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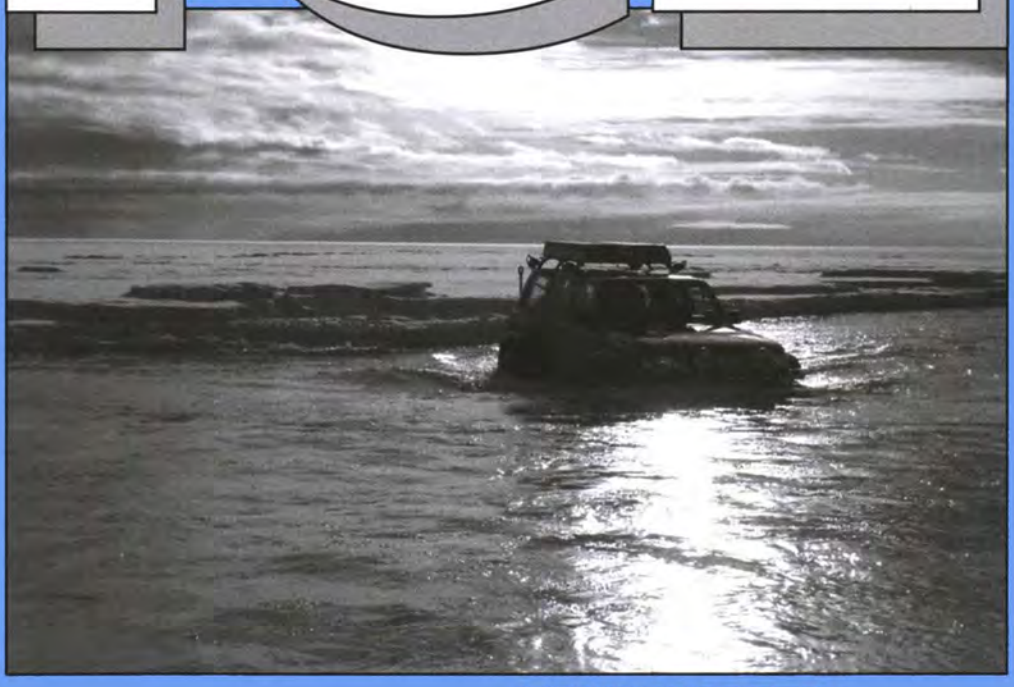
ICE



NEWS BULLETIN OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY

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Ice

News Bulletin of the International Glaciological Society

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Contents

Cover picture: Vehicles travelling on the Greenland ice cap encounter a major meltwater river. Picture taken in September, approx. 1500 m a.s.l. and 150 km from the edge of the ice cap. (Photograph by E. Kolbeinsson).

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

From the Editor

Dear IGS member

The backlog of papers waiting to be published has now been cleared. Once accepted and the relevant electronic files have been received at the IGS office, a paper should appear in the next issue of the *Journal*. So it should be out in print within three to six months of acceptance. So now it is up to you, the authors to ensure that you respond quickly to the requests made by the Scientific Editor handling your paper. The *Journal* Chief Editor has started to 'crack the whip' at the editorial process, the SEs, the reviewers and the authors themselves. The *Journal* will then be a publication where you can be confident that your work will be published in the shortest possible time.

You will notice that in this issue we do not have the regular report from an IGS correspondent. Instead we have obtained permission to publish the introductory chapter from the new book by Pudasaini and Hutter about avalanches. This chapter contains a historical overview of the development of avalanche research in the various countries of the world. We thought it would be of interest to the IGS members to have such an overview on their shelves.

Another issue I would like to address in these notes is the importance of our members supplying us with all relevant membership information. I am referring to both the contact information, i.e. an up to date address, and payment details. There is considerable movement within the glaciological community: people move from one academic institution to another and to a different research institute. We have several instances every year where the *Journal* is returned to us as the person whose name is on the address label has moved. We also have instances where members contact us and ask us why they have not received the latest *Journal* when their colleagues have done so. Usually this is because they have moved and the address information has not been updated in the IGS membership database. Thus it is very important that you send us your new contact details as soon as possible to ensure you receive our mailings promptly. Other information that must be kept up to date is your payment details. Most of you now pay by credit card and we automatically deduct your fee every year. But credit cards expire on a regular basis and for us to be able to deduct your membership fee, we must have the latest expiry dates. Also, we now must have the three-digit security code that is printed on the signature strip on the back of the card. If we do not have the security code, it is much more expensive to process the payment. Supplying this security code will become mandatory in the future. So please keep your details up to date by sending all relevant information to igsoc@igsoc.org, where Linda will receive it and process and file it in an appropriate place.

There is one more issue that I would like to mention in this 'editorial' and that is illustrations. We have been working hard at improving the quality of figures in the *Journal* and the *Annals*. And it is of the utmost importance that you supply us with your figures in the correct format. If they are line drawings we must have them in vector format and if they are raster images we must receive them in tiff or raw format. And if you have created your figure in a design platform, please send us the figures in the format you created them in. For example, if you created the figure in Photoshop, send us the original .psd files. They will contain all the relevant layer information necessary for us to produce a high-quality figure. Do NOT save the file as, for example, jpg as this will degrade the image considerably. The production team has compiled a more detailed information package for you. Please refer to the column 'Notes from the production team' later in this issue.

Finally I would like to mention that our next issue of ICE will be dedicated to our late Treasurer, John Arnfield Heap, who died 8 March 2006.

Magnús Már Magnússson
Secretary General

Special feature

Some notes on the history of snow and avalanche research in Europe, Asia and America

Contributed by:

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- S. Sokratov, Moscow, Russia

Avalanche Dynamics, a book written by Shiva P. Pudasaini (SPP) and Kolumban Hutter (KH) is presently in print at Springer Verlag. Its subtitle, *Dynamics of Rapid Flows of Dense Granular Avalanches*, provides a glimpse of introduction on the subjects that are treated in great details. Whereas the book deals with the mathematical derivation of today's most popular formulation of dense granular flows from the fundaments of physics as well as its application to the avalanching motion of debris in forms of landslides and pyroclastic flows, its initial stage has focused on dense avalanches of snow, so-called flow avalanches. For this reason the book focuses more intensely on applications to snow avalanches than landslides and pyroclastic flows.

In its first chapter, the book contains brief statements on snow and avalanche research as it has been conducted during the recent history in the most avalanche-prone countries in Europe, Asia and America. The texts are primarily written by the authors stated as contributing authors on this note. They were asked by KH and SPP for contribution, and the text below is mainly what they submitted.

It is indicated below which part each of the authors contributed. A few texts were written by us on the basis of material delivered by others, but the help and the sources used are equally indicated.

KH and SPP believe that these brief historical statements are sufficiently interesting for the members of the International Glaciological Society, that this publication in ICE is warranted. All authors have seen this version of the manuscript, which is almost identical to the corresponding part in the book. We hope the readers find this somewhat unusual paper useful.

The Swiss contribution to avalanche research

The Swiss are the pioneers in avalanche awareness, research and application in real life problems. First scientific statements related to the behaviour of snow and avalanches can be traced back to the beginning of the 18th century with work by Johann Jacob Scheuchzer, 1706. Early serious attempts aiming at a closer understanding of the physical behaviour of snow in snow cover and in motion were undertaken by the head of the Swiss Forest Inspectorate, Johann Coaz, who from 1876 until the early years of the twentieth century played an influential role in establishing a public awareness to the danger of snow avalanches in Switzerland and abroad. In 1931 the Snow and Avalanche Commission of Switzerland was formed. It soon recognised that fundamental research was required. Robert Haefeli, a geotechnical engineer and Henri Bader, a young crystallographer, started the first snow mechanical measurements in the winter of 1934/35 and continued these in the early winter of 1936 together with Edwin Bucher, a civil engineer, and a few helpers at the Weissfluhjoch, 2670 m a.s.l. This is the birth of the Swiss Federal Institute of Snow and Avalanche Research which was stationed at the Weissfluhjoch from 1936 until 1996, when it moved to its new headquarters in Davos-Dorf. Bader, Haefeli and Bucher published in 1939 their first report 'Snow and its metamorphism', which to date still remains a worthwhile reading for any snow scientist. In approximately 70 years of its history, the Institute was headed by four directors, E. Bucher (1936–1949), M. de Quervain (1950– 1979), C. Jaccard (1980–1991) and W. Ammann (1992–today). Through the years more than 250 scientists had been employed, and more than 1000 scientific memoirs and several thousand technical reports have been published. The Institute grew

from a small beginning of a handful people slowly to a considerable size of approximately 40 employees in the sixties and seventies to more than 100 full time and temporary employees at the turn of the millennium.

