time. Elevation is measured using photogrammetrically derived DEMs and ground based GPS acquisitions. Elevation changes are estimated to determing the geodetic volume changes over many time epochs. Velocity is measured annually from stake measurements and at higher temporal resolutions using stand-alone GPS stations, and with high spatial resolution using repeat satellite imagery on Kronebreen.

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# **AWS Kongsvegen**

Jack Kohler (NPI); Friedrich Obleitner (UInn) Since 2000 a number of automatic weather stations have been maintained on Kongsvegen. Data from the AWSs are being used to support energy balance modelling, as well as to elucidate superimposed ice formation.

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# Mass and energy balance of Jan Mayen glaciers

Cecilie Rolstad Denby, John Hulth (UMB) Meteorological data (AWS) from Sørbreen applied in distributed melt model. Stake measurements of mass balance.

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# Superimp

Carl Egede Bøggild (UNIS); Ruth Mottam (DMI)

The project aims at implementing semi-analytical solutions to quantify superimposed ice formation on glaciers to the HIRHAM climate model, in order to improve the run-off modeling for glaciers and ice-sheets. Field experiments are being carried out where superimposed ice is grown at the snow/ice interface on the Tellbreen glacier on Svalbard. Monitoring of refreezing rate as well as ice and snow temperatures is carried out in one week long field campaigns in the late winter just prior to onset of melt in order to derive the needed parameter constants for the equations describing superimposed ice growth.

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## Influence of climate variations on mass balance and associated meltwater runoff of glaciers in Norway

Markus Engelhardt, Thomas V Schuler (UIO); Liss M Andreassen (NVE); Gaute Lappegard (statkraft); Jon Ove Hagen (UIO)

This study investigates the role of Norwegian glaciers in a changing climate, to improve predictions of mass balances and associated meltwater runoff. Specifically, we address uncertainties related to parameter calibration, input data and model structure through an multi-objective optimization approach. A range of different field data is exploited, including stake measurements, continuous surface displacement, snowline mapping and bulk meltwater discharge. The parameter space is mapped using a Monte-Carlo approach, and the model will be enhanced by accounting for glacier geometry changes, thus, permitting projections of future meltwater discharge for altered climate conditions.

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# Glaciodyn

Jon Ove Hagen, Thomas Vikhamar Schuler, Trond Eiken, Thorben Dunse, Geir Moholdt, Torbjørn Østby (UiO); Jack Kohler (NPI)

Austfonna is a > 8000 km2 polar ice cap on Svalbard, consisting of a main dome feeding a number of drainage basins, some of which are known to have surged in the past. Recent airborne and satellite altimetry (1996-2008) indicate a marginal thinning oncurrent to a thickening of the interior, revealing considerable uncertainty about the current state of balance. Annual field campaigns have been conducted since 2004, including glacier mass balance measurements using stakes, snow radar, snow pits and density surveys. In addition, surface elevation changes have been assessed by GPS-profiling along several 100 km across the ice cap. Two automatic weather stations have been operated since 2004. Nearsurface snow- and ice temperatures are measured several places distributed in different zones of the ice cap. Surface velocities are measured by repeatedly surveying stakes distributed across the glacier, and since spring 2008 continuous GPS measurements are measured along the central flowlines of two fast flowing outlets. Glacier elevation changes are determined by comparing repeated GNSS surface profiles, airborne altimetry and ICESat/CryoSat altimetry. Since spring 2008 we collect continuous Global Positioning System measurements along the central flowlines of two fast flowing outlets, namely Basin-3 and Duvebreen. The record allows for investigation of seasonal and year-to-year velocity variations and a comparison with mid-1990s velocities based on satellite SAR interferometry. Numerical simulations of Autfonna aim at generating an ice cap similar in size and dynamic behaviour to present day Austfonna. We utilize the large-scale ice sheet model SICOPOLIS (SImulation COde for POLythermal Ice Sheets; http://sicopolis. greveweb.net/) and investigated a number of model parameters that excert controls on the dynamics of the simulated ice cap, specifically the description of basal sliding in conjunction with the basal thermal regime.

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# Mass balance Austfonna

Jon Ove Hagen, Thomas Vikhamar Schuler, Trond Eiken, Thorben Dunse, Geir Moholdt, Torbjørn Østby (UiO); Jack Kohler (NPI)

Mass balance has been measured on Etonbreen, Austfonna, since 2004. The field data provide input to a detailed study of surface energy balance, accounting for energy exchange with the subsurface snow and ice volume. This work is currently extended to simulate mass balance of the entire ice cap. In addition, a more simplistic model is used to provide a coherent mass balance history of Austfonna, exploiting atmospheric data from ERA40 and ERAinterim. The reanalysis data are used to downscale the large-scale precipitation and temperature fields to a 1km grid covering Austfonna. Results are evaluated with field measurements available for 1999, and 2004-2010. Having validated the method, it is applied to the entire period covered by the reanalyses 1957-2009. The results are analysed for trends and compared with the evolution of sea ice area of the Barents Sea.

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# Global Land Ice Measurements from Space (GLIMS) on Svalbard

Max König (NPI), Chris Nuth (UiO), Jack Kohler (NPI)

The Norwegian Polar Institute has prepared a dataset of glacier outlines for Svalbard, which in late-2011 will be available through the GLIMS project at www.glims.org. Glacier Outlines are available for the years 1936, 1966, 1990 and 2007/8. Not all of Svalbard is covered yet in each of these years, but the aim is to provide a full coverage of Svalbard for 2007/08 as soon as possible. The dataset has been presented in a poster (Max König, Christopher Nuth , Jack Kohler, Geir Moholdt and Rickard Pettersen, New Digital Glacier Database for Svalbard, Poster Presentation, AGU Fall meeting 2010), copies are available from the lead author. A preliminary

overview of our data can be seen on this test-web page: http://willem.npolar.no/cryoclim/ Email: max@npolar.no

# CryoClim

Max König, Stein Tronstad, Ola Brandt, Boele Kuipers, Jack Kohler (NPI)

Within the CryoClim project, the Norwegian Polar Institute prepares and delivers raster data showing glacier surface type for a number of glacier around Svalbard for the time period between 1991 and 2011 derived from classified SAR products. At present, we are also validating our SAR method to derive mass balance from classified SAR images Email: max@npolar.no

# SEA ICE

# ACCESS

EC FP7 project with 27 partners, lead partner is Université Pierre et Marie Curie (UPMC), Paris, France.

Research into the socio-economic impacts of climate change in the Arctic, with particular focus on the Nordic Seas. In this project the Ice Service will be evaluating existing user needs for sea ice information, and how these may change in future due to changing sea ice cover. 4 years from March 2011.

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# SIDARUS

EC FP7 project with 8 partners, lead partner is Nansen Environmental and Remote Sensing Centre, Bergen, Norway.

Development of new sea ice information products from satellite sensors. The Ice Service will be determining what information is desired by users, and also aiming to operationalize radar altimetry techniques for estimating sea ice thickness for ice charting. 3 years from January 2011.

Email: frode.dinessen@met.no

# ICEMAR

EC/ESA GMES project with 11 partners, lead partner is Kongsberg Satellite Services, Tromsø, Norway.

Delivery of sea ice information on board ships, and in particular through Electronic Navigation Chart (ENC) systems. 3 years from December 2010. Email: helge.tangen@met.no

# Radiative transfer and heat budget processes on Arctic sea ice

Mats Granskog, Sebastian Gerland (NPI); Børge Hamre (UB); Stephen Hudson (NPI); Donald Perovich (CRREL); Jakob Stamnes (UB); Knut Stamnes (SIT)

Develop a system to efficiently measure the spectral albedo and full radiation budget of sea

ice at a scale of a few metres. Use measurements from this system made at many points on a grid covering an area on the order of 100x100 m, along with a sophisticated radiative transfer model of the coupled atmosphere sea-ice ocean system to understand how small-scale processes affect the evolution of the larger, pixel-scale energy budget of first-year sea ice.

Email: mats.granskog@npolar.no

# Improving understanding of melt processes on first-year Arctic sea ice

Mats Granskog (NPI); Hajo Eicken (UAF); Sebastian Gerland (NPI); Børge Hamre (UB); Stephen Hudson (NPI); Bonnie Light (APL); Donald Perovich (CRREL)

Using improved methods, observe the spectral transmission of solar radiation to the underside of first-year sea ice, along with coincident measurements of physical and biological properties that affect the light transmission. Combine these observations with a radiative transfer model of the system to better understand the processes controlling the reflection, absorption, and transmission of sunlight by sea ice in a variety of conditions.

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## AEM sea ice sensor second generation

Andi A Pfaffhuber, Mathieu Boda (NGI); Stefan Hendricks, Rüdiger Gerdes, Dirk Kalmbach (AWI); Christophe Coillot (CNRS)

Development and integration of a second generation airborne electromagnetic (AEM) sea ice sensor. Over the last decade AEM has been established as a convincing tool for regional sea ice thickness mapping both from helicopters and fixed wing aircrafts. Initial work in Canada lead to large scale use mainly driven by AWI and later adopted by other groups in Canada, China and Norway. Our goal is a major step forward in AEM technology for advanced sea ice studies. Single frequency, single component AEM systems are state of the art, providing reasonable level ice thickness estimates but biased results over more complex but common sea ice regimes (ridges, rubble fields, grounded ridges, ...). We are developing a multi-frequency-, multi-component EM system equipped with accurate DGPS and INS systems plus the option for further sensors including a LIDAR scanner, FMCW snow thickness radar and optional environmental sensors such as an IR thermometer. The integration of these sensor data will enable significantly more complex interpretation especially with respect to 3D sea ice geometry, surface characteristics and internal ice properties. AWI sponsors the majority of this development with NGI as the main technology provider.

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# Svalbard sea ice monitoring

Sebastian Gerland, Mats Granskog, Olga Pavlova (NPI)

The coastal areas of Svalbard are ice covered during winter and spring, and ice free in summer and early autumn. The Norwegian Polar Institute runs monitoring programs at four locations, usually based on regular drillings at a few sites. Sea ice thickness off the island of Hopen is monitored since 1966, in collaboration with the Meteorological Institute of Norway, and fast ice in Kongsfjorden since the late 1990s. At Kongsfjorden, the staff of the NPI base Sverdrup Station in Ny-Ålesund does the drillings while no other scientific teams are on the fjord ice. For both sites the general ice situation with the local ice extent is monitored, too. In addition to that fast ice thickness in Storfjorden and Rijpfjorden (Nordaustlandet) is investigated by occasional visits since the mid 2000s. Results from this monitoring are implemented in the Norwegian environmental monitoring of Svalbard and Jan Mayen (MOSJ).

Email: gerland@npolar.no

# Fram Strait sea ice monitoring

Sebastian Gerland, Edmond Hansen, Mats Granskog (NPI)

The Fram Strait is the main export route of sea ice from the Arctic Basin. Sea ice drifting with the transpolar drift ends up here, and investigating the sea ice in this key area gives insight about the condition of the sea ice in a larger region. The sea ice in Fram Strait is monitored by the Norwegian Polar Institute since the 1990s. The monitoring includes moored upward looking sonar instruments, in situ thickness measurements (drillings and ground electromagnetics, since 2003) and occasionally helicopter-borne electromagnetics. Whereas upward looking sonars run all-year, in situ work is limited to scientific cruises in late summer each year, or occasionally also during spring. Results from this monitoring are implemented in the Norwegian environmental monitoring of Svalbard and Jan Mayen (MOSJ). Email: gerland@npolar.no

### AMORA (Advancing Modelling and Observing solar Radiation of Arctic sea-ice – understanding changes and processes)

Sebastian Gerland, Mats Granskog (NPI) and partners from China (Polar Research Institute of China, Shanghai, and Dalian University of Technology), Finland (Finnish Meteorological Institute, Helsinki), USA (Cold Regions Research and Engineering Laboratory, Hanover) and Germany (Alfred Wegener Institute, Bremerhaven) This project, funded by the Research Council of Norway, is designed to (i) improve the quantification of the surface energy balance of the ice covered Arctic Ocean, and (ii) increase the understanding of mechanisms leading to observed changes. The project combines autonomous observations from drifting buoys, manned in-situ observations, and numerical studies to create a new knowledge base on seasonal and spatial variability of snow and sea-ice processes related to solar radiation fluxes. In addition to advances in climate research, the project focuses on knowledge transfer among all partners, includes common field work and cultural exchange, and has its own outreach activities. A new measurement system is currently developed for autonomous observations of spectral radiation (Spectral Radiation Buoy, SRB). The new SRB is based on an approved sensor system and will be deployed together with an Ice Mass-balance Buoy (IMB). Continuous and all-year measurements of energy and mass balance of drifting sea ice will be received via satellite communication in realtime. The high resolution thermodynamic snow/ ice model HIGHTSI will be improved by new schemes for penetration of solar radiation within snow and ice. The numerical studies are aiming for more accurate description of thermodynamic snow and sea-ice processes and their spatial distributions in the Arctic. Email: gerland@npolar.no

# Synchrotron-based X-ray studies of sea ice

Sönke Maus (UiB); Juliane Büttner (UiB, NPI); Thomas Huthwelker (PSSI); Frieder Enzmann, Michael Kersten (JGU); Susann Müller, Anssi Vähätolo (UHF)

We have performed, for the first time, synchrotronbased X-ray studies of sea ice. We applied (i) nondestructive 3-dimensional imaging of sea ice by synchrotron-based cryo-microtomography, as well as (ii) quasi 2-dimensional spectroscopy (micro-fluorescence, micro-diffraction) to image centimeter-sized sea ice samples with 1 to 10 microns resolution. Application of (i) gave us unprecedented information about pore networks and their connectivity, while (ii) was used to explore the spatial details of sea ice chemistry and precipitation of its crystalline salts.

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# **ICE-fluxes**

20+ participants, about half from NPI and the others from various national and international institutes

ICE-Fluxes is one of three flagship projects of the Centre for Ice, Climate and Ecosystems (ICE) at the Norwegian Polar Institute in Tromsø, Norway. The project investigates sea ice in the Arctic and processes that are leading to changes of the sea ice cover. ICE-Fluxes will focus on studying and quantifying the processes that

control the development of sea ice in the Arctic. including energy and mass fluxes at the interfaces atmosphere-snow-sea ice-ocean. The heat flux from the ocean may change by increased heat content in the Atlantic water layers, or by changes in the ocean stratification, mixing energy distribution or eddy transports. In addition to studying the key ice and ocean processes in the area north of Svalbard, we also aim at quantifying and understanding the large scale changes in the Arctic Ocean ice-ocean system by monitoring the main export gateway in Fram Strait. Overarching aim: To improve the fundamental understanding of the processes controlling the behavior of the Arctic sea

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# **Polar View**

ESA GMES project with multiple partners, lead partner British Antarctic Survey.