Researchwise, the EISLF has concentrated its activities on four different divisions:

- Weather, snow cover, and avalanches,
- Snow cover and avalanche protection,
- Snow cover and vegetation,
- Basic research on snow and ice.

In most of these specialities, lasting contributions were made. For instance, Bruno Salm, Hans-Ueli Gubler and Dieter Issler contributed essentially to the theoretical description of the mechanics of the snow cover and of dense flow and dilute powder snow avalanches as well as to the development of experimental techniques, and this activity is continued today by many PhD students and post doctoral assistants under the leadership of Perry Bartelt.

Samuel Steinemann contributed in the 1950's with his depth reaching dissertation to the creep behaviour of monocrystalline and polycrystalline ice, published in 1958. Much of this work was done concurrently with the work performed on the same subject by John Glen at Cambridge University, that would justify to rename the flow law of ice as Glen-Steinemann flow law. Furthermore, Ronald List and Bruno Federer pushed the study of the formation of hale ahead. Interestingly, the four brief, but very influential papers by A. Voellmy, published in 1955 in the *Schweizerische Bauzeitung*, are not contributions of the EISLF, as Voellmy was an engineer at the Swiss Institute of Materials Testing in Dübendorf, Switzerland. They may well be called the most influential papers on snow mechanics and motion of the twentieth century. Similarly, the early papers on flow avalanches were written by Savage-Hutter at ETH, Zürich, and the laboratory experiments by T. Scheiwiller and K. Hutter, T. Scheiwiller, F. Herrmann and S. Keller were initiated by K. Hutter at the Laboratory of Hydraulics, Hydrology and Glaciology at ETH, Zürich and B. Salm at EISLF; most early work was performed in Zürich but with close cooperation of scientists from the EISLF.

The French contribution to avalanche research

CEMAGREF (Centre National d'Etudes du Machinisme Agricole, du Génie Rural, et des Eaux et Forêts) is a French research institute focused on environmental science for sustainable management of land and water. It was created in 1981 and employs approximately 1000 persons. One of its laboratories, nowadays referred to as the Torrential Erosion, Snow and Avalanches (TESA), focuses on snow avalanches, blowing snow, debris flows, and bed load transport. Although CEMAGREF is quite a recent institute, TESA takes its roots in a long standing tradition of avalanche engineering, which dates back to the middle of the 19th century.

In 1860, after a series of catastrophic floods in the 1850s, the French government created a new department inside the powerful Forest and Water Administration (*Eaux et Forêts*): the *Restauration des Terrains en Montagne* (RTM or Restoration of Mountain Terrain), whose objective was primarily to deal with erosion and floods by covering erodible terrains with forests and dying up torrents. At the end of the 19th century, the RTM service also started trying to fight against avalanches.

In 1899, a young forest engineer, Paul Mougin, went to Switzerland, met J. Coaz, who was the head of the Swiss forest service at that time, and went back to France, full of ideas. He organised a system of field observation, including meteorological measurements (notably snowfall) and monitoring the avalanche activity in some avalanche paths. After becoming the head of the RTM service, he continued the scientific study of snow and avalanches. In 1922, he published his results on the physical characteristics of snow and proposed a simple model to compute the avalanche velocity and impact pressure: an avalanche was considered a sliding block experiencing a Coulomb force. The model was used in a few engineering applications, e.g., the cableway at the Aiguille du Midi in the Chamonix Valley.

After Mougin, research into snow and avalanches was dormant in France till 1970; the *Eaux et Forêts* administration had its own research centre, shared with the meteorological services and *Electricité de France*, but only limited work was done. In February 1970, an avalanche killed 39 people in a chalet in Val d'Isère. This catastrophe caused a deep commotion in the population, and the French government took a series of measures to avoid the occurrence of such catastrophic events. This led to the creation of an Avalanche Science laboratory of CTGREF (an applied research centre of the *Eaux et Forêts* administration, which became CEMAGREF in 1981).

One of the first engineers employed in CEMAGREF was Claude Charlier. As a forest engineer, he was mainly interested in the naturalist's knowledge of avalanches and in rational ways of studying avalanche paths. At the end of 1980s and the beginning of the 1990s, he worked with Laurent Buisson on how to translate expert rules into formal (mathematical or logical) rules that can be incorporated into a programme. Despite its interests and promising results, this research route was abandoned when Laurent Buisson left CEMAGREF in 1995.

In 1978, two engineers, Brugnot and Pochat, suggested using the analogy between snow avalanches and floods; they adapted the shallow-

flow (Saint Venant) equations to model avalanches. They faced severe mathematical issues when trying to numerically solve the depth-averaged equations of motion. One of the first theses launched in this laboratory was by Jean-Paul Vila, (now mathematics professor in Toulouse), who implemented Godunov and van Leer schemes to solve numerically the shallow-flow equations.

At the same time, another PhD student, Pierre Beghin, started conducting small-scale experiments to investigate the properties of powder-snow avalanches in the laboratory. In 1981, he provided evidence that the simplified model, proposed by the two Soviet researchers Kulikovskiy and Sveshnikova (1977) was able to provide the key characteristics of buoyancy-driven particle clouds. In the 1980s, he continued his experimental research and explored the effect of various parameters on dust-cloud dynamics. Pierre Beghin was also a great alpinist who successfully reached the summits of several Himalaya peaks above 8000 m. He tragically disappeared in 1992 when he descended the South face of the Annapurna (one of the central Himalaya peaks in Nepal), in a storm. It may also be of interest that most of this work concentrated upon air borne density currents, appropriate for powder snow avalanches rather than dense flow avalanches.

Avalanche research in Canada

The research on snow and avalanches in Canada originated when Robert F. Legget visited the Federal Institute of Snow and Avalanche Research in Switzerland in 1946. Being impressed by the work of the Institute, Legget decided that this is what Canada needs as well because Canada has more snow than Switzerland.

In 1948, when Legget had become the director of Building Research of the National Research Council of Canada, he arranged for Marcel de Quervain of the Swiss avalanche research institute to spend a year in Canada with the task of recommending activities about snow, ice and avalanche research. After touring Western Canada, de Quervain recommended that avalanche research should be carried out. In 1950, Legget created the Snow and Ice Section within the Division of Building Research. Lorne W. Gold became the section head. In 1956, the Department of Public Works of Canada requested the National Research Council to assist with the design of the avalanche control at the highway at Rogers Pass in British Columbia. The Snow and Ice Section, which previously had carried out only studies on snow and ice, made available weather instruments and snow observation equipment and in 1957 added to his staff Peter Schaerer for the avalanche studies.

Besides designing the avalanche control for the Trans Canada Highway at Rogers Pass, Schaerer analysed the weather and snow conditions that produced the avalanches. The avalanche research was dormant after the completion of the Rogers Pass highway in 1962. Schaerer was engaged with highway engineering and with research on the control of snow and ice on roads.

In 1966, Robert Legget, recognising a future demand for information on avalanches, decided that Peter Schaerer should resume the avalanche studies. Consequently, in September 1966, Schaerer began a new avalanche research program. The research objective was to develop information that has application with locating and designing engineered avalanche control. The studies included:

- Observations of the speed of avalanches,
- Observations of the mass of avalanches and determining the volume of a design avalanche,
- Observations of avalanche impact pressures on load cells in avalanche paths,
- Correlation of avalanche frequencies with features of the terrain,
- Variation with elevation of the maximum amount of snow on the ground.

Rogers Pass in the Selkirk Mountains became the outdoor laboratory of avalanche research. The avalanche research staff of the National Research Council initially comprised of a research officer, a full-time technician and two temporary technicians during the winter. Lorne Gold with headquarters in Ottawa was the supervisor. The administration of Glacier National Park, where Rogers Pass is located, made available accommodation, office space and technical support.

In 1975, Tony Salway, who was a geophysicist, joined the staff as a temporary research associate. His principal duty was to develop the equipment for measuring avalanche impact pressures and to analyse the observations. When the term of Salway's employment expired in 1979, David McClung, also a geophysicist, obtained the position. He was appointed to a regular research officer later.

The avalanche research program of the National Research Council ended in March 1991 when the Government of Canada reduced funds and the Research Council reassigned its priorities. The avalanche research officers and the technicians were laid off. Peter Schaerer retired, and David McClung obtained a teaching and research position in the Geography Department of the University of British Columbia at Vancouver.

In 1998, McClung secured a chair for avalanche research at the University with the support of the Government of British Columbia and CMH Heli Skiing. His research includes fracture mechanics of the start of avalanches, dynamics of avalanches, and the prevention of avalanche damage in forests.

In 1989, Colin Johnston at the Department of Civil Engineering of the University of Calgary

began an avalanche research project in collaboration with Mike Wiegele Helicopter Skiing at Blue River in British Columbia. The National Sciences and Engineering Research Council gave financial support. Bruce Jamieson was in charge of the field work and the analysis of data. The research concentrated on the stability of snowpacks including studies of the strength of weak layers, the development of stability tests, fracture propagation and the spatial distribution of snowpack weakness. Colin Johnston has retired and now the project runs under the designation Applied Snow and Avalanche Research of the University of Calgary under Bruce Jamieson with financial support of the ski industry and governments. Field observations take place at Blue River and at Rogers Pass.

In summary, the National Research Council of Canada carried out avalanche research from 1948 until 1991. The University of British Columbia (David McClung) and the University of Calgary (Bruce Jamieson) equally continue the research. In addition, the following agencies are engaged with avalanche observations, public warnings and education:

- Canadian Avalanche Center with headquarters at Revelstoke,
- National Parks of Canada,
- Ministry of Transportation of British Columbia,
- Canadian Avalanche Foundation (a funding agency).

The Norwegian contribution to avalanche research

Avalanches may occur at any altitude in Norway, right down to the sea level along the fjords with their high, steep slopes. In many areas, especially along the west coast, safe ground for settlements is very scarce, and avalanches have claimed 20 lives per year on average over three centuries. This was brought to public attention by Arthur Klabo's book *Farlige fjell* (*Dangerous Mountains*) in 1942. After World War II, Gunnar Ramsli was commissioned by the state as a consultant to counties, communes and the Road Authorities to help them plan mitigative measures; in 1951, he also issued a popular booklet *Snø og snøskred* (*Snow and SnowAvalanches*). Somewhat later, Knut Wold, a hydrologist, began to systematically collect data on snow depth and snow water equivalent on behalf of the National Water and Electricity Board.

Several tragic avalanche accidents between 1968 and 1972, where locals, workers, ski tourists and rescuers lost their lives, aroused the emotions of the public.The Parliament passed a resolution to initiate snow and snow avalanche research in Norway. The Norwegian Geotechnical Institute (NGI), a non-profit foundation in Oslo active in geotechnical research and consulting, was chosen as the host institution in January 1973. The newly formed group, headed by Karstein Lied, soon set up a snow research field at Fonnbu near Stryn, western Norway.

Besides the classical types of measurement, loads on poles and snow bridges due to snow creep and gliding were systematically investigated. As one of the first activities, data on extreme avalanches in all of Norway were collected. Analysis of these data led Lied, Bakkehøi and others to the still widely used α–β model. It is a statistical correlation between the run-out angle α (measured from the fracture crown to the toe of the deposit) and the mean inclination angle β of the avalanche track from the crown to the beginning of the run-out zone. It captures the observation that, for a given fall height, fast avalanches with steep tracks generally have a shorter run-out than slower avalanches on more gentle slopes.

In the early 1980s, the full-scale avalanche test site Ryggfonn was established in Grasdalen near Fonnbu. Dynamic loads were measured at a high steel pylon (with internal strain gauges), a concrete wedge (instrumented with load plates) and on cables across the width of the path. A 16 m high and 100 m wide dam is a unique feature of this test site. The equipment has changed over time, partly in response to destructive avalanche events, and has been extended in 2004 by a Doppler and a profiling radar system for measuring internal velocity spectra, flow depths, velocity profiles and erosion rates. From the data, various formulae for dimensioning structures have been derived. The measurements also led the formulation of two avalanche dynamics models based on different approaches to the granular nature of snow avalanches: The PLK model by the American Perla, Lied and Kristensen simulates the avalanche as a collection of mini-avalanches (each of them described by the PCM (Perla-Cheng-McClung) model, which is similar to the Voellmy-Salm model) with stochastic interaction among each other. It is presently the most often used model for consulting in America. Harald Norem, Fridtjov Irgens and Bonsak Schieldrop, NIS, specialised the rheology of a Criminale-Ericksen-Filbey fluid to snow avalanches that may exhibit both granular and viscoplastic behaviour and implemented it in the NIS (Norem-Irgens-Schieldrop) model, routinely used for consulting by NGI.

The 1990s have seen continued full-scale measurements, refinements of the existing models, studies of the interaction of avalanches with deflecting dams, improved hazard mapping and risk analysis techniques, and many studies of slush avalanches. Since 2000, research on avalanches and other gravitational mass movements both on land and in the water has been coordinated and intensified in intense collaboration with other European institutes. In particular, more detailed measurements at

Ryggfonn and extensions and an improved implementation of the NIS model are at the centre of the activities up to 2005.

The Austrian contribution to avalanche research

First attempts of avalanche research in Austria began with the construction and erection of protective shelters at the western ramp of the Arlberg railway track in 1880–1884 by Vincenz Pollak. He may justly be regarded as the founder of avalanche research in Austria. However, an official bureau was only established after the World War II by the Innsbruck branch of the Torrent and Avalanche Control Office in the Wattener Lizum. Its duties were research on the prevention of avalanches.

In the aftermath of the avalanche catastrophes of 1951 and 1954, with a total of 271 deaths, it was realized that roughly two-third of all avalanches were released below the timber line. The research office was moved to Obergurgl in the Ötz Valley at 2000 m a.s.l. Research concentrated then on methods of forestation at high altitudes, which should replace classical expensive protective measures (of structural engineering). In 1963 this research office was incorporated as an external station for subalpine forest research into the Federal Forest Institute (Forstliche Bundes Versuchsanstalt, FBVA) in Vienna, and later, in 1966, it became part of the Forest Engineering Service in Torrent and Avalanche Control (Institute für Wildbach- und Lawinenverbauung). Increasing urbanisation in the alpine valleys and the accompanied demand for the necessary infrastructure led in the 70s of the last century to extraordinary protective measures. Financial restraints demanded a close cooperation with the Swiss Federal Institute of Snow and Avalanche Research at the Weissfluhjoch, Davos, with emphasis on structural-geotechnical problems. In 1975 Fritsche, Aulitzky and Rabofsky critically analysed the state of the art of avalanche research in Austria and drew attention to its unsatisfactory conditions, thus vehemently requesting the foundation of an institute exclusively devoted to avalanche research.

However, the time was not yet ripe; research was still done by individuals. Hoinkes and Ambach at the University in Innsbruck, Fritsche at the Technical University in Graz and Aulitzky at the Institute of Torrent and Avalanche Control at the 'University of Natural Resources and Applied Life Sciences' (Universität für Bodenkultur) in Vienna all contributed to avalanche related problems. Moreover, Lackinger at the University of Innsbruck contributed to glide avalanches and foundation problems and Slupetzky at the University of Salzburg contributed successfully for over two decades to the analysis of avalanche casualties.

The avalanche catastrophes in 1974 and 1981, finally, led to the foundation in 1985 of the Avalanche Institute at the Federal Forest Institute in Innsbruck. It was merged in 1995 with the Institute for Torrent Studies and then renamed Institute for Avalanche and Torrent Studies.

Avalanche research at the Innsbruck office of the Federal Forest Institute since 1985 includes national and international projects related to avalanche dynamics, avalanche forecasts and avalanche formation within forests, forest ecology and afforestation in the subalpine regime, risk analysis of landslides, rockfalls, debris flows, mud flows, floods and avalanches. Of particular interest is the initiation in 1992 and subsequent development of a mathematical–numerical model for the hindcast and forecast of the dynamics of mixed avalanches, comprising of a bottom layer for a dense granular flow overlaid by a particle-laden turbulent flow of air, the powder avalanche, atop of the dense particle flow, see Zwinger and Zwinger *et al.* The software of this coupled Savage-Hutter and powder avalanche model called SAMOS (Snow Avalanche MOdelling and Simulation) allows determination of avalanche geometry and velocities along the concomitantly determined track.

The Japanese contribution to avalanche research

Scientific snow avalanche research in Japan was started by Mikio Shoda from the Railway Technical Research Institute. He released avalanches artificially on a test slope in Niigata and measured front velocities and impact forces on structures from 1959 to 1962. After his pioneering work, avalanche studies were executed mainly under the leadership of the Institute of Low Temperature Science (ILTS), Hokkaido University, which was founded in 1941.