Production of weekly (Mondays) high resolution sea ice charts for the Weddell Sea and Antarctic Peninsula area.

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# RIVER ICE

# Anchor ice formation and habitat choice of Atlantic salmon (salmo salar L.) parr in steep streams

PhD project of Morten Stickler, Supervisor Knut Alfredsen (NTNU)

Studies on formation of anchor ice dams in steep rivers and ice effects on river flow. Experiments with radio and pit tagged juvenile Atlantic salmon to understand behaviour and habitat use during ice events.

Email: knut.alfredsen@ntnu.no

# Ice formation in artificial habitats

Knut Alfredsen, Morten Stickler (NTNU); Tommi Linnansaari (University of New Brunswick)

Analysis of ice formation in an area with artificial habitat and experiments with pit tagged juvenile Atlantic salmon to study habitat use and behaviour in the enhanced reach from autumn through winter to spring.

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# HydroPeaking – ice problems in rivers

Netra Timalsina, Knut Alfredsen (NTNU); Julie Charmasson, Håkon Sundt (SINTEF)

The objective of the project is to estimate impacts on ice formation, ice cover duration and ice breakup as a function of future scenarios for hydropower production and climate. The project is a part of the Centre for Environmentally Designed Renewable Energy (CEDREN).

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# Impacts of ice on hydraulic infrastructure in a changing climate

Solomon Gebre, Knut Alfredsen (NTNU)

The objective of the project is to study impacts of ice on hydraulic infrastructure from in a future climate. Climate change scenarios is used to develop future scenarios for ice in rivers and lakes, and link this to safety and function of hydraulic infrastructure such as hydro power installations and bridges.

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# Nordic Centre of Excellence: Cryosphere-Atmosphere Interactions in a changing Arctic climate (CRAICC): Work package2: Cryospheric changes

Gerrit de Leuw (Finnish Meteorological Institute); Knut Alfredsen, Solomon Gebre, Netra Timalsina (NTNU)

Our contribution to the CRAICC WP2 will be studies of ice climatology, changes in duration of river ice cover in a future climate and impacts of changed river ice.

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# ANTARCTICA

# ICE Fimbul Ice Shelf – top to bottom

O. A. Nøst, H. Anschütz (NPI); J O Hagen, S-E. Hamran (UiO); T. Hatterman (NPI); A. Humbert (UH); E. Isaksson, J. Kohler, K. Langley (NPI); L H. Smedsrud (UB); A. Sinisalo, S.-E. Hamran (UiO) Meltwater fluxes from the Fimbul Ice Shelf (FIS),

Meltwater fluxes from the Finbul Ice Shelf (FIS), play an important role in the large scale Weddell Sea ocean processes and despite its relatively small size, has been found in models to have the highest meltwater flux and largest total basal mass loss of all the ice shelves around Antarctica. This project aims to estimate the FIS melt rates based on observations, and to increase the understanding of the processes controlling the melt rates through a combination of glaciological measurements, including stake nets and radar, and oceanographic time series obtained via borehole installed instruments.

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# Geological and glaciological controls on ice flux to the ocean from Sør Rondane Mountains, East Antarctica

Frank Pattyn, Denis Callens (ULB), Daniel Steinhage (AWI).

This project is currently investigating glaciers nearby Sør Rondane Mountains in eastern Dronning Maud Land, Antarctica, in order to (i) decipher regional ice-sheet evolution over the Quaternary and (ii) examine the sensitivity of the ice sheet in this area to possible changes in atmosphere and ocean. The observational goals of this project are surface and bed topography, englacial structures (i.e. internal reflecting layers, if existing) as well as radar power returned from within and beneath the ice (a proxy of basal water. Alfred Wegener Institute's Polar 5 airplane completed the flights over Ragnhild glaciers, and western glaciers in January 2011, and we will soon initiate data processing. The data acquisition was supported by European Facility for Airborne Research (EUFAR).

Email: matsuoka@npolar.no

# Norwegian–US Scientific Traverse of East Antarctica

J-G Winther (NPI); M. Albert (DC); H. Anschütz (NPI); R. Edwards (DRI); S-E. Hamran (UiO); J O Hagen (UiO); E. Isaksson, J. Kohler, K. Langley (NPI); G. Liston (CSU); J. McConnell (DRI); K. Müller (UiO); A. Muto (UCO); T. Neumann (NASA); T. Scambos (NSIDC); A. Sinisalo (UiO); S. Solbø; A. Tøllefsen (NORUT); Z. Courville (CRREL)

The field expedition for this international partnership involved two overland traverses in East Antarctica: one going from the Norwegian Troll Station to the United States South Pole Station in 2007-2008; and a return traverse by a different route in 2008-2009. The project aims to investigate climate variability; establish spatial and temporal variability in snow accumulation in East Antarctica; investigate the impact of atmospheric and oceanic variability on the chemical composition of firn and ice; revisit areas and sites first explored by traverses in the 1960s, for detection of possible changes; and, for all fields, to establish benchmark data sets for future research efforts.

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# Evolution of ice rises during the late Holocene and implications for mass balance in the Antarctic coastal area

Kenichi Matsuoka, Elisabeth Isaksson, Jack Kohler (NPI); Svein-Erik Hamran (FFI,UiO)

This project aims to carry out comprehensive sets of investigations on grounded ice isles (ice rises) in the vicinity of the Fimbul ice shelf, western Dronning Maud Land. The primary goal of this project is to elucidate the mass-balance history of the Fimbul ice shelf area over the past several millennia. Ice shelves such as Fimbul are intrinsically sensitive to changes in the ocean due to direct access of warm water from proximal abyssal plains. The secondary goal is to decipher ice-flow dynamics of the inter-connected system of ice rises, shelf ice and outlet glaciers. A better understanding of ice-flow dynamics has been identified by the Intergovernmental Panel on Climate Change as being critical for predicting future Antarctic mass balance and hence sealevel rise. Our results will be used to decipher the impacts of future ocean changes on the mass balance in the Antarctic coastal area. Email: matsuoka@npolar.no

# SNOW, AVALANCHES, HAZARDS

#### **Snow and basal ice, Brøggerhalvøya** lack Kohler (NPI)

Since 2000 winter snow and basal ice accumulation has been measured along transects on the low elevation plains around the Brøgger Peninsula in NW Svalbard. The main goal of the measurement program has been to document winter snow conditions and its impact on the local reindeer population. Email: jack@npolar.no

## Avalanche forecasting service for Norway

Rune Engeset, Ragnar Ekker, Karsten Müller, Andrea Taurisano (NVE); Ivar Seierstad (met.no); Frode Sandersen (NGI); Tore Humstad (SVV); Steinar Myrabø (JBV)

To establish a national snow avalanche forecasting service in Norway, the Norwegian Water Resources and Energy Directorate (NVE) has a three-year project (2010-2012) in collaboration with the Norwegian Meteorological Institute, Norwegian Geotechnical Institute, Norwegian Public Roads Administration and Norwegian National Rail Administration. NVE is the national authority responsible for avalanches and landslides and is managing the project. International collaboration has been established with SLF in Switzerland and MeteoFrance in France. The project aims at testing and developing methods in support of the regional avalanche forecasting. The project is focusing on snow avalanche forecasting service, but has a component on data processing (weather data, snow and hydrological modelling and data dissemination) which also supports a complementary project aimed at developing tools for the regional landslide forecasting service to be established. The project is split into these components: (1) danger level setting, (2) local snow observations and collaboration, (3) weather data, (4) snow simulations, (5) web portal development based on senorge.no, (6) presentation of avalanche events, and (7) test forecasting in test regions. For further information, please visit http:// www.nve.no/snoskredvarsling (in Norwegian). Email: rue@nve.no

# Filefjell snow research station

Heidi Grønsten, Karsten Müller, Knut Møen, Tuomo Saloranta, Thomas Skaugen, Heidi Stranden, Elise Trondsen (NVE)

The snow research station at Filefjell (1000 m a.s.l.) has since 2009 provided a test ground for a variety

of instruments for measuring snow depth and water equivalent (permanent snow sticks, snow pillows and snow weights of different type and size, as well as ultrasonic and gamma sensors). The site houses also an automatic weather station including short and long-wave radiation as well as temperature profile sensors. The Filefjell snow research station is visited 2-4 times per month during the snow season and manual control measurements are taken (snow courses for snow depth and density, as well as description of snow profile). Besides testing of automatic snow measuring instruments, the detailed data from this station is also used in development and evaluation of snow models. Email: eltr@nve.no

# Modelling of snow conditions

Karsten Müller, Tuomo Saloranta, Thomas Skaugen (NVE)

Daily maps of snow conditions in Norway (1x1 km resolution) are simulated at the Norwegian Water Resources and Energy Directorate (NVE) by the degree-day based seNorge snowmodel. The snow maps are updated daily at the website www. senorge.no, and the archive of maps goes back to 1957. This information on snow conditions is useful for a range of applications, from hydropower production planning to outdoor enthusiasts. In the NorClim projects snow scenarios in projected future climate were simulated. Further development of the seNorge model as well as automatic calibration and uncertainty analysis (MCMC simulation) is ongoing. NVE is also testing and applying more sophisticated energy-balance based multi-layer snow models (CROCUS, SNOWPACK) in connection with the establishment of a national snow avalanche forecasting service in Norway.

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# Structure and age of snow patches

Geir Vatne, Ivar Berthling, Martin Callanan (NTNU)

Norwegian alpine snow patches have produced a wide range of prehistoric artifacts over many years. Little is known about the history and age of the snow patches, but artifacts suggest they existed during the Bronze Age (1800-550 BC). A key feature of alpine snow patches are the presence of multiple organic horizons, assumed to represent ice surfaces at the end of warm periods. This project aims at reconstructing Alpine snow patch history in Central Norway by dating organic horizons obtained by coring multiple snow patches.

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# Slushflow hazard - risk analysis and zonation

E. Hestnes, K. Kristensen, S. Bakkehøi, C. Jaedicke (NGI)

Slushflows – flowing mixtures of water and snow – are a major natural hazard in Norway and

constitute a considerable part of our consulting work within risk assessment, hazard zoning and recommendation of mitigative measures. The destructive forces are larger than those observed from other snow related mass flows of comparable volume. Ongoing research is focusing on the location, release conditions and consequences of slushflows in a historical perspective and how different climatic scenarios may affect these conditions and regional distribution in the future, as well as developing guidelines for risk analysis and zonation.

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# Slushflow hazard prediction and warning

S. Bakkehøi, E. Hestnes, K. Kristensen, C. Jaedicke (NGI)

Pioneering work has previously been contributed to the international scientific community, sometimes in co-operation with foreign coauthors. Developing regional models for slushflow hazard forecasting based on real time meteorological data and weather prognosis are focused. Our model for estimation of the meltwater contribution during critical periods will be adjusted to new meteorological source-data and implemented and in our routines of slushflow forecasting. Testing of simple field-instrumentation for identifying acute slushflow hazard is planned. Email: sba@ngi.no

# Hazard mapping for snow avalanches

K. Kronholm, K. Kristensen (NGI)

Hazard mapping is on high demand in a society where new developments continuously push further into terrain that is exposed to avalanches. Research in this field improves the applied methods for hazard zonation such that run out frequencies, pressures and velocities can be estimated along the avalanche path. The results are used as input to the design of avalanche protection measures such as deflection dams. Email: kak@ngi.no

# Avalanche warning

C. Jaedicke, S. Bakkehøi (NGI)

Operational avalanche warning needs constant support from research to improve methods and routines. Recent efforts include the development of GIS based support systems for the avalanche warning, new terrain based methods to classify avalanche paths and testing and implication of improved field methods. The GIS development focuses on the integration of all important information for the avalanche forecaster into one system. Additionally the systems aims to produce stability indexes for the most exposed avalanche paths on a given day. The research is directly applied in the NGI avalanche warning services. Email: cj@ngi.no

# Modeling of snow avalanches

D. Issler, P. Gauer (NGI)

Dynamical models of snow avalanche motion are a cornerstone in hazard mapping and design of protection measures because they predict the velocity, flow depth, and pressure along the path if suitable initial conditions can be determined by other means. An important weakness of existing models is that they do not include the fluidized flow regime (with a density between that of the dense flow and the powder-snow cloud) and most models do not include snow entrainment. Both phenomena have been observed in all major and many small dry-snow avalanches at Ryggfonn and other sites and are important for the dynamics and the runout length of avalanches. Therefore, theoretical developments focus on erosion and entrainment processes and flow-regime changes. A rigorous analytical erosion mode for entrainment along the avalanche bottom in an idealized situation was recently developed, and an extension to more general situations proposed. A depth-resolved 1D model allows detailed studies of the interplay between entrainment and flow rheology. The NoremI-Irgens-Schieldrop rheology was extended to describe the density decrease due to dispersive pressure at high shear rates and the associated changes of the rheological parameters. The new model will be extensively tested and implemented as 1D and 2D depth-averaged numerical codes.

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# Remote sensing of avalanche critical parameters

K. Kronholm, R. Frauenfelder (NGI)

Surface hoar is one of the most dangerous persistent weak layers in snow pack causing many fatal avalanches each winter. Remote sensing techniques are developed to detect and map the extent of surface hoar before it is buried with new snow. Remote sensing could also be used to locate and map avalanches after a storm cycle to better guantify the extent and intensity of the avalanche activity. Both applications of remote sensing meet challenges and we hope to contribute with new results to improve the use of remote sensing in operational avalanche warning.

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# InfraRisk

C. Jaedicke, N. Meyer (NGI); B. Romstad (CICERO); A. Verpe-Dyrrdal (met.no)

The infrarisk project studies the risk of extreme weather events causing irregularities for the Norwegian infrastructure. The study includes the primary triggers precipitation and wind and secondary effects of landslides, rockfalls and snow avalanches. The aim is to guantify the number of traffic stops per year in the present climate and make predictions for future climate scenarios. An interdisciplinary outreach of the project aims to extend the analysis of the physical consequences of road closures to economical losses and psychological consequences of limited or no access to hospitals or other important infrastructure. The project is scheduled to continue until 2013. Email: cj@ngi.no

# Ryggfonn fullscale test site

## P. Gauer, K. Kristensen (NGI)

The Ryggfonn full-scale test site was first established in the early 1980s. The first avalanche dynamic studies at the site date actually back to 1975 and the site has ever since been used for avalanche studies. The avalanche path has ca. 900 m fall height and a 16 m high avalanche dam is located in the run out zone of the avalanche. Recently, the site has been upgraded with modern instrumentation and can be used to study both velocities, flow height, and pressure in the moving avalanche. Email: pg@ngi.no

# REMOTE SENSING

# Investigation of supraglacial dust and debris composition and variability using in situ and satellite data from Iceland, Norway, Nepal, New Zealand, Switzerland, and Svalbard

Kimberly Casey, Andreas Kääb (UiO)

Department of Geosciences and European Space Agency, GlobGlacier project to investigate the variability of supraglacial dust and debris. In situ snow, ice, and debris samples have been collected along with field spectrometry data from Norway, Nepal, New Zealand, Switzerland and Svalbard. In situ samples are analyzed for inorganic geochemical content by inductively coupled plasma mass spectrometry, x-ray diffraction and x-ray fluorescence spectroscopy, and field spectrometry reflectance patterns. In situ data is then compared with multi- and hyperspectral satellite remote sensing data for description of supraglacial dust and debris composition. Results from the different regions are inter-compared, methods for optical remote sensing debris characterization are presented.