Eizi Akitaya conducted a series of experiments on depth hoar in a cold laboratory in 1975 and quantitatively revealed the growth conditions of skeleton type and solid type snow. The quick growth of depth-hoar crystals near the snow surface was investigated by Takuya Fukuzawa and Eizi Akitaya in 1993. They found that depth-hoar was formed under clear skies after a thin deposition of new snow on denser snow, and obtained the relationship between the growth rate and the temperature gradient both in the laboratory and the field. In 2001 Akihiro Hachikubo and Eizi Akitaya measured vapour sublimation rates and meteorological conditions in the fields, and discussed the effect of wind on the growth of surface-hoar.

Avalanche observation was made in the Kurobe Canyon by a joint group from Toyama University and ILTS from 1972 to 78. The test site is in the North Japanese Alps and has been known as a district of frequent large-scale powder snow avalanches, which have been named 'Hou'

in the local dialect. Observations were made in the Shiai-dani area to discover the overall features and dynamics of this avalanche type (see Shimizu and Huzioka).

In January 1985, an avalanche broke out at Gongen-dake, Maseguchi, Niigata; it was so large that it killed 13 people and destroyed more than ten houses. After the disaster, Japanese avalanche researchers organised a systematic project of snow avalanche observations in the Shiai-dani area in 1987. Velocities in the snow cloud were measured with an ultra-sonic anemometer. Velocities of the lower flowing layer were calculated by differencing measurement of impact pressure, see Nishimura *et al.*, Nishimura and Ito, 1997).

Physical properties of fluidised snow were investigated by Norikazu Maeno and Kouichi Nishimura from ILTS with experiments of a fluidised bed of snow and the chute system set in a cold laboratory, from 1978 to 1996. They revealed that shear stresses are linearly proportional to the shear rate in a lower shear rate region and shear stresses depend on the square of the shear rate in the higher shear rate region. A strong increase of the viscosity coefficients with the density was also observed. In 1987 Tsutomu Nakamura from the National Research Centre for Disaster Prevention in Shinjo constructed a 20 m out door chute and measured the impact forces by snow blocks with speeds of about 12 ms^{-1}.

Based on the above observations and experiments, several avalanche models were proposed. In 1989 Yasuaki Nohguchi from the Nagaoka Institute of Snow and Ice Studies derived a three-dimensional model for the motion of the centre of mass of an avalanche on a surface of arbitrary configuration No89. Norikazu Maeno and Kouichi Nishimura (1989) considered the snow entrainment and viscous resistance in the prediction of the motion of this center-of-mass model. Fukushima described the suspension layer of a powder snow avalanche with his quasi two-dimensional block model in 1990.

In 1995, Kouichi Nishimura and Yasuaki Nohguchi started ping-pong ball avalanche experiments at the Miyanomori ski jump in Sapporo to study three-dimensional granular flows. Up to 550,000 balls were released near the top of the landing slope. Ping-pong balls are particularly suitable, since they reach the terminal velocity in only a few meters, so fully developed flows occur even on relatively short slopes. The aim of these experiments is to elucidate the dynamics of two-phase granular flows rather than to directly extrapolate the results to dense snow avalanches. The experiments provided detailed data and insights on the physically significant dynamical processes controlling avalanches. This work was carried out with the help of Stefan Keller from ETH, Zürich and James McElwaine from Cambridge University.

Avalanche research in Iceland

Snow avalanches and landslides have caused many catastrophic accidents and severe economic damage in Iceland since the country was settled in the ninth century. Avalanche problems are relevant to most populated areas of the country, although they are by far most serious in the north-western, northern and eastern coastal regions.

The pioneering work of Ólafur Jónsson in 1957, which was updated in 1992, lists avalanches reported in annals and other sources since the twelfth century. Avalanches and landslides have killed 194 people in Iceland since 1901 and the direct economic damage due to avalanches and landslides in the period between 1974 and 2000 has been estimated as about US$40 million.

Apart from the work of Ólafur Jónsson, snow avalanches were not seriously considered as a natural hazard in Iceland until a catastrophic avalanche occurred in Neskaupstaður in eastern Iceland in 1974, which killed 12 people. During the next several years following this accident a few studies of the avalanche hazard situation in Iceland were conducted, including a short report, from a visit by Marcel R. de Quervain in 1975, head of the SLF in Davos at the time, and preliminary suggestions for protection measures for Neskaupstaður written in 1976 by Karstein Lied and Steinar Bakkehøi at NGI in Oslo.

Somewhat later, Erik Hestnes, also at NGI, made a short report about the snow avalanche hazard situation in several villages in western and north-western Iceland. Furthermore, civil defence authorities in Neskaupstaður and at the national level conducted some studies of snow avalanche hazard after the Neskaupstaður accident.

These studies did not lead to significant actions, neither in terms of improved safety measures nor much scientific research of snow avalanches in Iceland. This situation did not change until 1995, when two catastrophic avalanches in the villages of Súðavík and Flateyri in north-western Iceland killed 34 people and caused extensive economic damage. These two accidents totally changed the view of the public and the political system regarding avalanche safety in Iceland.

Following the accidents in 1995, the law regarding snow avalanche and landslide hazard was changed and the Icelandic Meteorological Office was given the responsibility for issuing avalanche warnings for settlements and ordering evacuations together with local civil defence authorities. The office was also made responsible for hazard zoning for areas at risk, it advises the government regarding the buildup of protection measures, and conducts scientific research on avalanches. Most avalanche research in Iceland since 1995 has been directly connected with the aftermath of the accidents at Súðavík and Flateyri.

Avalanche hazard zoning methods based on individual risk were developed at the University of Iceland and at the Icelandic Meteorological Office, utilising among other things dynamical and statistical studies of the run-out of avalanches. Studies of the run-out of Icelandic avalanches included a calibration of the Norwegian α–β model using a data set of avalanches with the longest run-out in the respective paths. New regulations about hazard zoning of settlements based on individual risk were formalised by The Ministry for the Environment. Since then hazard maps have been made for 14 villages. The regulations specify acceptable risk in terms of the annual probability for an individual of being killed in an avalanche accident.

In the year following the accidents in 1995, an overview study was made of the avalanche situation and the need for avalanche protection measures in Iceland. Based on this study, the Icelandic government drew up a 10 year plan to construct avalanche protection measures for hazard areas and/or to purchase endangered property in order to reduce the death toll and the economic damage caused by avalanches. Laboratory experiments with avalanches of granular materials in scale models were carried out in order to study the dynamics of snow avalanches that hit obstacles, such as breaking mounds, catching dams and deflecting dams These experiments led to the realisation that discontinuities or shocks in the flow depth and velocity are an important, but often ignored, aspect of the interaction of snow avalanches with obstacles such as protection dams. An evaluation of the effectiveness of such protection measures cannot be made except by properly considering this aspect of the dynamics.

Avalanches that hit the dams constructed in Iceland since 1995 are closely monitored in order to obtain much needed field data about the effectiveness of these structures. A total of 11 avalanches have since 1999 hit 6 deflecting dams and deflecting wedges in north-western and northern Iceland. The avalanches have in all cases been successfully diverted away from the settlements. It should, however, be noted that none of these avalanches have been nearly as large as the design avalanches of the dams, so a full-scale test of the effectiveness of the dams has yet to be made. In some of these cases, observations indicate that the impact with the dam channelled a part of the width of the avalanche into a stream along the dam where the thickness of the flow seems to have increased with respect to the undisturbed flow farther away from the dam side, in a similar way as seen in the above mentioned laboratory experiments. In many or most cases, detailed observations of avalanches that hit dams are difficult because the avalanches fall during snow storms and much of the evidence about run-up on the dam sides and even the outlines of the avalanches are partly obscured by snowfall after the avalanche and by snow drift. A CW-Doppler was recently installed on the deflecting dam at Flateyri by the Icelandic Meteorological Office in collaboration with avalanche research institutes in other European countries in order to study the flow of avalanches that hit the dam more closely.

In summary, a large effort has been made in Iceland during the last 10 years to build up avalanche research, establish an avalanche warning service, to construct protection measures and implement other safety measures such as relocating settlements at risk. Much work remains to be done, however, before a satisfactory safety situation is achieved, as is evidenced by two relatively serious avalanche cycles in north-western and northern Iceland in 2004 and 2005, which led to the loss of one life and caused a significant damage of property.

The Soviet/Russian contribution to avalanche research

First serious studies of snow avalanches in the Russian territory started in the 19th century and were initiated for, and related to, the transportation on road and by rail through the Caucasus Ridge. Avalanche danger and meteorological conditions along the 'Military-Georgian Road' were estimated and started to be published in 'The Caucasian Calendar' in 1852. The avalanche map along this road – the first of its kind in Russia – was prepared by B. N. Statkovskii who also participated in building the first Russian snow protection constructions. The investigations were finalised at the beginning of the 20th century by the appearance of the railroad around the Caucasus Ridge along the Black Sea coast.

This provisional end was actually only an intermission; indeed, avalanche research was re-launched and rehabilitated in the thirties of the 20th century due to the revitalisation of the idea of the construction of a railroad through the Caucasus Ridge. G. G. Saatchan, A. G. Goff and G. F. Otten applied equipment and experimental methods from soil mechanics to the study of the mechanical properties of snow. For the first time, the pressure exerted by a moving snow avalanche on an obstacle was measured by mechanical sensors. They also developed methods of determination of some mechanical properties of snow. The results of the studies led to schemes of estimations of avalanche velocities and avalanche pressures on obstacles, published in the first *Soviet Handbook on Snow and Avalanche Research*. Almost simultaneously, another centre of snow and avalanche research was founded in the Khibiny Mountains (Kirovsk) by the apatite mining industry, (The APATITE mining company's snow avalanche department has been active in

avalanche research until today). Here, I. K. Zelenoi organised the Snow Meteorological Service and the first Snow Avalanche Station in the Soviet Union. The scientific research efforts resulted in the construction of a forecast method of the time of avalanche danger, the first of its kind in the history of snow and avalanche research. With their experiments A. G. Goff and G. F. Otten obtained records of the temporal evolution of the pressure on an obstacle that was subjected to an avalanche. Some of the protective constructions designed by them were unique worldwide. Artificial snow avalanches, released by detonations from artillery shells, were also used; they led to a detailed account of the basis of avalanche release phenomena.

The growing industrial development in mountainous regions after World War II, enlarged avalanche research activities in various regions of the Soviet Union. Results on investigations of snow avalanche research by G. K. Tushinskii at the mountain passes of the Caucasus, published in 1949, belong to these as do the numerous investigations on thermodynamic and mechanical properties of snow and avalanche dynamics in the Elbrus region by Sulakvelidse.

In the late fifties of the 20th century the institutions dealing with the observation and physical description of snow avalanches in the territory of the Soviet Union were subordinated to the State Committee of Hydrometeorology and Environmental Control. The meteorological centre of snow avalanche observations and forecast was concentrated in the Central Asian V. A. Bugaev-Hydro-Meteorological Research Institute (SANIGMI) in Tashkent; it subsequently collected information on avalanche events from all Snow Avalanche Stations in the Soviet Union. SANIGMI was responsible for the development of a theoretical basis and of applied methods of snow avalanche forecast. The Laboratory of Snow Avalanches and Mudflows (LSAM), at the Faculty of Geography, Moscow State University, became the centre of developing methods of grading and mapping avalanche danger, and studying mechanical and thermodynamical properties of snow and their spatial and temporal variability. K. F. Voitkovskii, E. S. Troshkina and V. N. Golubev are today's representatives of this research.

The sixties to eighties of the 20th century were characterised in the Soviet Union by a focus of snow and avalanche research on experimental studies and mathematical modelling of snow stability on slopes, dynamics of dense, powdery and slush avalanches and their interaction with the underlying slopes and obstacles. Principal investigators are S. S. Grigoryan, M. E. Eglit, A. N. Bozhinskii and K. S. Losev,

The peak of snow avalanche research in the Soviet Union had been reached at the end of the eighties in the 20th century. From 1984 until 1991 twenty volumes of snow avalanches of the USSR were published. About 40 institutions of the State Hydro-Meteorological Service maintained snow avalanche departments in various regions of the country. Such intensive concentration resulted in several monographs entirely related to avalanche research.

Since the foundation of the Russian Federation recent activities on snow avalanche research are primarily concentrated at the Moscow State University and in the Snow Avalanche Department of the APATITE mining company. Nevertheless, some of the institutions that were actively involved in avalanche studies during the Soviet times are still active now as institutions of their own countries. These include SANIGMI in Uzbekistan, the Institute of Geography of the Kazakh Academy of Sciences and others.

The history of avalanche research in the USA

The history of avalanche research in the United States is the story of the frontier west and the practical need to defend against avalanches. Hence – it is also the story of a community of dedicated, practical avalanche professionals working closely and cooperatively with a cadre of avalanche scientists and research engineers.

Avalanches and the need to reduce their hazard to life and property began in the US with the western mining boom of the 1800s. As a consequence, by the late 1800s miners in the San Juan mountains of Colorado were already protecting their surface facilities with avalanche barriers and splitters.

Year-round mountain communities and attendant transportation needs flourished in the post-World War II era, as isolated mining and ranching communities began to grow, and winter recreation, especially ski resort development, began in earnest. During this time systematic avalanche research began to address the growing need for understanding avalanches and reducing their hazard.

Avalanche research activities took root during this time at Alta, Utah; where Monty Atwater was hired as a snow ranger by the US Forest Service. As a 10th Mountain Division veteran of the European war, he quickly put his skills and experience to work on the avalanche problems at Alta, instituting a rigorous avalanche forecasting program, and utilising explosives and artillery for avalanche mitigation work. With Alta as the model, other Forest Service snow rangers began address their own local problems in a systematic way in places like Berthoud Pass, Colorado; and the passes of Washington's Cascade range.

In 1949, the Forest Service brought Swiss avalanche expert Andre Roch to the US to tour the most avalanche-prone areas and to provide advice and expertise. In addition, the Forest Service started the Alta Avalanche School, which

grew into what is, today, the National Avalanche School. These early schools became a focal point for the exchange of information between practitioners and scientists of the time. In the 1950s, Ed LaChapelle joined Atwater in Alta, and with the later addition of Ron Perla, a formidable research team was assembled in Alta to investigate a wide range of avalanche problems.

At this same time, avalanche research was also taking hold in other locations around the country. The US Army's Snow, Ice and Permafrost Research Establishment (SIPRE), which was to become the US Army Cold Regions Research and Engineering Lab (CRREL) in Hanover, New Hampshire, had a mission to provide support for the US military and civilian needs. They imported European avalanche researchers and engineers, mainly from the Swiss Federal Institute for Snow and Avalanche Research, and translated their knowledge and experience into monograms for both military and public consumption.

Avalanche research also took hold at Montana State University (MSU) in Bozeman. The research of Charles Bradley and John Montagne, both 10th Mountain Division veterans like Atwater, grew out of practical needs; Bradley had some close calls with avalanches, and Montagne was the ski patrol leader for Bridger Bowl, which was expanding up the mountain and into significant avalanche terrain. Bradley's work focused on depth hoar and snowpack structure. He developed the *resistograph* to investigate these problems, an instrument which has seen many improvements and continues to be refined today. Montagne's work focused on studying and mitigating the dangerous cornices overhanging Bridger Bowl. In time, they enlisted the help of the MSU civil engineering department in their work, launching the notable contributions of Ted Lang and Bob Brown, and later their students Ed Adams, Rand Decker and Jimmy Dent, among others. Lang and Brown's pioneering work on snow microstructure and metamorphism has been integrated into the latest snowpack evolution models.

By the late 1960s, realignment in the Forest Service resulted in the transfer of the duties of the Alta Avalanche Study Centre to the Forest Service's Rocky Mountain Research Station in Fort Collins, Colorado. Perla left for work in Canada, while LaChapelle began a successful academic career at the University of Washington, where he mentored students like Dave McClung, Sam Colbeck, Sue Ferguson, and Mark Moore. A new Forest Service research team emerged in Colorado, led by Pete Martinelli, it included Art Judson, Dick Sommerfeld, and R. A. Schmidt. They expanded the facilities at Berthoud Pass, and began investigating a variety of avalanche and snow problems. They also saw the need to address the growing demand for public awareness, and avalanche information and forecasts; and in the early 1970s founded the Colorado Avalanche Warning Centre under the direction of Knox Williams.

Also in the early 1970s, the San Juan research project was launched on Red Mountain Pass in Colorado in a cooperative effort between Jack Ives at the University of Colorado and LaChapelle at the University of Washington. Led by Richard Armstrong, the project aimed to improve understanding and forecasting of avalanches along this hazardous mountain highway. The research team investigated snow metamorphism, the role of snow structure in avalanche release, and statistical techniques of avalanche forecasting, amongst other important and practical issues.