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# CryoClim – Monitoring climate change in the cryosphere

Rune Solberg (NR); Norwegian Computing Center (NR), Norwegian Meteorological Institute (met.no), Norwegian Water Resources and Energy Directorate (NVE) and Norwegian Polar Institute (NPI). Project for the European Space Agency (ESA)

The vision of the CryoClim project (www.cryoclim. net) is to develop operational and permanent services for long-term systematic climate monitoring of the cryosphere. The system will

be provided as a web service. The system and service is a contribution to GCOS (Global Climate Observing System) and is designed to be integrated with the international system of systems for global monitoring (GEOSS), the part of the system aimed for climate monitoring, and according to the climate monitoring principles recommended by GCOS. The project currently develops services for sea ice and snow products of global coverage and glacier products covering Norway (mainland and Svalbard). At this stage the project has developed the first (incomplete) version of the web service, completed the sub-service for sea ice, developed the passive microwave component of the snow sub-service, made the first full glacier product coverage for mainland Norway based on optical data and implemented SAR-based algorithms for glacier monitoring in Svalbard. The current and upcoming project phases will complete the subservices, produce the full time series of cryospheric products and establish fully operational production to regularly update the product sets (in near realtime for sea ice and snow). The web service will be completed with an operational backend system and with a portal and machine-readable interfaces. The products will be freely available.

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# GlobSnow – Global mapping of snow cover for climate change monitoring

Rune Solberg (NR); Norwegian Computing Center (NR), Finnish Meteorological Institute (FMI), Finnish Environment Institute (SYKE), ENVEO GmbH (Austria), Environment Canada (EC) and GAMMA Remote Sensing Research and Consulting AG (Switzerland). Project for the European Space Agency (ESA)

One of the goals of the GlobSnow project is to develop a global product and a near real-time service for Snow Extent (SE) and carry out snow mapping of the whole seasonally snow-covered Earth for the years 1995-2010 based on the optical sensors ERS-2 ATSR-2 and Envisat AATSR data. The project has tailored and validated SE retrieval algorithms for this purpose, and the first version of the global SE product set spanning 15 years was completed in early 2011. The main aim of the snow products is primarily linked to climate monitoring, and they are freely available (www. globsnow.info). NR's main roles in the project are to compare and analyse algorithms, improve them and implement the chosen algorithms in a laboratory processing chain for SE products. The laboratory processing chain is applied for testing and improving SE products in an iterative process based on a dialogue with a user group. The final version of the laboratory processing chain functioned as a reference system for the implementation of an operational system for the full time series of snow maps as well as near-realtime products produced on a daily basis. Email: Rune.Solberg@nr.no

# 'Snøskred' – Avalanche warning applying snow variables from satellite images

Rune Solberg (NR); Norwegian Geotechnical Institute (NGI) and Norwegian Computing Center (NR). Project for the Norwegian Space Centre (NSC)

The Avalanche project ('Snøskred' in Norwegian) aims to establish a relationship between snow variables retrieved from satellite data and in situ measured data in order to build a model that allows the prediction of, e.g., snow grain type as measured in the field from the analysis of space-borne data. Such model output may then be used as an additional input variable to an avalanche forecasting (warning) model. The focus of the project work so far has been simultaneous collection of in situ data and the acquisition of satellite data and comparison of those. Specifically, in situ measured surface snow grain characteristics have been compared to snow grain characteristics as derived from MODIS satellite data. Data from four test sites have been studied: three in the Strynefjell mountain range and a fourth site in the Oslo region. Retrieval and analysis of snow variables from MODIS data was done for the two snow seasons, 2007-2008 and 2008-2009, from December until May. A few cases of rime frost development, often a source of a weak snow layer formation, have been observed in the field, suspected to explain rapid grain size development as retrieved from satellite data. Email: Rune.Solberg@nr.no

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# AvalRS – Remote sensing derived avalanche inventory data for decision support and hindcast after avalanche events

Norwegian Geotechnical Institute (NGI) and Norwegian Computing Center (NR), project for the European Space Agency (ESA)

AvalRS aims at demonstrating that automatic detection of avalanches in very-high resolution satellite imagery is possible and that it will provide decision support during avalanche-imposed road closures, and to help validate the issued avalanche forecasts. Overview of the affected problem area, specifically the length of the avalancheaffected road section and the volume of snow on the road, are essential for the authorities during road closures. The project is also aiming for development of methodology that can be used for making avalanche statistics in remote regions. NR is responsible for development of the pattern recognition algorithms for automatic detection of the avalanches.

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# Cryosat Cal/val

Jack Kohler (NPI); Jon Ove Hagen (UiO)

Austfonna is a calibration site for ESA's CryoSat mission. A series of field measurements (elevation, density, stratigraphy, radar etc.) are conducted along the CryoSat ground tracks, which have also been overflown by flights with the aibrone Cryosat simulator ASIRAS instrument. Email: jack@npolar.no

# Precise analysis of mass movements through correlation of repeat images

Andreas Kääb, Torborg Heid, Misganu Debella-Gilo (UiO)

The project aims at the one hand to develop and test image matching technologies for precise measurement of movements such as glacier flow, rockglacier creep or landsliding. Such high precision allowed for instance mapping ice flow on all major Antarctic ice shelves from repeat lowresolution imagery (MODIS). As another result, a method was developed to measure glacier surface strain rates directly and at an unprecedented resolution from repeat images, and not through gradients of a velocity field measured beforehand. A second major aim of the project is to find robust matching techniques and analysis methods for global-scale mapping and monitoring of glacier velocities. The project is funded by the Norwegian Research Council.

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# Multiseasonal, multifrequency, multipolarization, and multiresolution radar speckle and feature tracking for Arctic glacier velocities

Andreas Kääb (UiO)

The project aims at the one hand to develop and test image matching technologies for precise radar satellite sensors with their all-weather and nighttime capability are the only means to continuously monitor glacier flow in polar environments. While the motion of slow-moving glaciers can in theory be derived through synthetic aperture radar (SAR) interferometry, fast-flowing glaciers have to be measured using correlation between repeat data (offset tracking). The project explores the dependency of trackable SAR backscatter features from different seasons and weather conditions, different radar bands (L, C, X), and different SAR polarizations and spatial resolutions, focusing in particular on new and upcoming sensors like TerraSAR-X, RADARSAT-2 or ESA Sentinel-1. A multitemporal glacier velocity map over entire Svalbard will be produced and the results be analysed towards Svalbard calving flux, surge activities, and velocity trends over time. The project is funded by the Norwegian Research Council, and conducted in cooperation with the Norwegian Polar Institute.

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# ESA Glaciers\_CCI

Andreas Kääb, Chris Nuth (UiO)

Within the ESA Climate Change Initiative (CCI) and its theme 'Glaciers and ice caps', UiO is responsible to develop and evaluate robust methods for glacier velocity measurements and elevation differences, and to apply these to regions selected by the user community. ESA CCI data will be freely available, together with detailed descriptions of the algorithms used. The Glaciers\_CCI project is coordinated by the University of Zurich and is conducted together with other partners from Switzerland, Austria and the United Kingdom.

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# GLOBAL CLIMATE CHANGE, CARBON CYCLE

## MONARCH – MONitoring and Assessing Regional Climate change in High latitudes and the Arctic

Johnny Johannessen, Christoph Heinze and Truls Johannessen (UiB)

The ultimate goal of MONARCH-A is to generate a dedicated information package tailored to a subset of multidisciplinary Essential Climate Variables and their mutual forcing and feedback mechanisms associated with changes in terrestrial carbon and water fluxes, sea level and ocean circulation and the marine carbon cycle in the high latitude and Arctic regions.

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# CARBOCHANGE – Changes in carbon uptake and emissions by oceans in a changing climate

Christoph Heinze, Truls Johannessen (UiB) CARBOCHANGE will provide the best possible process-based quantification of net ocean carbon uptake under changing climate conditions using past and present ocean carbon cycle changes for a better prediction of future ocean carbon uptake. We will improve the quantitative understanding of key biogeochemical and physical processes through a combination of observations and models. We will upscale new process understanding to large-scale integrative feedbacks of the ocean carbon cycle to climate change and rising carbon dioxide concentrations. We will quantify the vulnerability of the ocean carbon sources and sinks in a probabilistic sense using cutting edge coupled Earth system models under a spectrum of emission scenarios including climate stabilization scenarios as required for the 5th IPCC assessment report. The drivers for the vulnerabilities will be identified. The most actual observations of the changing ocean carbon sink will be systematically integrated with the newest ocean carbon models, a coupled landocean model, an Earth system model of intermediate complexity, and fully fledged Earth system models through a spectrum of data assimilation methods

as well as advanced performance assessment tools. Results will be optimal process descriptions and most realistic error margins for future ocean carbon uptake guantifications with models under the presently available observational evidence. The project will deliver calibrated future evolutions of ocean pH and carbonate saturation as required by the research community on ocean acidification in the EU project EPOCA and further projects in this field. The time history of atmosphere-ocean carbon fluxes past, present, and future will be synthesized globally as well as regionally for the transcontinental RECCAP project. Observations and model results will merge into GEOSS/GEO through links with the European coordination action COCOS and will prepare the marine branch of the European Research Infrastructure ICOS.

Email: christoph.heinze@gfi.uib.no

# ICOS – Integrated carbon observation system

Philippe Ciais (IPSL); Truls Johannessen (UiB) Mission statement: to provide the long-term observations required to understand the present state and predict future behavior of the global carbon cycle and greenhouse gas emissions; and to monitor and assess the effectiveness of carbon sequestration and/or greenhouse gases emission reduction activities on global atmospheric composition levels, including attribution of sources and sinks by region and sector. Email: Truls.Johannessen@gfi.uib.no

MEECE – Marine ecosystem evolution in a changing environment

Icarus Allen (PML); Corinna Schrum, Richard Bellerby (UiB)

MEECE is a scientific research project which aims to use a combination of data synthesis, numerical simulation and targeted experimentation to further our knowledge of how marine ecosystems will respond to combinations of multiple climate change and anthropogenic drivers. With an emphasis on the European Marine Strategy (EMS), MEECE will improve the decision support tools to provide a structured link between management questions and the knowledge base that can help to address those questions. A strong knowledge tranfer element will provide an effective means of communication between end-users and scientists. Email: corinna.schrum@gfi.uib.no

# MISCELLANEOUS

# Glaciers and seismicity

Miriam Jackson (NVE); Knut Christianson, Sridhar Anandakrishnan (PSU); Paul Winberry (CWU) Passive seismicity is used to acquire information

about processes at the glacier bed. Normally seismometers are placed on the glacier surface or on bedrock adjacent to the glacier. However, by using the tunnel system under Engabreen in northern Norway the seismometers can be placed only a few metres from the ice-rock interface. Measurements were initiated in 2008 and preliminary results show basal motion occurs both as stick-slip events at times, and also as more constant, even motion. Email: mia@nve.no

# Svartisen Subglacial Laboratory

Miriam Jackson, Hallgeir Elvehøy (NVE)

Svartisen Subglacial Laboratory is a unique facility situated beneath Engabreen glacier under 200m of ice. Several joint projects with other institutions are in progress or completed. These projects make use of direct access to the bed of the glacier, facilitating experiments that would be impossible, or difficult to perform elsewhere. Several earth pressure sensors are installed at the bed of the glaciers and continually measure changes in pressure at the glacier base. It is possible to take samples of the sediment-rich basal ice, to install instruments at the glacier bed, to study the biochemistry at the glacier base and to pump water to the glacier bed and monitor the response of the glacier. Experiments performed in the subglacial laboratory give valuable information for a better understanding of glacier behaviour. Email: mja@nve.no

# Marthabre ice road

Carl Egede Bøggild (UNIS)

The project analyzes possible consequences on the glacier from coal dust related to an ice road where transport of mined coal is planned to take place in the future. Based on model calculations the change in glacier surface ice albedo has been estimated and its visible impact is thereafter evaluated. Results show that the albedo is mainly affected by the amount of dust as well as the black carbon concentration within the dust. Email: carl.egede.boggild@unis.no

CRYOLINK: Permafrost and seasonal frost in Southern Norway, understanding and modelling the atmosphere-ground temperature relation

Bernd Etzelmüller, Ole Humlum, Thomas V Schuler, Herman Farbrot, Tobias Hipp, Karianne S. Lilleøren, Kjersti Gisnås (UIO); Rune Ødegård (HiG); Ketil Isaksen (met.no); Thomas Skaugen (NVE)

CRYOLINK aims at improving knowledge on past and present ground temperatures, seasonal frost, permafrost distribution and related periglacial processes in Southern Norway and adjoining regions of the North Atlantic region (Greenland and Iceland), by addressing the fundamental problem of heat transfer between the atmosphere and the ground surface. Methodologically, the project will develop functional thermal offset models linking air temperatures to ground and permafrost temperatures through seasonal surface transfer functions and subsurface thermal properties based on field observations. A total of 13 boreholes have been drilled and equipped to survey groundtemperature profiles at three arrays of boreholes. The arrays are situated along a continentality gradient across southern Norway and at each site, boreholes are arranged along altitudinal gradients. The project further develops and applies transient heat transfer models in 1D and 2D to address past and future heat transport into the ground. Ultimately, regionally distributed models are developed to address the distributions of surface and ground temperatures in space, and annual thaw and freezing depths. This model is forced by gridded meteorological data and output of a distributed snow model. The outcome is expected to be of importance for infrastructure maintenance (seasonal frost), slope stability (permafrost) and further geomorphological processes.

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## **ABBREVIATIONS**

AC	Arctic Centre, Finland
APL	Applied Physics Laboratory, U. Washing- ton, Seattle
AU	Aarhus University, 8000 Aarhus, Denmark
AWI	Alfred Wegener Institute, Bremerhaven
AWI	Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
CAS	Chinese Academy of Sciences
CEH	Centre for Ecology & Hydrology, Environ- ment Centre Wales
CICERO	Centre for Climate Research
CMA	China Meteorological Administration
CNRS	LPP/CNRS Ecole Polytechnique, Palai- seau, France
CRREL	Cold Regions Research and Engineering Laboratory
CSU	Colorado State University, USA
CWU	Central Washington University
DC	Dartmouth College, USA
DMI	Danish Meteorological Institute
DRI	Desert Research Institute, U. Nevada Reno
EC	Environment Canada, Burlington, Canada
GIUZ	Geography Institute, U. Zurich

HSF	Sogn og Fjordane University College, Sogndal, Norway
IG TUT	Institute of Geology, Tallinn University of Technology, Estonia
IMAU	Institute for Marine and Atmospheric Research, Utrecht University, The Nether- lands
IPSL	Laboratoire des Sciences du Climat et de l'Environnement. Institut Pierre-Simon Laplace, CEA-CNRS-UVSQ, France
JBV	Norwegian National Rail Administration
JGU	Institute of Geosciences, Johannes Guten- berg University Mainz, Germany
Met.no	Norwegian Meteorological Institute
MISU	Dept. Meteorology, U. Stockholm
NGI	Norwegian Geotechnical Institute, Oslo, Norway
NGI	Norwegian Geotechnical Institute
NILU	Norwegian Institute for Air Research
NPI	Norwegian Polar Institute
NR	Norwegian Computing Center

- PML Plymouth Marine Laboratory, UK
- PSI Paul Scherrer Institut, Switzerland
- PSU Pennsylvania State University
- SIT Stevens Institute of Technology
- SVV Norwegian Public Roads Administration
- UAF University of Alaska, Fairbanks
- UB University of Bern, Switzerland
- UB University of Bergen
- UCO Univ. Colorado, USA
- UH University of Hamburg, Germany
- UHF Department of Environmental Sciences, University of Helsinki, Finland
- UiB Geophysical Institute, University of Bergen
- Ulnn Institute of Meteorology and Geophysics, Innsbruck University

# Jack Kohler



# **International Glaciological Society**

# JOURNAL OF GLACIOLOGY

Papers accepted for publication between 1 July and 14 October 2011. The papers are listed in alphabetical order by first author. Some of these papers have already been published.

Improvements to shear-deformational models of glacier dynamics through a longitudinal stress factor Surendra Adhikari, Shawn J. Marshall

Growth and collapse of the distributed subglacial hydrologic system of Kennicott Glacier, Alaska, USA, and its effects on basal motion Timothy C. Bartholomaus, Robert S. Anderson, Suzanne P. Anderson

Seasonal evolution of water contributions to discharge from a Greenland outlet glacier: insight from a new isotope-mixing model Maya P. Bhatia, Sarah B Das, Elizabeth B. Kujawinski, Paul Henderson, Andrea Burke, Matthew A. Charette

Analysis of ice plains of the Filchner–Ronne Ice Shelf, Antarctica, using ICESat laser altimetry Kelly M. Brunt, Helen A. Fricker, Laurie Padman

Subglacial clast-bed contact forces John Byers, Denis Cohen, Neal R Iverson

Melt regimes, stratigraphy, flow dynamics and glaciochemistry of three glaciers in the Alaska Range

Seth Campbell, Karl Kreutz, Erich Osterberg, Steven Arcone, Cameron Wake, Douglas Introne, Kevin Volkening, Dominic Winski

Modeling 5 years of subglacial lake activity in the MacAyeal Ice Stream (Antarctica) catchment through assimilation of ICESat laser altimetry Sasha P. Carter, Helen A. Fricker, Donald D. Blankenship, Jesse V. Johnson, William H. Lipscomb, Stephen F. Price, Duncan A. Young

The annual glaciohydrology cycle in the ablation zone of the Greenland Ice Sheet: Part 2. Observed and modeled ice flow William Colgan, Harihar Rajaram, Robert S Anderson, Konrad Steffen, H. Jay Zwally, Thomas Phillips, Waleed Abdalati

Subsurface hydrology of an overdeepened cirque glacier Christine F. Dow, Jeffrey. L. Kavanaugh, Johnny W. Sanders, Kurt M. Cuffey, Kelly R. MacGregor Does the normal stress parallel to the sliding plane affect the friction of ice upon ice? Andrew L. Fortt, Erland M. Schulson

A decade of change in the hydraulic connection between an Antarctic epishelf lake and the ocean Ben K. Galton-Fenzi, John R. Hunter, Richard Coleman, Neal Young

Signatures of supercooling: McMurdo Sound platelet ice

Alexander J. Gough, Andy Mahoney, Pat J. Langhorne, Michael J. M. Williams, Natalie J Robinson, Tim G. Haskell

Temporal evolution of the structural properties of seasonal sea ice during the early melt season Haruki Ishii, Takenobu Toyota

A new laboratory device for study of subglacial processes: first results on ice-bed separation during sliding Neal R. Iverson, Ben B. Petersen

Transmission of solar radiation through the snow cover on floating ice Onni Järvinen, Matti Leppäranta

Modelling the retreat of Grosser Aletschgletscher, Switzwerland, in a changing climate Guillaume Jouvet, Matthias Huss, Martin Funk, Heinz Blatter

Glacier mass loss induced the rapid growth of Linggo Co on the central Tibetan Plateau Yanbin Lei, Tandong Yao, Chaolu Yi, Weicai Wang, Yongwei Sheng, Junli Li, Daniel Joswiak

On the coupled response to ice shelf basal melting Christopher M. Little, Daniel Goldberg,

Anand Gnanadesikan, Michael Oppenheimer

The grounding zone of the Ross Ice Shelf, West Antarctica, from ice-penetrating radar Joseph A. MacGregor, Sridhar Anandakrishnan, Ginny A. Catania, Dale P. Winebrenner

Dynamics of tidewater surge-type glaciers in northwest Svalbard Damien Mansell, Adrian J Luckman, Tavi Murray Assessing the summer water budget of a moulin basin in the Sermeq Avannarleq ablation region, Greenland ice sheet

Daniel McGrath, William Colgan, Konrad Steffen, Phillip Lauffenburger, James Balog

Kinematic waves in polar firn stratigraphy Felix Ng, Edward C. King

Biogeochemical properties of water in surface ponds on Antarctic fast ice and their relationship with underlying sea-ice properties Daiki Nomura, Daisuke Simizu, Hideo Shinagawa, Chinatsu Oouchida, Mitsuo Fukuchi

Estimating the long-term calving flux of Kronebreen, Svalbard, from geodetic elevation changes and mass balance modelling Christopher Nuth, Thomas Vikhamar Schuler, Jack Kohler, Bas Altena, Jon Ove Hagen

Microstructural evolution in the fine-grained region of the Siple Dome (Antarctica) ice core R.W. Obbard, K.E. Sieg, I. Baker, D. Meese, G.A. Catania

Parallel finite-element implementation for higherorder ice-sheet models

Mauro Perego, Max Gunzburger, John Burkardt

Three positive feedback mechanisms for icesheet melting in a warming climate Diandong Ren, Lance M. Leslie

Competition between grain growth and grainsize reduction in polar ice Jens Roessiger, Paul D. Bons, Albert Griera, Mark W. Jessell, Lynn Evans, Maurine Montagnat, Sepp Kipfstuhl, Sérgio H. Faria, Ilka Weikusat

The chemical forms of water-soluble microparticles preserved in the Antarctic ice sheet during Termination I Toshimitsu Sakurai, Hiroshi Ohno, Shinichiro Horikawa, Yoshinori Iizuka, Tsutomu Uchida, Kazuomi Hirakawa, Takeo Hondoh Snapshots of the Greenland ice-sheet configuration in the Pliocene to early Pleistocene Anne M. Solgaard, Niels Reeh, Peter Japsen, Tove Nielsen

ISMIP-HEINO experiment revisited: effect of higher-order approximation and sensitivity study Ondrěj Soucek, Zdeněk Martinec

Glacier change on Axel Heiberg Island, Nunavut, Canada

Laura I. Thomson, Gordon R. Osinski, Simon L. Ommanney

Crystal growth of air-hydrates over 720 ka years in Dome Fuji (Antarctica) ice cores: microscopic observations of morphological changes below 2000 m depth

Tsutomu Uchida, Atsushi Miyamoto, Atsushi Shin'yama, Takeo Hondoh

A compact lightweight multipurpose groundpenetrating radar for glaciological applications E.V. Vasilenko, F. Machío, J.J. Lapazaran, F.J. Navarro, K. Frolovskiy

Using high-resolution tritium profiles to quantify the effects of melt on two Spitsbergen ice cores L.G. van der Wel, H J. Streurman, E. Isaksson, M.M. Helsen, R.S.W. van de Wal, T. Martma, V.A. Pohjola, J.C. Moore, H.A.J Meijer

Evaluating ice fabrics using fabric analyser techniques in Sørsdal Glacier, East Antarctica Christopher J.L. Wilson, Mark Peternell

Ice deformed in compression and simple shear: control of temperature and initial fabric Christopher J.L. Wilson, Mark Peternell

Distribution of debris thickness and its effect on ice melt at Hailuogou Glacier, southeastern Tibetan Plateau, using in situ surveys and ASTER imagery

Yong Zhang, Koji Fujita, Shiyin Liu, Qiao Liu, Takayuki Nuimura



Vijay P. Singh, Pratap Singh, Umesh K. Haritashya, eds. 2011. *Encyclopedia of snow, ice and glaciers*. Springer Dordrecht. 1254 p. (ISBN: 978-90-481-2641-5 (hardback) €399.00, ISBN 978-90-481-2642-2 (online access) €399.00; ISBN 978-90-481-2643-9 (book + online access) €499.00). Roger Barry, Thian Gan. 2011. *The global cryosphere: past, present and future*. Cambridge University Press. 498 pp; 42 b/w illus. 46 colour illus. 24 tables. (ISBN: 978 0 521 76981 5 (hardback) \$130.00, ISBN 978 0 521 15685 1 (paperback) \$80.00).

# ANNALS OF GLACIOLOGY 52(59)

The following papers have been selected for publication in Annals of Glaciology 52(59) (thematic issue on Earth's Disappearing Ice: Drivers, responses and impacts), edited by Kees van der Veen

A reconstruction of annual mass balances of Austria's glaciers from 1969 to 1998 J. Abermann, M. Kuhn, A. Fischer A new glacier inventory for the Jostedalsbreen region, Norway, from Landsat TM scenes of 2006 and changes since 1966 Frank Paul, Liss M. Andreassen, Solveig H. Winsvold

Annals 52(59) is now complete

# ANNALS OF GLACIOLOGY 53(60)

The following papers have been selected for publication in Annals of Glaciology 53(60) (thematic issue on Interactions of Ice Sheets and Glaciers with the Ocean), edited by Slawek Tulaczyk

Relationships between iceberg calving and sea ice conditions on NE Devon Ice Cap, Nunavut Luke Copland, Emilie Herdes, Brad Danielson, Martin J Sharp

The influence of ice mélange on fjord seiches Douglas R MacAyeal, Julian Freed-Brown, Wendy W Zhang, Jason M Amundson Tropical forcing of circumpolar deepwater Inflow and outlet glacier thinning in the Amundsen Sea embayment, West Antarctica Eric J Steig, Qinghua Ding, David S Battisti, Adrian Jenkins

More papers for *Annals* 53(60) will be published in the next issue



In May 2011 we were joined by Louise Buckingham, who has taken over as Membership and Accounts Manager from Trevor Margereson. Trevor is remaining with us for the meantime to concentrate on systems development and the creation of some much-needed documentation for our office procedures. Louise studied at Edinburgh University, specializing in glaciology in her final year. Since university she has gained wide-ranging experience in the fields of property management and valuation, bookkeeping and design in the UK, USA and Australia. Louise has fitted in very quickly and has already been in communication with many of you. She is responsible for managing membership records and payments, library subscriptions, general accounts and administration.



# **Annual General Meeting 2011**

# Thursday 9 June,

Scripps Seaside Forum, Scripps Institute of Oceanography, La Jolla, California, USA.

The President, Dr Eric Brun, was in the Chair.

A total of 51 persons attended, of which 42 members from 16 countries were present.

## 1. The previous AGM's minutes

The Minutes of the last AGM, published in *ICE* 2010, No 154, p. 19–23, were approved on a motion by O. Sergienko, seconded by T.H. Jacka and signed by the President.

## 2. The President's report

The President gave the following report for 2010–2011:

Dear Members, Ladies and Gentlemen

The International Glaciological Society has completed its 75th year. At the end of my 3-year term as IGS President, it's an immense pleasure for me to present the report on the Society's activities for the past year.

I will start this report with an overview of our publication activities. The last years have been marked by continuous progress in that field. Once again, 2010 has been a record in terms of submitted and published papers. We published six issues of the *Journal of Glaciology*, including the special Issue 200. It represents 1172 pages in all. It must be noted that it has been achieved while maintaining and even enhancing the quality of our publications. Indeed, the rate of acceptance is now 49%, compared to 51% in 2009, 66% in 2008 and 58% in 2007. Such a quality is the best warranty for the future of the *Journal of Glaciology*. And 2011 looks like it will be a substantial volume, as well.

The online submission system for the *Journal* is now working well. It has greatly simplified the tasks of the IGS Chief Editor and the IGS staff and it should contribute to a further increase of production efficiency. It has been well received by authors, which should contribute to the *Journal*'s attractiveness.

Concerning the *Annals of Glaciology*, we received the excellent news that it has been accepted as a journal for the Thomson Reuters ISI Web of Science. It will receive an impact factor. Hopefully the first one will be available in June 2011. This is indeed very good news and shows that introducing a new *Annals* editorial policy was fruitful. I would like to acknowledge the continuous action of our Secretary General,

Magnús Már Magnússon, who maintained the pressure on that issue during the last 3 years.

Volume 51 of the *Annals* is now complete. *Annals* 51(56) was completed in March this year. This was the first *Annals* issue to be published completely independently of any meeting. We are investigating the possibility of publishing another 'independent' issue of the *Annals* and of making this a regular feature of the *Annals of Glaciology*. We are due to publish 4 issues in 2011, which will make up Volume 52. We have now published 2 of those, *Annals* 52(57) (parts 1 and 2), *Annals* 52(58) is almost complete on the web and we are well advanced with *Annals* 52(59).