In the 1980s the Forest Service began to scale back its support for avalanche research, cutting the program at the Rocky Mountain Research Station in Colorado. In addition, they had already begun transferring much of the snow ranger program and responsibility for avalanche mitigation to individual ski areas and departments of transportation. At the same time, increasing demand for avalanche information for a growing backcountry recreational population led to increasing numbers of regional avalanche centres; providing awareness, education and *real-time* avalanche forecasts to the public. These centres were mostly staffed by the Forest Service, with the exception of the Colorado centre, which became an activity supported by Colorado's state government.

Today's Forest Service National Avalanche Centre, led by Doug Abromeit and Karl Birkeland supports a number of separate regional avalanche forecast centres across the country and in Alaska with coordination and modest amounts of research, funded by competitive grants from the National Science Foundation (NSF). This research work is primarily in the practical field of snowpack spatial variability. The National Avalanche Centre also continues to coordinate the on-going use of surplus military weapons by ski areas and highway departments in their efforts to control avalanches.

Today, avalanche research in the US has become more de-centralised, with research taking place at a number of different institutions and universities, including those in Arizona, California, Colorado, Montana, New Hampshire, Oregon, Utah, Washington and Wyoming. Despite this dispersed nature of avalanche research in the US, practitioners and scientists still gather with their colleagues from Canada and around the world at the biennial meetings of the International Snow Science Workshops (ISSW). The ISSW's are valuable gatherings that provide for information exchange and catalyse avalanche research activities in North America. As in the past, the ISSW is founded on and serves to connect today's avalanche researchers with the on-going, practical needs of the avalanche hazard reduction community working in the field.

International Glaciological Society

A REPORT FROM THE DUNEDIN SYMPOSIUM

5–9 December 2005, University of Otago, Dunedin, New Zealand

Sea ice, sunshine, and scenery. These were compelling reasons to travel to Dunedin, New Zealand in December 2005 for the International Glaciological Society's International Symposium on Sea Ice. The sunshine and scenery began with the ride from the airport to the University of Otago. There were cerulean skies, endless verdant hillsides and a profusion of flowers in bloom. A marvellous sight for eyes accustomed to Northern Hemisphere winter.

The symposium offered a range of housing opportunities including the dormitory of St Margaret's College. The highlight of dorm life was a delicious buffet breakfast in a dining hall whose massive wooden tables and chairs had more than a hint of Hogwarts. There is always something rejuvenating about staying in a dorm that hearkens back to those undergraduate days. Reminiscing was natural since it was graduation week and the campus abounded with caps and gowns and happy families.

Figure 1. 56 posters were on display throughout the week

The symposium was a four and a half day festival of sea ice. There were 96 oral presentations and 56 posters covering the Arctic and the Antarctic; sea ice mechanics and thermodynamics; optics and biology; morphology and evolution; as well as field experiments, laboratory studies, remote sensing observations, and modeling results. There were plenary, parallel, and poster sessions. The adroit timing of the speakers and the session chairs allowed easy shuttling between the two auditoriums during the parallel sessions. For more details on the science of the conference, get *Annals of Glaciology* Volume 44 – it will bring you up to date on the latest in sea ice research.

Figure 2. 96 oral presentations were given

Of course, a symposium is the aggregate of all activities; the formal presentations, the sidebar meetings, the impromptu hallway discussions, conversations over beer or coffee and, not least, the social events. The sea ice symposium was outstanding on all fronts.

The first social event was cocktails and hors d'oeuvres at the Otago Museum on Monday night. It was an excellent opportunity to catch up with old friends and talk science. There were many stories of past field experiments, where the sleds get heavier, the snow deeper, the wind stronger and the temperatures colder with the passage of time. In contrast to the tall tales of polar deprivation were the elegant galleries of the Otago Museum. There are fascinating collections on the flora, fauna and geology of New Zealand. One of my favourites was the royal albatross, the 747 of birds, with a huge 3.5 m wing span. There are extensive and informative exhibits on the traditions and cultures of the Pacific Islands. The exhibit ranges far beyond New Zealand to explore

Figure 3. The Ice Breaker was held in the Otago museum and was attended by some local inhabitants

the people of Papua New Guinea, Fiji, Easter Island and Hawaii. A highlight of the exhibit is a 2-m-tall Moai statue from Easter Island made from dense, difficult to carve volcanic stone.

After two and a half days the 200 attendees had an ample helping of sea ice, with an abundance of excellent presentations and posters. By Wednesday afternoon we were ready for more sunshine and scenery. The afternoon tours did not disappoint.

Boxed lunches in hand, our group piled on to the bus ready for a field trip. The first stop was the beach; a spectacular beach with azure skies and aquamarine water, where a giant's marbles were scattered about.

Figure 4. The Moeraki boulders

These were the Moeraki boulders, round stones 1–3 m in diameter. Maori legend has them as gourds from a great voyaging canoe. Geologists explain them as septerian concretions of calcium, carbonates and other minerals that formed about 65 million years ago. One could ponder the confluence of geological processes responsible for the boulders, or jump from boulder to boulder playing tag and trying not to get wet in the waves. Truth be told our group resembled a first grade class more than a group of distinguished glaciologists. And like a first grade class it was difficult to get everyone back on the bus.

Our next stop was the village of Macrae's Flat where the ladies of Macrae's Moonlight School had prepared an extraordinary afternoon tea for us. This organization is devoted to serving the educational needs of the students of the community. There was a cornucopia of small sandwiches, petit fours and individually customized cookies. Each item looked sumptuous and tasted delicious. You could eat a dozen cookies and never repeat yourself. This hypothesis was experimentally tested and confirmed by numerous dedicated glaciologists. Complementing the comestibles was a wide selection of coffees and teas.

After an all too brief stay, it was back to the bus for a quick trip to OceanaGold in Macrae's Flat to see the largest gold mine in New Zealand. The scale was beyond comprehension. It wasn't toy trucks in a sandbox but house-sized vehicles in an open pit hundreds of meters deep. Finding gold means moving a lot of ore. The signal to noise ratio in gold mining is one teaspoon of gold in 32 tons of ore. By the standards of a scientific instrument this is abysmal. By gold mining standards this is profits of tens of millions of NZ dollars per year. After seeing the factory where gold is extracted from the ore, it was back on the bus once again.

In a scene from an action adventure movie, the bus raced against time to Pukerangi and our rendezvous with the Taieri Gorge Limited train. We arrived just as the departure whistle was blowing. Once under way the adventure continued, as the train twisted and turned through the narrow, steep, and dazzling Taieri Gorge. We saw verdant hillsides and precipitous chasms as we crossed vertiginous iron viaducts and raced through stone tunnels hewn by hand through mountains, gradually descending towards the Taieri River far below.

All too soon the train rolled into Dunedin Railway Station ending a marvellous afternoon. It was a short walk from the train station back to the University of Otago. But it was even a shorter walk to Speights Ale House, a perfect spot to end the day with a bit of rehydration and some conviviality and camaraderie.

The tours were the penultimate social event of the symposium. The grand finale was the conference banquet held on Thursday night at Larnach Castle. Following the afternoon sessions, the buses left the University of Otago, travelled

through the outskirts of Dunedin and began to climb up and up a winding road until reaching the top and the Castle Larnach. The distant view was spectacular, a grand vista encompassing Dunedin, the Otago peninsula, the harbour and the Pacific Ocean. Up close were the soaring presence of the castle and spacious surrounding flower gardens. Inside, tables covered with glasses of champagne awaited us to kick off a social hour of conversation and exploration.

Figure 5. The delegates were met at the Larnach Castle by a Scottish piper in full regalia

The castle has the finest of everything; stone, marble, wood, tile and glass. The craftsmanship of the panelling and the inlaid floors is exquisite and the cut glass of the chandeliers sparkled in the evening night. It seemed like a wee bit of Scottish royalty magically transported to New Zealand. The historical exhibits expounded on the magnificence of the castle and the achievements of the Larnach family. But there is also a dark side, with tales of conspiracy, skullduggery and melodrama worthy of Shakespeare; and of ghosts that still haunt the hallways.

Dinner was served in the grand ballroom, a large open room framed by wooden arches, with doors opening to the patio and formal gardens. The room was quickly filled with the happy buzz of dozens of conversations as we sat and began to eat. We had it all, fine cuisine, a magnificent setting, and warm camaraderie. What could be better? The question was answered by the blare of bagpipes and a procession of armed Highlanders marching into the ballroom. Was this an attack by

Figure 6. Banquet in the ballroom at Larnach Castle

a rival clan? Not to worry. At the head of the invading column, clad in kilt and full Highland regalia, was none other than our own Secretary General Magnús Magnússon. This was no invasion, rather it was the presentation of the haggis. A wild-looking, long-haired spectre straight from the movie *Braveheart* stepped forward and in a rich, penetrating tenor recited Robert Burns's 'Address to the Haggis'. We were transported to another place and another time; Scotland in the 1800s. It was a magical moment in a delightful evening.

As dinner drew to a close, there were addresses to the audience as well as the haggis and many heartfelt thanks to Pat Langhorne and Vernon Squire for their superb job in organizing the conference.

Figure 7. The refreshments provided were fabulous, culminating on the last day

AN 'INTERVIEW' WITH A DUNEDIN SEA-ICE SYMPOSIUM PARTICIPANT

5–9 December 2005, University of Otago, Dunedin, New Zealand

Interview with Sam T. Cold-Ridge on the 207th anniversary of the composition of:
The Rime of the Ancient Mariner

IGS. You recently returned from New Zealand where, I understand, you attended a wedding. Is this wedding experience what gave you the beginning of your poem, where you say: 'The Bridegroom's doors are opened wide, And I am next of kin; The guests are met, the feast is set: May'st hear the merry din'?

STC. No, no, it was a conference on the science of sea ice that I visited in New Zealand, at a city called Dunedin, at the University of Otago. Well, these conferences are part of a long tradition that the organising society, the IGS, hosts once or twice a year. I got the idea of a wedding banquet while I was attending the 'symposium banquet' held at Castle Larnoch on the fourth day of the symposium. I figured the public just wouldn't understand how raucous the atmosphere is at some of these IGS conference banquets, for example, seeing an Icelandic glaciologist dressed up in a kilt and carrying on about the haggis and making references to the pudding race.

Figure 1. The Haggis Crew

No it's much better to keep the setting simple, avoid the suspension of disbelief required to understand how such a bunch of seemingly stodgy scientists can howl it up at a misty castle setting high up over the lochs of Dunedin.

IGS. Well, then surely you took something from this conference about sea ice, because doesn't sea ice figure prominently in the early part of the poem?

STC. Right, when I wrote [STC reads from his poem]:

And now there came both mist and snow
And it grew wondrous cold:
And ice, mast-high, came floating by
As green as emerald.
And through the drifts the snowy clifts
Did send a dismal sheen:
Nor shapes of men nor beasts we ken –
The ice was all between.
The ice was here, the ice was there,
The ice was all around:
It cracked and growled, and roared and howled,
Like noises in a swound!

I learned a great deal about sea ice at some of the sessions, and found out that some of the scientists were using lasers (hence my references to 'green as emerald' and to the 'dismal sheen') to probe the freeboard of the ice in the Arctic and Antarctic oceans. For some reason this intrigued me and I thought I'd create an image of 'horrific drama' by supposing that this ice could float by at the level of a ship's mast. And the stuff about the roaring and howling, well, that was an image I took away from some of the locals at the conference who presented long mathematical analysis about how sea ice behaves when subject to ocean waves. But the word 'swound', well, I guess I made that one up after seeing some bunch of videos about crazy Scandinavians who were trying to cut holes in thick sea ice just to watch how the water refreezes. I figure 'swound' is short for 'sea-ice wound.'

IGS. Fair enough, using an IGS sea-ice symposium as an inspiration for a frightening, horrific poem is pretty out there at the fringe of literary work; but why the sudden reference to the albatross? What could possibly have given you the idea for the albatross in your poem?

STC. You're right to call it strange, but hear me out; it actually makes perfect sense. Let me read the part about the albatross [STC reads from his poem]:

At length did cross an Albatross,
Thorough the fog it came;
As if it had been a Christian soul,
We hailed it in God's name.
It ate the food it ne'er had eat,
And round and round it flew.
The ice did split with a thunder-fit;
The helmsman steered us through!
And a good south wind sprung up behind;
The albatross did follow,
And every day, for food or play,
Came to the mariner's hollo!

So, on the third day of this sea-ice symposium, the afternoon was devoted to a pair of outings (participants in the symposium could choose between an inland trip to the gold mining areas of Otago or, as I chose, a trip along the peninsula that protects Dunedin from the ocean to visit a series of bird sanctuaries including one at Taiaroa Head featuring the only mainland breeding ground for the royal albatross).

Figure 2 A Royal albatross on its nest

The experience on this well-prepared trip was extraordinary, and it wasn't long before I noticed that the normal conversations about sea-ice details were dropped as the group became more engaged in the natural scenery and wildlife.

Figure 3 The idyllic and quiet location of the yellow-eyed penguin colony

The first stop on our visit was a sanctuary for yellow-eyed penguins, and here we were delighted to learn that these interesting and comic little animals are related to the now-extinct *Penguin giganticus* – a penguin that stood 7 feet tall and weight 150 kg. What was even more amusing on our visit to the penguin colony was the chance to see the small houses for the tiny blue penguins. These small ones would watch us parade by on the viewing trails from their tiny houses set along the wind-swept bluffs.

After taking tea at the penguin colony, we encountered the main event of the afternoon, the royal albatross colony, seen by boat excursion to the Taiaroa Head followed by a nest viewing opportunity from bunkers set within the tussocks on the headland itself.

Figure 4 A pair of Royal Albatrss in flight

These amazing birds are indescribably large and graceful when coasting through the air. They flew circular patterns over their nests, and rarely had to flap their wings for lift: they were in perfect sync with eddies and whirls of air rushing off the hummocky topography. Our awe at their gracefulness was only broken by the clumsiness of their landings – these giant birds, with wing spans over 6 feet, are designed for long-distance flight, not short landings and take offs.

IGS. What a fantastic inspiration for a poem, a conference about sea ice including a chance to see one of the rarest wildlife habitats in the world. What made it all possible?

STC. What made it possible? Well, that's easy: The incredible planning and execution of the local organising committee headed by Pat Langhorn; but I should also mention that the IGS has a long tradition of hosting superlative meetings, and works hard to achieve this, for example, using visits to prospective conference venues by its Secretary General as a way to keep the high standards.

IGS. So what's next?

STC. Actually, I have a project I'm doing with a dada playwright, Sam Beckett, inspired by the mid-week conference excursion offered by the Amex Geo Union (AGU). This one will be quite the opposite of what was inspired by the IGS experience. We're calling it *Waiting for Godot*, and it's a kind of existential piece on the nothingness of existence at these AGU midweek

excursions. The whole piece takes place in a giant lobby with a subglacial hydrologist and a snow avalanche experimentalist trying to decide where to go for lunch.

I guess before I go, I'd like to close my interview with a last stanza from my poem:

> Farewell, farewell! but this I tell
> To thee, thou Wedding-Guest!
> He prayeth well, who loveth well
> Both man and bird and beast.

I guess that's sort of the message I took away from my experience with the IGS sea-ice symposium in Dunedin: It was a fantastic week that highlighted the region's magnificent natural landscapes and wildlife, and where the concern the locals have for preservation of these features is a world-class example of what can be done for man, bird and beast.

Figure 5 The Secretary General and Doug MacAyeal (who conducted the interview) sampling the local delights while looking for albatrosses

A REPORT FROM THE DUNEDIN POST SYMPOSIUM TOUR

The post-symposium excursion provided an excellent opportunity to become better acquainted with the region in which the symposium was held and to explore ice-related and other processes in the field, as well as for social interaction and follow-up of discussions in Dunedin. Two mini-buses with guides/drivers Sarah and Chris and all the participants met well prepared on Saturday morning, starting the tour at an overlook point with a view over Dunedin and adjacent regions. And who was there but our never-tiring symposium host Pat Langhorne? Perhaps she wanted to see for herself and enjoy the moment when we, the last ones, finally left town, allowing the hosts to relax after a week of hard work. No, the reasons she was there included provision of T-shirts to make sure that we spread information about where we were coming from, and good words and recommendations for our upcoming activities – a heartwarming start!

The tour proceeded away from the coast towards the promised warmer and drier inland climate, a surprisingly rapid shift on this mini-continent, inviting speculations about scaling laws for weather systems and topographical effects. Following a river valley with fruit trees and hydropower development, we arrived in the inland lake district in the afternoon. The organizers had allowed a couple of hours free time, believing that the participants needed a break after a long day of scientific excursion. However the students were so eager to learn

Figure 1. Representatives from nine countries took part in the post-symposium tour

more about the the properties of the soil, the landscape and its interaction with weather and climate that we all decided to spend this free time sensing and observing these very properties via a quite valuable indirect measurement technique: wine-tasting! An accompanying lecture convinced us that not only are harvesting of grapes and production of wine in this area scientifically based but in fact micro-climate manipulation methods, partly relying on the latent heat of water, are also actively pursued.