The *Annals* online submission system should be live to accept the papers submitted to the thematic issue of 'Interactions of Ice Sheets and Glaciers with the Ocean'.

We have completed the 2010 publication of ICE and are hoping to be up to date by the end of 2011. We are hoping to move to an online ICE in the near future.

For the continuous efforts which make the success of the IGS publication activities, I would like to acknowledge our Chief Scientific Editor, Jo Jacka, the editorial board, the Publication Committee, chaired by Christina Hulbe, the IGS Production Manager, Christine Butler, the IGS staff in Cambridge and our Secretary General, Magnús Már Magnússon.

We are now in our third year of using the new membership and events management software. It has substantially helped in the running of the Society and simplified several tasks within the office, with the online membership renewal and symposium registration system; it has made things considerably easier.

The IGS staff is constantly modifying the workflow within the office to make full use of the software and further action will be necessary to bring all operations and tasks up to speed. We are hoping to make full use of our 'portal website' and we are working on introducing an 'online shopping basket', which will enable authors to pay for page charges online, and for members and the public to buy past issues of the *Journal, Annals* and all IGS publications.

The Society should see the full benefit of the management system in the latter half of 2011 and in 2012. Staffing now amounts to approximately

two and a half full time positions in production, one and a half positions in administration and one position in membership/subscriptions. Staffing costs remained high for 2010 but we are intending to bring those down in 2011.

The IGS Council has for some years been very concerned by the decrease in membership between 2000 and 2008. Our Secretary General put this issue at the top of his priorities. Thanks to his action, we have been able to stem the decline in our membership. 2010 saw a significant increase in membership, with 92 more than in 2009. And so far this year we have 48 new members and 70 old members that have rejoined. Members are also more alert to the fact that paying promptly is beneficial to the Society. There is a steady stream of new members, as can be seen by the list that appears in every issue of ICE. We do need, however, to continue to press former members to renew their membership.

Last year during the AGM in Sapporo, I reported the Council's concern about the Society's finances. The Council, which met on Monday, paid particular attention to the Treasurer's report. The finances of the Society are hopefully stabilizing. In 2009 we had a large deficit, and although we still have a deficit in 2010 it has gone down considerably. And there is reasonable hope that the reduction in staffing costs will allow us to balance our budget in 2011 or early 2012.

I will finish this annual report by mentioning our Symposia activities.

The IGS sponsored the 'International Symposium on Snow, Ice and Humanity in a Changing Climate' held in June 2010 in Sapporo. It was attended by 154 delegates and was a great success.

We also sponsored the Byrd Polar Center celebratory symposium 'Earth's Disappearing Ice; Drivers, Responses and Impacts', attended by 102 delegates and a great success as well.

We are presently sponsoring the 'International Symposium on Interactions of Ice Sheets and Glaciers with the Ocean', in La Jolla, California. We are impressed by the excellent organization and quality of the presentations.

In addition we are working on symposia in Helsinki, Finland, southern France and Fairbanks, Alaska in 2012; South America, New Zealand and China in 2013; Alberta, Canada in 2013–14 and Hobart, Australia in 2014. We are also planning symposia in China and the UK in 2015 and in Boulder, Colorado, in 2016.

As I now complete my term as President of the IGS, I would like to thank Magnús and his staff, Jo and all the editors of the *Journal* and *Annals*, and all of you, the members of IGS who have made my term most enjoyable.

The Secretary General invited members to discuss the President's report. A question was asked from the floor about whether personnel changes were driven by monetary motives or the need for greater efficiency. The President responded that in light of the introduction of new technology within the office it was clear that reorganization was required as some responsibilities became superfluous while new ones were required. Indeed it started before we faced a large deficit. Another guestion was raised as to the procedure and policy regarding how ordinary members would go about initiating a publication of a thematic issue of Annals of Glaciology. The IGS Chief Editor responded that the issue had been raised in an editorial in ICE but it would be beneficial to publish a separate note in *ICE* on the issue. In response to the guestion, he said any individual or group may submit a proposal to the IGS Council through the Secretary General. The Council may refer the proposal to the Publications Committee for advice. The proposing group should be confident that the issue will attract a substantial number of submissions of high scientific calibre and that it will attract a high readership level. The proposal may also include the names of potential scientific editors.

R. Bindschadler proposed and F. Pattyn seconded that the President's report be accepted. This was carried unanimously.

# 3. The Treasurer's report

The Secretary General, on behalf of the treasurer, Dr I.C. Willis, presented the following report with the audited financial statements for the year ended 31 December 2010.

Council opted to have our accountants undertake an Independent Examiner's Report rather than a full audit this year. This was deemed sufficient since the day to day running of the accounts by IGS staff was more accurate this year than in recent years due to better management of and greater familiarity with the accounts software.

The Society's finances are best summarized by considering the changes from 1 January 2010 to 31 December 2010, as shown on page 10 of the accounts. In the table, the Restricted Fund is money earmarked specifically for costs associated with the Seligman Crystal and the Richardson Medal. The Unrestricted Funds is everything else.

*Restricted Funds*: decreased from £9,059 to £8,206 due to the costs of making 6 blank Richardson Medals (£853), one of which was awarded in 2010. A Seligman Crystal was also manufactured (£280) and £201 was transferred from Unrestricted Funds to add to the £82 made on bank interest so that the net cost to the Restricted Funds of the Seligman Crystal was zero.

Unrestricted Funds: decreased by £69,720 from £443,684 to £373,964 showing that the income to IGS largely from membership, sales of the Journal and Annals, page charges and symposia attendance fell short of expenditure associated with Journal and Annals printing and publication, and associated office support, and office support for activities related to running symposia.

*Total*: The Society had net resources expended before revaluation of £71,564 resulting in the negative movement in the Society's funds of £70,573 in 2010, compared to the bigger loss of £122,499 in 2009 a much smaller loss of £4,837 in 2008, a net profit of £11,327 in 2007 and a profit of £29,799 in 2006.

This reduction in the net loss of the Society compared to last year is encouraging but we still have some way to go before we break even or turn in a small profit. The Society must continue the trend of reducing the deficit over the next year or two and should aim to be producing a surplus again in 2012 or 2013.

In more detail, income is itemized in notes 2–6, pages 14–16 and expenditure is listed in notes 7–10, pages 16–18. The accounts are presented under the same headings that were introduced last year of 'Journal, ICE & Books', 'Annals', and 'Meetings/Symposia' to reflect the three main activities of the Society.

#### Income:

Note 2. Voluntary income increased from  $\pounds 1,987$  to  $\pounds 6,308$  due to an increase in royalties (which more than offset a decrease in donations).

Note 3. Trading activities is a new category this year associated with the selling of ties. It turned in a small profit of £915. Once the online membership software is fully operational, perhaps the Society should investigate the selling of other merchandise (brooches, towels, mugs, etc.).

Note 4. Due to continued low bank interest rates, Investment Income is low again this year (£4,800) and similar to last year (£4,973); very different from the situation in 2008 where income from this source was £29,986.

Notes 5 & 6. Compared with 2009, income from membership subscriptions, sales of the *Journal, ICE* and books, sales of *Annals*, and conferences and symposia are all up in 2010. This is good, and reverses the negative trend for all these activities over the 2008–9 period.

Membership subscriptions are shown to be up by £9,876 from £44,869 to £54,745 (page 10). Membership numbers have increased and payments have been received before the new subscription year or early in the year as a result of much better management of the membership database and sending out of renewal notices, helped by the new membership management software that the Society introduced at the start of 2009.

*Journal* sales to libraries and other organizations were up slightly by £2,189 from £84,469 (2009) to £86,658, a rise of 2.6%. This compares with a rise of 4.3% in the annual subscription rate (£300 to £313) and together this suggests that the number of libraries subscribing to the *Journal* fell between 2009 and 2010. This continues the trend from 2008–9 and should be a concern to the Society.

Page charge income increased by £10,984 from £88,441 to £99,425 (i.e. an increase of 12%). This compares to an increase of £11,697 (2008–9) and an increase of £21,695 (2007–8). Page charges to authors remained the same from 2008 to 2010. The increased income of 12% compared to an increase in pages published of 5.4% implies more authors were able to honour page charges in 2010 compared to 2009. The implementation a new 'page charge structure' of the *Journal* in mid 2010 (to bring it in line with the *Annals* page charge structure) will hopefully enable more authors to pay the page charges and will yield a further increase in income per page in the future. This needs to be monitored.

Total income from *Annals* is up by £4,997 from £64,635 to £69,632, up by about 8%. [N.B. This does not include income for the *Annals* from delegates at conferences who essentially receive their copy 'free', i.e. this is accounted for under the income to meetings/symposia heading.] This item is dominated therefore by income from library subscriptions and page charges. The total 2009–10 income increased by 8% despite the fact that the number of volumes decreased from four to three (i.e. 25%) and the number of pages dropped from 628 to 513 (i.e. a decrease of 18%).

### Expenditure:

Note 7. The expenditure of £3,212 reflects sponsorship of the activities of UKPN and the Alaska Glaciology Summer School in Fairbanks in June. Council agreed that these two ventures were worth supporting, primarily because they helped young scientists. These are excellent things for the Society to sponsor but we should be careful not to overcommit to this type of help until our accounts start breaking even or turning in a profit once more.

Note 8. The direct costs associated with editing, printing, publishing and distributing the *Journal* and *Annals* and material for Meetings/Symposia increased by £8,676 from £121,735 to £130,411 compared to an increase of £16,568 (2008–9) and a decrease of £9,513 (2007–8). Wages and salaries associated with these activities actually decreased in 2010 compared to 2009, reflecting increased efficiency by the IGS production staff. Editorial fees and expenses increased, largely because of the

increased number of papers being submitted. Proof reading and editorial costs increased also, largely for the same reason.

Note 9. The support costs associated with *Journal, Annals* and Meetings/Symposia activity have increased by £81,754 from £272,431 to £354,185, an increase of 30%. This compares with an increase of £39,475 (17%) in 2008–9 and an increase of £77,793 (50%) in 2007–8. The biggest hikes between 2009 and 2010 are associated with:

(i) Symposia, where support costs increased by £62,556 because three major IGS sponsored symposia were held during 2010 (500 participants in total) compared to two in 2009, one of which was held in the UK (100 participants) and one in India which was attended by 40 'foreigners'. The participation of local scientists in India was supported by the local organizers, as were all logistics costs.

(ii) Wages and salaries, which increased by £13,294, most of which (about £11,000) was associated with a redundancy payment (for the position of Assistant to the Secretary General).

Some of the wages and salary costs are associated with the continued employment of a part-time Membership Manager (Trevor Margereson) throughout 2010 (he was appointed part way through 2008) and the additional appointment of two student helpers. Trevor and the students were employed to oversee the transition to the new computerized and online members' management/ payment system. In 2011 and beyond, we envisage that Support Costs' wages and salaries will be reduced because: (a) we no longer employ an Assistant to the Secretary General; (b) as the new management/payment system is up and running, the Membership Manager's working hours will gradually be wound down and finish in the summer of 2011; furthermore there will be no need to hire in additional temporary help. It should be recognized, however, that the Society has recently employed a new part-time person, Louise Buckingham, to the position of Membership and Accounts Manager and the salary associated with this position will go some way to offsetting the future wages and salary savings.

(iii) Pension costs of £30,109. Council agreed to introduce a pension scheme for the main IGS employees, which became operational in 2010. Because of the delay in implementing the scheme after Council first approved it, it was agreed to backdate the pension payments pro rata to 2006. Thus, over £20,000 of the £30,109 is due to these one-off back payments and to paying a Financial Advisor to set up the scheme. The annual cost of the pension scheme in future will be <£10,000.

Travel and subsistence costs, largely the Secretary General representing the Society at

meetings, have also increased. It is useful for our Secretary General to be seen at meetings and present talks about the Society and try to solicit new members. But these costs have increased from £10,843 in 2008 to £15,142 in 2009 and £18,609 in 2010. In 2010 the IGS paid for the travel costs for Society officers on three occasions. An additional cost increase is, I suspect, due to the increased costs of air travel and the weak Sterling against other currencies. Care is needed to ensure this item of expenditure does not increase out of proportion with other support costs.

The provision of doubtful debts actually represents a negative cost (credit) to the Society since continued substantial effort with a lot of success has been expended on chasing up aged debts. Most debtors are now less than a few months old, rather than up to several years old as was the case a few years ago. As note 18 on page 21 shows, net debtors (i.e. after the provision has been removed) amounted to £32,423 in 2010 compared to £49,859 in 2009. In 2008 it was £110,481! This continued reduction in the net debt and the provision for the debt is therefore a very good thing for the Society. The new online management/payment system, together with restructuring of personnel within the IGS office, should reduce the debtors within each year still further in the future.

Note 10. Governance costs associated with running the Society as a Charity have remained stable. Opting for an Independent Financial Report rather than a full Audit has saved the Society £2,000. The accountants, the Secretary General and I agree that this was a perfectly adequate procedure to assess the Society's accounts and could be continued in the future. Furthermore, costs have decreased due to savings brought about by IGS staff's increased efficiency in the use of the office accounting/membership software.

# Summary

The Society's finances are still in fairly good shape but there would still appear to be room for improvement in the way the Society operates. We ran a moderate deficit in 2010 (~18% of funds) compared to a much bigger deficit in 2009 (~27% of funds), a small deficit in 2008 (<1% of total funds), a small profit in 2007 (~2% of total funds) and a bigger profit in 2006 (~5.5% of total funds). The net result over the past 5 years is that we have been running at a loss. Our assets are still £382,170 and so there is no need for major alarm, but clearly our recent position is unsustainable in the long term.

On the income side, it is hoped that the new page charging structure for the *Journal* will result in more authors paying page charges. Faster invoicing and the ability to pay online should help with this. The Society has increased its paying membership

recently and it is hoped that more people will be encouraged to join in the future. More innovative ways of attracting younger members and members from emerging industrialized nations, especially India and China, should be investigated. The Society must also try to ensure that library subscriptions to the Journal and Annals do not continue to slip and, again, investigate possible different ways of obtaining more income from sales/online access to libraries/institutions. The Society has recently moved some of its bank assets to a higher interest account, but until interest rates increase generally, the Society will continue to suffer from lack of revenue from this source. Perhaps the Society should investigate the possibility of obtaining grants from private industry sponsors to support some of its activities. Sale of merchandise online could also be investigated.

On the expenditure side, the Society should note that some of the items will not be continued into 2011. In 2010 the Society paid the salaries of a full time Assistant to the Secretary General in addition to a part-time Membership Manager and student assistants. From 2011 onwards it will only employ a part time Membership and Accounts Manager. Furthermore, in 2010 the Society made one-off payments of ~£31,000 which were redundancy costs and pension back payments.

The Society has now made the transition to the new joint MRM–SAGE management and accounting system, and has made some personnel changes within the office. Although implementing these changes has cost the Society in recent years, the Society should now be in a position to start benefitting from these changes in terms of lower salary costs, lower costs and fees payable to an outside examiner/auditor, and reduced losses associated with aged debtors.

# Ian C. Willis, Treasurer

1 June 2011

The SG invited members to discuss the Treasurer's report.

M. Truffer asked what proportion of authors paid page charges. The SG replied that information had not been compiled but it would be useful to do and he would collate the data. H.J. Zwally asked whether there was still reluctance in Europe to pay page charges. He also asked whether it was still IGS policy to publish papers where page charges had been paid faster than those where page charges had been paid faster than those where page charges had not been paid. The SG responded that, as publication is now very prompt in the *Journal*, it is now of little relevance to the publication order whether page charges are paid or not, all papers accepted for publication in the *Journal of Glaciology* are published as quickly as possible. A. Jenkins commented on the non-compliance policy and if it became widely known that the IGS was willing to waive page charges it would encourage authors not to pay. He felt authors should submit a well-reasoned argument why page charges should be reduced or waived. The SG said this was the case, all requests for non-payment were considered on a case by case basis and the individual author's arguments were carefully considered. He knew of no case where a paper had not been published or had been withdrawn because page charges had not been paid. The Chief Editor made it clear that as a policy he does not know whether the author will be able to pay page charges so it does not affect his scientific judgement. T. Murray commented that often it is students who have just finished their studies and do not have financial support who are unable to pay.

T. Murray proposed and A. Jenkins seconded that the Treasurer's report be accepted. This was carried unanimously.

### 4. Election of auditors for 2011 accounts.

On a motion from the Secretary General, R. Bindschadler proposed and A. Rivers seconded that Messrs Peters Elworthy and Moore of Cambridge be elected Independent Inspectors for the 2011 accounts. This was carried unanimously.

### 5. Elections to Council.

After circulation to members of the Society of the Council's suggested list of nominees for 2011–14, no further nominations were received, and the following members were therefore elected unanimously.

President:

Douglas MacAyeal

Vice-Presidents: Perry Bartelt Francisco Navarro

Elective Members:

Xiao Cunde Shuji Fujita Catherine Ritz Margit Schwikowski

These appointments were unanimously approved by the AGM.

The outgoing President Eric Brun handed over the meeting to the incoming President, Douglas A. MacAyeal.

The President thanked the Immediate Past President for his valuable contribution during his term of office. The president also recognized the attendance of past president Robert Bindschadler.

### 6. Other business:

No other business was raised.

The AGM was adjourned at 13:06 on a motion from R. Robertson seconded by O. Sergienko.



# Dear IGS Members

I am delighted to be your representative as the IGS president for the coming three-year term. I begin my term not with any specific agenda, but rather with the recognition that the IGS is perpetually engaged in the effort to adapt itself to ever-changing scientific focal points, membership composition, publishing competition, funding conditions and societal viewpoints about glaciology. My plan is to work as effectively as possible with the Secretary General, other officers, council and advisory committees to see to it that the IGS conducts itself wisely, makes intelligent changes when prudent and is respectful of diverse viewpoints that are endemic to the community of scientists.

Over the coming year, the Secretary General and I shall work to address the recommendations made by our Treasurer in the 2011 Annual General Meeting. While we delight in the extraordinary volume of publication, the large numbers of sponsored meetings, and strategic changes to the operations and practices of our home office and staff, we remain obliged to balance our budget in the coming years. I will meet with the Secretary General in September to discuss views and examine data in order to present to the council in November (and to the IGS membership at the 2012 Annual General Meeting in Spring) a series of reforms and other actions that are intended to achieve this. We shall also work toward providing the council with regular budget forecasts so that future modifications to financial conditions can be anticipated.

Like many members, I am very interested in, and possibly a bit worried about, the fast pace of change in the way our peer scientific societies (e.g. AGU and EGU) are evolving the way they publish, particularly with the pace of online-only options. The publication committee of the IGS has done a remarkable job of providing the IGS with well-considered advice. My personal view is to see continued evolution of the way the IGS presents the Journal and Annals online. I shall ask the Publications Committee to advise the council on whether it is possible to change how membership operates with respect to receipt of high-quality printed journal issues. For example, one option to consider will be



The outgoing President, Eric Brun, handing over to the incoming President, Doug MacAyeal, at the AGM in La Jolla.

for all members to have access to fully searchable online PDF versions of the Journal and Annals, and to have the option of electing to receive at additional cost for printing and mailing high-quality printed issues. I would like to see ICE circulated both online as well as in a recyclable newsprint format that provides thumb-through reading material that is convenient for a guick scan-through. It is possible that the invention of new media technology may allow the IGS to present its publications as a convenient 'app' on a tablet or wireless telephone in the future. I caution, however, that these changes in publication technology are not necessarily going to reduce the annual dues or make the ever-more-valuable page charges go away. The IGS provides publication products where value is measured as much by the intangible aspects of quality editing, impeccable house production and effective delivery to the scientific community as by the cost of paper and ink.

### **Douglas R. MacAyeal**

# **Meetings of other societies**

# UKPN Cryospheric and Remote Sensing Workshop and Summer School

The NERC Earth Observation Technology Cluster promotes knowledge exchange in the broad field of terrestrial Earth Observation (EO). One of the cluster themes is Circumpolar and Cryospheric EO, run in partnership with the UK Polar Network (UKPN, the UK branch of APECS; http://www.polarnetwork. org, http://www.apecs.is), an organization of over 300 early career scientists in Britain with interests in all fields of polar and cryospheric sciences. As part of the Circumpolar and Cryospheric theme, two events were held: a one-day workshop and a three-day summer school.

### **Circumpolar Remote Sensing Workshop**

On 20 September 2010 this workshop of over 30 students and researchers was hosted by the Scott Polar Research Institute, University of Cambridge. The day featured a range of sessions including Freely Available GIS and Remote Sensing Resources for Polar Research, Innovation in Imaging Antarctica, Airborne LiDAR for Glaciology, Real-time Reception and Analysis of Satellite Data, Remote Sensing to Address Mapping Needs for Environmental Management in Antarctica, and Ice Shelf Retreat in Antarctica.

In addition, five panelists from universities, research institutes, and a remote sensing

consultancy also sat on a career discussion panel to help attendees answer questions about moving forward in their journey to move from early career to more experienced. They stressed the importance of building your skill set throughout your career, making connections in your research community, and always making sure to have fun and play with your data. Attendees expressed that the 'sessions provided [them] with useful and practical information to move forwards and motivate' their future studies and research.

The PDF and video recordings of the day's presentations are available through the UKPN website (www.polarnetwork.org or http://bit.ly/ pqPuGZ).

# Remote Sensing for Polar Scientists Summer School

Held on 20-22 July 2011 at the University of Reading's Meteorology Department, this summer school encouraged a full understanding of a range of EO techniques exploited by polar scientists. Students listened to lectures on Remote Sensing of Greenland Mass Balance; ESA and Earth Observation of the Changing Climate, the Cryosat Mission & Remote Sensing of Arctic Sea Ice; Fieldwork, Remote Sensing, and Modeling of



Participants in the Remote Sensing for Polar Scientists summer school. Credit: Matthias Kunz.



Taken by NASA's Terra satellite on 7 January 2010, this image shows widespread snowcover as the UK was gripped in a cold snap. Credit: NASA/ GSFC, MODIS Rapid Response.

Snow Cover; and the Use of LiDAR in Building DEMSs and their Glaciological Applications. They also were able to get hands-on with real data and models in practical sessions focusing on glacier feature tracking with multispectral imagery, ESA data products and toolboxes, snow water equivalent data products, and airborne LiDAR data collected over a glaciated region.

After an inspiring talk by Paul Hardaker on the importance of sharing our science with a wider audience, students got together into small groups to produce a modular presentation that aimed to introduce the use of Remote Sensing in different areas of Polar Science to those following us up the career ladder. In addition, attendees produced 'yearbook pages' about their research. The completed materials aimed at early undergraduate/ A-level will be available in the near future through APECS and the EO Tech Cluster.

Attendees shared that they appreciated the ability of the instructors to link together fieldwork, remote sensing and modeling in a variety of ways. 'It was really good to get a go at the different techniques in the practicals,' wrote one, and another appreciated the mentoring and networking possibilities so that they could 'talk to people who are more experienced in my topic.' In addition, all



Chris Stewart (European Space Agency) gives a lecture and tutorial on available ESA data products and processing software. Credit: Matthias Kunz.

students were invited to bring a poster detailing their own work, and almost all attendees took advantage of the opportunity. Displayed throughout the school in the room where refreshments were served, the posters inspired many lively discussions.

The content and structure of the theme activities were designed to encourage knowledge transfer across the EO and polar/cryospheric research communities. Based on the success of these events, the UKPN hopes to run another remote sensing summer school in the coming years. Further planned activities including outreach events to school groups, development of public interest materials, publication of scientific results related to the theme, and further networking activities.

The UKPN has future workshops planned for Polar Biological Sciences at the British Antarctic Survey in November and mentor panels planned for the IGS British Branch meeting and the UK Arctic Science Conference in September. Email com@polarnetwork.org for more details.

Many thanks to summer school organizers (Debbie Clifford, Matthias Kunz, and Debbie Clifford), the mentors, lecturers, and instructors who gave their time (Stephen Briggs, Fiona Danks, Ken Dean, Adrian Fox, Peter Fretwell, Katharine Giles, Paul Hardaker, Colin Harris, Seymour Laxon, Pauline Miller, Hamish Pritchard, Gareth Rees, Nick Rutter, Mel Sandells, Andrew Shepherd, Chris Stewart, and Aud Sundal), and the further event sponsors (National Centre for Earth Observation, the 11th International Circumpolar Remote Sensing Symposium, and Environmental Research & Assessment) without which these activities would not have been possible.

Allen Pope and Jen Hall



# A NEW GLOSSARY OF MASS BALANCE AND RELATED TERMS

Anonymous (1969) is a citation that elicits bafflement from colleagues in other disciplines, but for four decades this short paper in the *Journal* of *Glaciology* on mass-balance terms has been familiar to specialists as the cornerstone not just of mass-balance terminology but of sample design for mass-balance measurements and of thinking about changes of glacier mass. Anonymous (1969) has been extraordinarily serviceable, but a consensus has been developing for some time that it is overdue for a tidying-up.

The fledgling International Association of Cryospheric Sciences (IACS) decided at the time of its formation in 2007 that, among the services it could offer to its community of scientists, a series of technical documents of broad relevance would be particularly valuable. The newly-published *Glossary of Glacier Mass Balance and Related Terms* (Cogley et al., 2011) follows *The International Classification for Seasonal Snow on the Ground* (Fierz et al., 2009) as the second of these documents.

The *Glossary* is the product of a threeyear collaboration among 11 glaciologists with interests in mass balance, constituted as the IACS Working Group on Mass-balance Terminology and Methods. The *Glossary* was greatly improved by detailed reviews from six colleagues and by many comments from a broader sample of the community. The stated aim of the *Glossary* is 'to promote clarity and reduce ambiguity in the communication of information about glacier mass balance, as well as to provide a range of useful ancillary material' – in short, the same aim as that of the still-shadowy group who contributed to Anonymous (1969).

Among the reasons for a new look at massbalance terminology, new measurement methods, advances in modelling and increased attention to ice sheets are prominent. Altimetry, interferometry and gravimetry have transformed our ability to measure changes of glacier mass, greatly enlarging the spatial scale on which measurements can be made without diminishing the importance of classical in-situ methods. Measurements of the mass balance of ice sheets, once practically impossible, are now a reality, although parts of the ice-sheet balance may be modelled rather than measured. All mass-balance researchers, not just those who concentrate on the ice sheets, now accept that modelling is an essential tool of analysis, and meeting the needs of modellers as well as those of field workers has been a major objective of the Working Group.

For many, the most noticeable revision of terminology in the *Glossary* may be that it retires the distinction drawn by Anonymous (1969) between net balance and annual balance. These two kinds of measured mass balance, both intended to span one year of accumulation and ablation, differ according to the time system in which the measurement is made, the former referring to the stratigraphic system and the latter to the fixed-date system. The idea of a time system remains important. For one thing, measurements of the same glacier in the same year can differ considerably between the two systems. Yet the two adjectives are now often used wrongly, or both at once, or in application to measurements not made in either of the original time systems. The *Glossary* explains why the Working Group thought it best to recommend that all measurements of one year's mass change should be described as 'annual' and be accompanied by an explicit description of the time system. The adjective 'net' becomes available in its plain-language meaning, although it will often be redundant.

More generally, the *Glossary* urges that metadata about balance measurements should include not just full temporal information but also full spatial information. For example the glacier's area and area-altitude distribution are needed for converting between specific and glacier-wide quantities.

The adjective *specific* is problematic in current usage. Some think that it means 'at a point' while others think, perhaps by analogy with its meaning in surface hydrology, that it means 'per unit area'. The *Glossary* favours the latter interpretation and suggests *point mass balance* as a clear alternative for the former. Decisions like this one, however, emphasize the risks of prescriptive as opposed to descriptive definitions, that is, of laying down the law as opposed to just documenting how people use words. In the example of *specific*, less ambiguity seemed preferable to continued anarchy, but the *Glossary* tries in general to steer a reasonable middle course.

Inconsistent usage in the literature led to the introduction of a few new terms. Traditionally,

surface mass balance is the sum of accumulation and ablation at the surface of the glacier. However an ambiguity arises because in some recent studies, especially in the ice-sheet context, its meaning has been extended to include *internal accumulation*. The glossary recommends that the sum of the surface mass balance and the *internal mass balance* be called the *climatic mass balance*, a term that preserves the distinction between its two components and captures the strong dependence of both on interactions between the glacier, the hydrosphere and the atmosphere. The *climatic-basal mass balance* also includes the balance at the bottom of the glacier.

The *Glossary* introduces the term *frontal ablation* for all mass losses at glacier terminuses. Anonymous (1969) was focused almost wholly on the surface mass balance and did not address calving. However, findings of significant submarine melting at calving fronts have made it clear that *calving* is itself an incomplete description of what happens at calving fronts. There is also subaerial melting and sublimation. This complexity highlights the need for keeping terminology up to date.

As work on the review of mass-balance terms progressed, it became clear to the Working Group that simple term-by-term decisions, either to reaffirm or redefine, would not lead to a satisfactory update of Anonymous. Mass balance is still the change in the mass of the glacier, or part of the glacier, over a stated span of time, but a reformulation of the subject as a whole was evidently necessary. The outcome is a 114-page volume that prefaces the glossary proper with 16 pages of background and formulation; spells out 43 acronyms; presents 539 definitions, of which many are discursive and some are multiple; and adds 'useful ancillary material' in the form of appendices containing seven tables listing old definitions, reference values of the properties of frozen water, and similar information. There is also a simple index.

The reformulation and resulting terminology for mass balance are placed in historical context, including one or two jokes about pedantry, by Cogley (2011).

The *Glossary* can be downloaded from http://unesdoc.unesco.org/images/0019/001925/ 192525E.pdf. A searchable online version is being considered. Paper copies can be ordered at no charge from the IHP Secretariat, UNESCO, Division of Water Sciences, 1 rue MioIlis, 75732 Paris Cedex 15, France, or from ihp@unesco.org.

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# **Graham Cogley**

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# Al Rasmussen

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INTERNATIONAL GLACIOLOGICAL SOCIETY

# International Symposium on Seasonal Snow and Ice



Lahti, Finland 28 May–1 June 2012

Co-sponsored by: Department of Physics, University of Helsinki Micro-Dynamics of Ice (Micro-DICE) network of the European Science Foundation

SECOND CIRCULAR October 2011 http://www.igsoc.org/symposia/ http://www.gastro.physics.helsinki.fi/IGS2012/



The International Glaciological Society will hold an International Symposium on 'Seasonal Snow and Ice' in 2012. The symposium will be held in Lahti, Finland, from 28 May to 1 June 2012.

# THEME

Seasonal ice covers wide zones around the globe, mostly in sub-polar latitudes. The main forms are seasonal snow, sea ice, lake and river ice and frozen ground. The extent of the seasonal ice zone is highly sensitive to climate as small climatic variations can have a large impact on the environment as well as human living conditions. Ice–climate feedback mechanisms are important to study, as they are often first identified in the seasonal ice zone.

New technologies have broadened our ability to examine the seasonal ice zone, though large uncertainties about its current state remain. Numerical modelling is advancing but thin ice and seasonal snow covers close to the climatological ice margin remain difficult to model because of their transient nature. Ecological impact studies in the seasonal ice zone have increased over the past ten years, and serve to further highlight the important role seasonal ice has on the many physical, chemical and biological systems of the sub-polar latitudes.

In view of these advancing technologies, modelling improvements and ecological studies, we announce a symposium focussed on the understanding of seasonal snow and ice. The goal of the symposium is to progress further in understanding how seasonal snow and ice is responding to changes in the environment and climate, and what changes can be expected in the future. This meeting seeks to address these problems by bringing together scientists from diverse communities engaged in research on snow, sea ice, freshwater lake and river ice and frozen ground.





# TOPICS

Topics include, but are not limited to:

- 1. Observations of temporal changes of seasonal snow and ice cover, including snow and ice phenomenology, in situ observations and mathematical modelling techniques.
- 2. Physical, chemical and biological processes of seasonal snow and ice, including snow metamorphosis, snow structure models and the effect of snow quality on the biosphere.
- 3. Micro-dynamics of ice, including analysis, modelling and interpretation of ice and snow microstructures, and linking microstructures to geophysical signals.
- 4. Seasonal sea-ice dynamics and the impact of seasonal sea ice on the ocean, including scaling of ice dynamics, mathematical models, ice ridges, and the oceanic boundary layer under sea ice.
- 5. Frozen ground and permafrost, focussing on observations, theoretical advances and modelling.
- 6. Lake and river ice, including ecology of frozen lakes, river ice models, estuaries.
- 7. Ecological impact of snow cover and snow quality.
- 8. Remote sensing techniques applied to seasonal snow and ice, including sea and lake ice and snow-mapping technology.
- 9. Theoretical and numerical advances in modelling seasonal snow and ice, including coupling of cryosphere models with regional climate models and intercomparison of models.
- 10. Projections and forecasts of seasonal snow and ice in a changing climate, including downscaling methods and evaluations.





# ABSTRACT AND PAPER PUBLICATION

Participants wishing to present a paper (either oral or poster) at the Symposium will be required to submit an abstract by 16 January 2012. A program and collection of submitted abstracts on a USB stick will be provided for all participants at the symposium. The Council of the International Glaciological Society has decided to publish a thematic issue of the *Annals of Glaciology* on topics consistent with the Symposium themes. Submissions to this issue will not be contingent on presentation at the Symposium, and material presented at the symposium is not necessarily affirmed as being suitable for consideration for this issue of the *Annals*. Participants are encouraged, however, to submit manuscripts for this *Annals* volume. The deadline for receiving *Annals* papers is 2 May 2012.

# **REGISTRATION FEES**

All fees are in euros, €

– Participant (IGS member):	€480
– Participant (not IGS member):	€540
- Student or retired IGS member:	€240
- Accompanying person (18+):	€170
– Accompanying person (12–17):	€100
– Accompanying person (<12):	Free
- Late registration surcharge (after 2 April 2012):	€80

The fees include the icebreaker, banquet, daily luncheons (Mon–Fri), daily morning/ afternoon coffee/snacks and the mid-week excursion with an evening barbecue.

REGISTRATION BY MAIL: Though we strongly prefer registration through the website, it can however also be done by filling in and returning the back page of this circular. If payment by credit card is not possible, contact the IGS office to arrange for a bank transfer. Payments made after 2 April 2012 must include the additional €80 late-registration fee. When completed, please send the form to the Secretary General at the IGS address.





ACCOMPANYING PERSONS: The accompanying person's registration fee (€170 for ages 18 and over, €100 for ages 12–17; under 12 free) includes the icebreaker, the mid-week excursion with evening barbeque and the banquet. Short excursions and activities in and around Lahti and to Helsinki will be offered on request at addiitional cost. These include short trips to sightseeing spots in the city and a day trip to the surrounding regions.

STUDENT/POSTDOC SUPPORT: Funding is available to partially support student and postdoc attendance at this symposium. Application details will be posted on the symposium homepage by November 2011 at the latest.

LOCATION: The meeting will be held at Sibeliustalo Hall, Lahti. Lahti is located in the southern part of the Finnish central lake district and has a population of about 100 000. The end of May is characterized by little precipitation and typical daily temperatures of 15–20°C (60–70°F) but peaks up to 25°C (77°F) may occur. The surroundings offer plenty of scope for geological and geographical excursions in the lake district.

ACCOMMODATION: Hotel information will be available later on the symposium website, with special prices for symposium participants. All these hotels will located within a 15-minute walk of the symposium venue or can be reached using the local bus service.

MID-WEEK ACTIVITIES: A half-day mid-week excursion will be organized to explore some of Finland's lake district and cultural surroundings. Lahti is located in the southern corner of the central lake district of Finland, the landscape of which was formed 10 000 years ago by the retreating Fennoscandian ice sheet. The excursion will end with a barbecue and sauna on the beach.





RECEPTION: There will be an icebreaker reception on Sunday 27 May in the Lahti Ski Museum, located in the Ski Stadion 15 minutes' walk from the city centre. You will also be able to complete your symposium registration there. Come along to meet your fellow delegates, get your bearings and collect your registration package.

BANQUET: The banquet will be held on Thursday evening in the Lahti officers' club at a historic army base.

POST-SYMPOSIUM EXCURSION Information will be available later on the symposium website.

Information will be updated on the symposium website, http://gastro.physics. helsinki.fi/IGS2012/ as it becomes available.

# IMPORTANT DATES

Abstract submission deadline:	16 January 2012
Notification of acceptance:	15 February 2012
Pre-registration deadline:	2 April 2012
Paper submission deadline:	2 May 2012
Deadline for refund:	2 May 2012
Registration and Icebreaker:	27 May 2012
Conference begins:	28 May 2012
Final revised papers deadline:	1 August 2012





SYMPOSIUM ORGANIZATION Magnús Már Magnússon (International Glaciological Society)

SCIENTIFIC STEERING AND EDITORIAL COMMITTEE Matti Leppäranta, Chief Editor (University of Helsinki, Finland), Lauri Arvola, Nikolai Filatov, Peter Jansson, Yuji Kodama, Zhijun Li, Lasse Makkonen, Martin Schneebeli and others to be appointed as required

# LOCAL ORGANIZING COMMITTEE

Matti Leppäranta (Chair), Lauri Arvola, Jari Haapala, Onni Järvinen, Kari Kajuutti, Esko Kuusisto, Sirpa Rasmus, Jukka Tuhkuri

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Dr Matti Leppäranta Department of Physics University of Helsinki PO Box 48 (Erik Paménin aukio 1) Helsinki, FI-00014, Finland Tel: +358 9 1915 1016/Fax: +358 9 19148802 E-mail: matti.lepparanta@helsinki.fi

Local symposium website: http://www.gastro.physics.helsinki.fi/IGS2012/





# INTERNATIONAL SYMPOSIUM ON SEASONAL SNOW AND ICE Lahti, Finland, 28 May–1 June 2012 REGISTRATION FORM

Register online at www.igsoc.org/symposia/2012/finland/registration

Family Name:	
Given Name:	
Address:	
Tel: E-mail:	
Accompanied by:	
Name:	Age (if under 18)
Name:	Age (if under 18)
Dietary and other requirements:	
· · ·	
Registration fees (euros)	
Participant (IGS member)	€480
Participant (not IGS member)	€540 6340
Accompanying person $(18+/12-17)$	€240 €170/€100
Late registration surcharge (after 2 April 2012)	€80
TOTAL REGISTRATION FEES £	
Payment of registration fee by MasterCard, VISA o	r American Express
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# INTERNATIONAL GLACIOLOGICAL SOCIETY

International Symposium on Glaciers and Ice Sheets in a Warming Climate



University of Alaska Fairbanks Fairbanks, Alaska, USA 24–29 June 2012

Co-sponsored by:

University of Alaska Fairbanks (UAF), Vice Chancellor for Research
 University of Alaska, Office of the Vice President for Academic Affairs
 & BP ConocoPhillips

 United States Geological Survey (USGS), Alaska Science Center
 University of Alaska Fairbanks (UAF), College of Natural Science and Mathematics

Arctic Research Consortium of the United States (ARCUS)
 Geophysical Institute, University of Alaska Fairbanks (UAF)

SECOND CIRCULAR October 2011 http://www.igsoc.org/symposia/ http://glaciers.gi.alaska.edu/events/igs2012



The International Glaciological Society will hold an International Symposium on 'Glaciers and Ice Sheets in a Warming Climate' in 2012. The symposium will be held in Fairbanks, Alaska, USA, from 24–29 June 2012.

# THEME

Glaciers and ice sheets are making large contributions to rising sea level, and their mass losses are expected to accelerate in a warming climate. New technologies have broadened our ability to detect and monitor glacier and ice sheet changes, though large uncertainties about the current state of the cryosphere remain. Moreover, predictive models are at present unable to capture many key processes of glacier mass balance and dynamics, many of which are non-linear. How are glaciers and ice sheets responding to recent changes in climate, and what changes can we expect in the future? This meeting seeks to address these problems by bringing together experts in glacier, climate and ocean studies, using in-situ observations, remote sensing and modeling.













of ALASKA Many Traditions One Alaska



# TOPICS

Topics include, but are not limited to:

- 1. Observations of glacier change, including mass and dynamic changes of mountain glaciers, ice caps, ice sheets, and ice shelves, glacier inventories, in-situ observations and remote sensing techniques.
- 2. Glacier mass balance climate interaction, including glacier meteorology, surface energy exchange, snow accumulation processes, mass-balance indices and the relation between glacier mass balances and atmospheric indices.
- 3. Ice dynamics, focusing on observations, theoretical advances and modeling of the flow of ice including ice streams and surges.
- 4. Glacier–ocean interactions, including ice shelf and tidewater glacier dynamics, observations and modeling of calving.
- 5. Role of subglacial processes in glacier changes, including glacier hydrology, sedimentation and volcanic interactions.
- 6. Ice sheet modeling, including advances in the physical understanding of ice-sheet processes, incorporation of non-linear ice-sheet response to environmental forcing, and assimilation of remote sensing and ground observations into ice-sheet models.
- 7. Future projections, including coupling glacier models to global and regional climate models, downscaling methods, evaluation and intercomparison of models.
- 8. Impacts of glacier changes, including the contribution of glacier wastage on sea-level rise, water resources in different climate, glacier engineering, glacier hazards, glacier outburst floods, ocean circulation, terrestrial and marine biogeochemical cycles and ecosystems, as well as isostatic changes.
- 9. Proxies and modeling of past glacier changes, including indicators from ice cores and other archives that reveal glacier responses to climate change.





# ABSTRACT AND PAPER PUBLICATION

Participants wishing to present a paper (either oral or poster) at the Symposium will be required to submit an abstract by 1 March 2012. A program and collection of submitted abstracts on a USB stick will be provided for all participants at the symposium. The Council of the International Glaciological Society has decided to publish a thematic issue of the *Annals of Glaciology* on topics consistent with the Symposium themes. Submissions to this issue will not be contingent on presentation at the Symposium, and material presented at the symposium is not necessarily affirmed as being suitable for consideration for this issue of the *Annals*. Participants are encouraged, however, to submit manuscripts for this *Annals* volume. The deadline for receiving *Annals* papers is 1 May 2012.

# **REGISTRATION FEES**

All fees are in US Dollars, USD

– Participant (IGS member):	\$490
- Participant (not IGS member):	\$600
- Student or retired (IGS member):	\$230
- Student or retired (not IGS member):	\$290
– Accompanying person (18+):	\$220
– Accompanying person (12–17):	\$110
– Accompanying person (<12):	Free
- Late registration surcharge (after 2 April 2012):	\$80

The fees include the icebreaker, banquet, daily luncheons (Mon–Fri), daily morning/afternoon coffee/snacks, an evening BBQ and the mid-week excursion.

REGISTRATION BY MAIL: Though we strongly prefer registration through the website, it can however also be done by filling in and returning the back page of this circular. If payment by credit card is not possible, contact the IGS office to arrange for a bank transfer. Payments made after 2 April 2012 must include the additional \$80 late-registration fee. When completed, please send the form to the Secretary General at the IGS address.





ACCOMPANYING PERSONS: The accompanying person's registration fee (\$220 for 18 and over; \$110 for ages 12 to 17; under 12 free) includes the icebreaker, an evening BBQ, the mid-week excursion, and the symposium dinner. Short excursions and activities in and around Fairbanks will be offered on request at additional cost. These include short trips to sightseeing spots in the city and a day trip to the surrounding regions.

STUDENT/POSTDOC SUPPORT: Funding is available to partially support student and postdoc attendance at this symposium. Application details will be posted on the symposium homepage by October 2011 at the latest.

LOCATION: The meeting will be held on campus of the University of Alaska, Fairbanks. Fairbanks is located in the heart of Alaska and has a population of roughly 100,000. The end of June is characterized by little precipitation and average daily temperatures of roughly 20°C (68°F) but peaks up to 30°C (86°F) may occur. The surroundings offer plenty of scope for glaciological, geological and geographical excursions with the Alaska Range including Denali National Park only a 2 hour drive away.

ACCOMMODATION: Blocks of rooms have been held at the Alpine Lodge (\$149 per night for a single/double; 5 km from campus and 1 km from the airport) and in the dormitories on campus (single room \$59, double room \$73, and 2-bedroom apartment (4 persons) \$155 per night). We offer shuttle transport to campus from the conference hotel. Parking is available on campus for a fee (\$3 per day).

MID-WEEK ACTIVITIES: A half-day mid-week excursion will be organized to explore some of Fairbanks's natural and cultural surroundings. Options include permafrost features and the CRRL permafrost tunnel in Fox, hot springs and the Ice Museum at Chena Hot Springs, gold-panning at the Eldorado Gold Mine, a historic gold dredge in Chatanika, and a tour of UAF's rocket launching facility Poker Flat.





RECEPTION: There will be an icebreaker reception in the pub at the Wood's Center on campus on Sunday 24 June from 5–10 pm. You will also be able to pick up your registration package (after 4 pm). Come along to meet your fellow delegates, get orientated at the conference site and pick up your registration package.

BANQUET: The banquet will be held on Thursday evening on a riverboat cruise floating down the Chena river. Transport to the boat will be provided.

Information will be updated on the symposium website, http://www.gi.alaska. edu/snowice/glaciers/ as it becomes available.

# IMPORTANT DATES

Abstract submission deadline: Notification of acceptance: Pre-registration deadline: Paper submission deadline: Deadline for refund: Registration and Icebreaker: Conference begins: Final revised papers deadline:





SYMPOSIUM ORGANIZATION Magnús Már Magnússon (International Glaciological Society)

SCIENTIFIC STEERING AND EDITORIAL COMMITTEE Gwenn Flowers, Chief Editor (Simon Fraser University, Burnaby, Canada), Etienne Berthier, Richard Hindmarsh, Matthias Huss, Tómas Jóhannesson, Tavi Murray, Francesca Pellicciotti, Valentina Radic, Catherine Ritz, Ben Smith, Ed Waddington.

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INVITED SPEAKERS Bob Bindschadler, Roger Braithwaite, Christian Schoof, Martin Sharp, Michiel van den Broeke

# CONTACTS FOR FURTHER INFORMATION

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Dr Regine Hock Geophysical Institute University of Alaska 903 Koyukuk Drive Fairbanks, Alaska, 99775-7320, USA Tel: +1 907 474 7691/Fax: +1 907 474 7290/ Email: regine@gi.alaska.edu

Local symposium website: http://glaciers.gi.alaska.edu/events/igs2012





# INTERNATIONAL SYMPOSIUM ON GLACIERS AND ICE SHEETS IN A WARMING CLIMATE Fairbanks, Alaska, USA, 24–29 June 2012 REGISTRATION FORM

Register online at www.igsoc.org/symposia/2012/alaska/registration

Family Name:	
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Accompanied by:	
Name:	Age (if under 18)
Name:	Age (if under 18)
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Participant (IGS member)	\$490
Participant (not IGS member)	\$600
Student or retired (IGS member)	\$230
Student or retired (not IGS member)	\$290
Accompanying person (18+/12–17)	\$220/\$110
Late registration surcharge (after 2 April 2012	) \$80
TOTAL REGISTRATION FEES £	
Payment of registration fee by MasterCard, VI	SA or American Express
Card number	
Expiration CVV (last 3 num	bers on signature strip)
Name of card holder as shown on card:	
Signature:	



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# 2011

# 27 June–9 July 2011 Norwegian Research School for Climate Dynamics Summer School:

Role of sea ice in the climate system University Centre in Svalbard Website: http://www.resclim.no/

# 28 June-7 July 2011

# IUGG XXV General Assembly: Earth on the Edge: Science for a Sustainable Planet Melbourne, Australia

Website: http://www.iugg.org/assemblies/ 2011melbourne/

# 29 June 2011

**Final Conference of the PermaNET project** Chamonix Mont-Blanc, France Flyer: http://www.igsoc.org:8000/symposia/ Flyers\_etc/PermaNET210411.pdf

# 10-14 July 2011

# Advances in Sea Ice Forecasting: 21st International Conference on Port and Ocean Engineering under Arctic Conditions

Montreal, Canada Website: http://www.poac11.com/

# 10-16 July 2011

**11th International Symposium on Antarctic Earth Sciences** Edinburgh, UK See conference website

# 20-22 July 2011

# Summer School: Remote Sensing for Polar Scientists

University of Reading, Reading, UK Website: http://www.surveymonkey.com/s/ VPYRWJX

Contact: Jennifer Hall [j.hall@sheffield.ac.uk]

# 20-27 July 2011

# International Union for Quaternary Research Congress

Bern, Switzerland Website: http://www.inqua2011.ch/ Contact: Christian Schluchter [christian. schluechter@geo.unibe.ch]

# 20-27 July 2011

# Geohydro 2011

Canadian Quaternary Association/ International Association of Hydrogeologists Québec, Canada Website: http://geohydro2011.ca/

## 1-12 August 2011

# Bert Bolin Centre's Arctic Climate Summer School

Abisko Research Station, Lake Tornatrask, Sweden Website: http://www.bbcc.su.se/2011-

summer-school-on-arctic-climate.html Contact: Anna Krusic [anna@krusic.org]

# 15–20 August 2011 **18th Northern Research Basins Symposium** Starting in Bergen, Norway Website: http://www.18thnrb.com/

# 22-26 August 2011

Second International Symposium on Mountain and Arid Land Permafrost Ulaanbaatar, Mongolia Website: http://www.geography.mn/

28 August-1 September 2011

# Air-Surface Interactions: Chemistry from Molecular to Global Climate Scales American Chemical Society National Meeting Denver, Colorado, USA Contact Amanda Grannas [amanda.grannas@ villanova.edu]

# 29 August-1 September 2011

# Climate Change in High Mountain Regions – From Understanding of the Past to Modelling of the Future

Salzburg, Austria Website: http://www.zamg.ac.at/veranstaltung en/125jahresonnblick Contact Wolfgang Schöner [wolfgang. schoener@zamg.ac.at]

# 3-6 September 2011

6th Open Assembly of the Northern Research Forum: 'Our Ice Dependent World' Hveragerði, Iceland Website: http://www.nrf.is/hveragerei

# 5-9 September 2011

Avalanches and Related Subjects IV International Conference: The contribution of theory and practice to avalanche safety Kirovsk, Murmansk region, Russia Website: http://cas.apatit.com/

7 September–30 November 2011 Free webinar series: Introduction to Changing Permafrost in the Arctic Landscape Wednesdays, 19:30–21:00 GMT (90 min) (Start times for the North American time zones 3:30 pm Eastern/2:30 pm Central/1:30 pm Mountain/12:30 pm Pacific/11:30 am Alaska) Website: http://apecs.is/permafrost-course-2011

# 9 September 2011

# Workshop for UK scientists: observations of 20th/21st Century changes in Antarctic Peninsula glaciers

Cambridge, UK – immediately following the IGS British Branch Meeting Website: http://www.antarctica.ac.uk/about\_ bas/events/igs2011/index.php

# 13-24 September 2011

# Karthaus course on Ice Sheets and Glaciers in the Climate System Karthaus, Italy

Website: http://www.phys.uu.nl/~wwwimau/ education/summer\_school/

## 14–16 September 2011

UK Arctic Science Conference 2011 Leeds, UK Website: http://www.ukarcticscience.org/ Enquiries to: arcticinfo@leeds.ac.uk

## 19–21 September 2011

# MOUNTAINHAZARDS 2011: Climate Changes and Natural Hazards in Mountain Areas

Dushanbe, Tadjikistan Website: http://www.mountainhazards2011. com/

# 21-23 September 2011

# Eighteenth Annual WAIS Workshop

Loveland, Colorado, USA Website: http://www.waisworkshop.org/ pastmeetings/workshop2011.html

# 21-24 September 2011

# Ecosystems: Understanding the Cycle AAAS Arctic Division 2011 Annual Meeting

Dillingham, Alaska, USA Website: http://www.arcticaaas.org/ meetings/2011/

# 23-24 September 2011

## ICSU Polar Science Symposium Siena, Italy Website: http://www.mna.it/english/News/ ICSU\_symposium

14-15 October 2011

# 2011 Northwest Glaciologists Meeting Portland, Oregon, USA Contact Andrew Fountain [andrew@pdx.edu]

# 24-28 October 2011

World Climate Research Programme Open Science Conference: Climate Research in Service to Society Denver, Colorado, USA Website: http://conference2011.wcrp-climate. org/ Contact the conference secretariat at [info. conf2011@wcrp-climate.org]

## 25–26 October 2011 **10th Ny-Ålesund Seminar** Kjeller, Norway Website: http://nyalesund-seminar.nilu.no/

# 27-29 October 2011

# \*\*International Glaciology Society Nordic Branch Meeting 2011

NVE, Oslo, Norway Website: http://www.nve.no/en/Water/ Hydrology/Glaciers/IGS-Nordic-Branch-Meeting-2011/

# 2-3 November 2011

Polar Simulations with the Weather and Research Forecasting Model Columbus, Ohio Website: http://polarmet.osu.edu/workshops/ pwrf\_2011/

# 7-9 November 2011

\*Ice Deformation: from the model material to ice in natural environments – Conference in honour of Paul Duval (part of the ESF project MicroDICE) Grenoble, France Website: http://microdice.eu/activities/icedeformation-from-the-model-material-topolar-ice/

# 7-9 November 2011

## Workshop: Assessing the History of the Greenland Ice Sheet through Ocean Drilling Corvallis, Oregon, USA Contact Joseph Stoner [jstoner@coas. oregonstate.edu] or Anders Carlson [acarlson@geology.wisc.edu]

# 7-11 November 2011

# Workshop: Simulation of Groundwater Flow with Freeze and Thaw

Montréal, Canada Course brochure: eps.mcgill.ca/~mckenzie/ SUTRA-Workshop-Nov7-11-2011.pdf Contact Jeff McKenzie [jeffrey.mckenzie@ mcgill.ca] or Cliff Voss [cvoss@usgs.gov]

20–27 November 2011 Advanced Workshop on the Micromorphology of Glacial Sediments School of Geography, Queen Mary University of London, London, UK Conveners: Jaap J. M. van der Meer, Simon Carr, Emrys Phillips, Mark Tarplee Contact Jaap van der Meer [j.meer@qmul.ac.uk]

#### 5–9 December 2011 American Geophysical Union Fall Meeting San Francisco, California, USA Website: http://www.agu.org/meetings/

Website: http://www.agu.org/meetings/

### 12–13 December 2011 Workshop: Ice Sheet System Model

(to coincide with software release) Pasadena, California, USA Website: http://issm.jpl.nasa.gov/ issmworkshop2011/ Contact issm@jpl.nasa.gov

# 9–12 January 2012

Nordic Geological Winter Meeting Reykjavík, Iceland Permafrost and Perglacial Processes session. Conveners: Ivar Berthling [ivar.berthling@ svt.ntnu.no] and Bernd Etzelmüller [Bernd. etzelmuller@geo.uio.no] Website: http://www.jfi.is/ngw\_2012

# 2012

10–13 January 2012 Workshop on the Dynami

# Workshop on the Dynamics and Mass Budget of Arctic Glaciers/IASC Network on Arctic Glaciology Annual Meeting

Zieleniec, Poland

Details as PDF: http://www.igsoc.org:8000/ symposia/Flyers\_etc/PolishMeetingJan2012.pdf Contact Krzysztof Migała [krzysztof.migala@ uni.wroc.pl]

# 2–3 February 2012

# 6th Alpine Ólaciology Meeting ETH Zürich, Zürich, Switzerland

Contact: Martin Lüthi [luethi@vaw.ethz.ch] or Martin Funk [funk@vaw.ethz.ch]

# 20–24 February 2012

# 2012 Ocean Sciences Meeting

Salt Lake City, Utah Website: http://www.sgmeet.com/osm2012/

# 22-27 April 2012

# IPY From Knowledge to Action Conference Montreal, Québec, Canada

Website: http://www.ipy2012montreal.ca/ index.php

# 23-26 April 2012

# Interpraevent 2012 – 12th Congress: Protection of Living Spaces from Natural Hazards

Grenoble, France Website: http://www.interpraevent2012.fr/

# 28 May-1 June 2012

# \*\*International Symposium on Seasonal Snow and Ice Lahti, Finland

Website: http://www.gastro.physics.helsinki.fi/ IGS2012/ Contact: Secretary General, International Glaciological Society

# 3–8 June 2012

# XV Glaciological Symposium: Past, Present and Future of the Cryosphere

Arkhangelsk, Russia Contact: Stanislav Kutuzov [s.kutuzov@gmail. com]

# 12–14 June 2012

26th international Forum for Research into Ice Shelf Processes (FRISP) Utö, Stockholms Archipelago, Sweden Contact: Adrian Jenkins [ajen@bas.ac.uk] Website: http://rechenknecht.natgeo.su.se/ FRISP2012

# 25–29 June 2012

# \*\*International Symposium on Glaciers and Ice Sheets in a Warming Climate

Fairbanks, Alaska, USA Website: http://glaciers.gi.alaska.edu/events/ igs2012 Contact: Secretary General, International Glaciological Society

# 25–29 June 2012

# Tenth International Conference on Permafrost Tyumen, Russia Website: http://www.ticop2012.org/

# 13–25 July 2012

# SCAR 2012: Antarctic Science and Policy Advice in a Changing World Portland, Oregon, USA Conference website available soon Contact: Andrew Fountain [andrew@pdx.edu]

# 1-5 October 2012

# \*International Symposium on Ice Core Science Giens, France

Website: http://www.ipics2012.org/

# 2013

8–13 July 2013 Joint IACS/IAMAS Conference: Air and ice – interaction processes Davos, Switzerland Contact: Charles Fierz [fierz@slf.ch]

# 2014

March–April 2014 **\*\*International Symposium on Sea Ice** Hobart, Australia Contact: Secretary General, International Glaciological Society



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# **International Glaciological Society**

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# **International Glaciological Society**

# Scott Polar Research Institute, Lensfield Road Cambridge CB2 1ER, UK

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# ICE

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