The third day started exceptionally early in order to get to the vicinity of Mount Cook and a boat trip sampling icebergs in front of the

Figure 2. Our tour guide showed us some very interesting ice crystals that were floating on the lake in front of the Tasman glacier

Tasman glacier. Although we never saw Mount Cook or any other mountains this morning because of heavy fog and clouds, we trusted the information that mountains had to be in the area, reasoning that the glaciers probably moved downhill rather than uphill. Boating a glacial lake among floating and grounded icebergs in dense fog was an interesting and definitely worthwhile experience. Eventually the weather cleared up somewhat and we could study in some detail both moraines and ice.

Sarah had produced a wonderful guide book with information about every part of the trip – exactly the kind of information that we tend to look for in everything from standard tourist brochures to encyclopedias when travelling on

Figure 3. We had some spectacular views of the Calvin front of the glacier and some very interesting 'flow lines'

Figure 4. We even got to walk on a floating iceberg!!!!

Figure 5. We also did some touristy things like looking at the local architecture

our own into unknown territory, but never really get a handle on. This guide book should never be put on the web – make a limited number of copies and you can sell them for a high price! Chris Petrich, the guide/driver of the second minibus started by excusing himself that he was not much of an expert in the area, having only lived there for 5 years. However, when moving to New Zealand he had apparently asked exactly the same questions as we were now asking, and had been there sufficiently long to find the answers. We had many illuminating discussions on the way. Professional tour guides can be good at many things, but when you can get knowledgeable guides from your own scientific community it is even better.

Peter M. Haugan

JOURNAL OF GLACIOLOGY

Papers accepted for publication between 16 November 2005 and 31 March 2006. The papers are listed in alphabetical order by first author.

Birgit Breuer, M.A. Lange, N. Blindow
Sensitivity studies on model modifications to assess the dynamics of a temperate ice cap such as on King George Island, Antarctica

Dave Gauthier, Bruce Jamieson
Towards a field test for fracture propagation propensity in weak snowpack layers

Neil Glasser, Becky Goodsell, Luke Copland, Wendy Lawson
Debris characteristics and ice shelf dynamics in the ablation region of the McMurdo Ice Shelf, Antarctica

Frank D. Granshaw, Andrew G. Fountain
Glacier change (1958-1998) in the North Cascades National Park Complex, USA

Mats A. Granskog, Timo Vihma, Roberta Pirazzini, Bin Cheng
Superimposed ice formation and surface fluxes on sea ice during the spring melt–freeze period in the Baltic Sea

Paul Herbst, Franz Neubauer, Martin P.J. Schopfer
The development of brittle structures in an alpine valley glacier: the Pasterzenkees, Austria, 1887-1997

Gaute Lappegard, Jack Kohler, Miriam Jackson, Jon Over Hagen
Characteristics of subglacial drainage systems deduced from long-term load cell measurements at Engabreen, Norway

Ivan S. Ashcraft, David G. Long
Relating microwave backscatter azimuth modulation to surface properties of the Greenland ice sheet

F.M. Nick, J. Oerlemans
Dynamics of calving glaciers: comparison of three models

Frederic Parrenin, R.C.A. Hindmarsh, F. Remy
Analytical solutions for the effect of topography, accumulation rate and lateral flow divergence on isoochrone layer geometry

W. Gareth Rees, N.S. Arnold
Scale-dependent roughness of a glacier surface: implications for radar backscatter and aerodynamic roughness modelling

Katrin Rohl
Thermo-erosional notch development at freshwater-calving Tasman Glacier, New Zealand

Akiko Sakai, Koji Fujita, Kequin Duan, Jianchen Pu, Masayoshi Nakawo, Tandong Yao
Five decades of shrinkage of July 1st glacier, Qilian Shan, China

E.M. Schulson, D. Iliescu
Brittle compressive failure of ice: proportional straining vs. proportional loading

Martin Truffer, William D. Harrison
In-situ measurements of till deformation and water pressure

J. van den Berg, R.S.W. van de Wal, J. Oerlemans
Effects of spatial discretisation in ice-sheet modelling

Frank Wilschut, Richard Bintanja, Roderik S.W. Van de Wal
Ice sheet modelling characteristics in sea level based temperature reconstructions over the last glacial cycle

H. Jay Zwally, Helen G. Cornejo, Mario B. Giovinetto, Jun Li, Matthew A. Beckley, Anita C. Brenner, Jack L. Saba, Donghui Yi
Mass changes of the Greenland and Antarctic ice sheets and contributions to sea level rise

ANNALS OF GLACIOLOGY, VOLUME 43

Since the publication of ICE 137-138, the following papers from the International Symposium on High Elevations Glaciers and Climate Records held in Lanzhou, China, 5–9 September 2005, have been accepted for publication in Annals of Glaciology *Vol. 43, edited by Ellen Mosley-Thompson and Lonnie Thompson*

Hou Shugui, Ren Jiawen and Qin Dahe
Modification of three ice core $\delta^{18}O$ records from an area of high melt

Jing Zhefan, Jiao Keqin, Yao Tandong, Wang Ninglian and Li Zhongqin
Mass balance and recession of Glacier No.1 at the Headwaters of the Urumqi River, Tianshan Mountains, China over the last 45 years

Li Yuefang, Yao Tandong, Wang Ninglian, Li Zhen,Tian Lide, Xu Baiqing and Wu Guangjian
Recent changes of atmospheric heavy metals in a high elevation ice core from Muztagh Ata in east Pamirs: initial results

Ren Jiawen, Jing Zhefan, Pu Jianchen and Qin Xiang
Glacier variations and climate change in the central Himalayas over the past few decades

Kunio Rikiishi and Haruka Nakasato
Height dependence of the tendency for reduction in seasonal snow cover in the Himalaya Mountains and Tibetan Plateau region from 1966 to 2001

Yafeng Shi, Shiyin Liu, Donghui Shangguang, Donglian Li and Baisheng Ye
Two peculiar phenomena regarding climatic and glacial variations on the Tibetan Plateau

Ninglian Wang, Tandong Yao, L. G. Thompson and M. E. Davis
Strong negative correlation between dust event frequency and air temperature over the northern Tibetan Plateau reflected by the Malan ice-core record

Xie Changwei, Ding Yongjian, Liu Shiyin and Chen Caiping
Response of melt-water runoff to air temperature fluctuations on Keqikaer Glacier, south slope of Mt.Tuomuer, western China

Xie Zi-chu, Wang Xin, Feng Qing-hua, Kang Ersi, Liu Chao-ha and LI Qiao-yuan
Modeling the response of glacier systems to climate warming in China

Tandong Yao, Zexia Li, Lonnie G. Thompson, Ellen Mosley-Thompson, Youqing Wang, Lide Tian, Ninglian Wang and Keqin Duan
$\delta^{18}O$ records from Tibetan ice cores reveal differences in climatic changes

Yoshitaka Yoshimura, Shiro Kohshima, Nozomu Takeuchi, Katsumoto Seko and Koji Fujita
Snow algae in a Himalayan ice core: new environmental markers for ice core analyses and their correlation with summer mass balance

V. Zagorodnov, O. Nagornov and L.G. Thompson
Influence of air temperature on a glacier's active layer temperature

Zhongping Zhao, Zhongqin Li, Ross Edwards, Feiteng Wang, Huilin Li and Yuman Zhu
Atmosphere-to-snow-to-firn transfer of NO_3^- on Glacier No. 1, eastern Tien Shan, China

Corrections and errata

Unfortunately, on occasion, mistakes creep into our publications. Usually we try to publish corrections in subsequent issues in the case of the *Journal*, but in the case of the *Annals* it is more difficult. Hence we are going to publish all corrections in *ICE* in future and whenever possible in the *Journal* also.

In *Journal* vol. 50, issue 171, Ilya Kravchenco, David Besson and Josh Meyers 2004 In situ index of refraction measurements of the South Polar firn with the RICE detector, page 523, there is an error in the caption of Figure 1, fifth line. The –1 should be superposed after the bracket to read:

$$\varepsilon = \varepsilon' - i\varepsilon'' = \varepsilon - i\sigma(\varepsilon^0\omega)^{-1}$$

ANNALS OF GLACIOLOGY, VOLUME 44

The following papers from the International Symposium on Sea Ice held in Dunedin, New Zealand, 5–9 December 2005, have been accepted for publication in Annals of Glaciology *Vol. 44, edited by Patricia J. Langhorne and Vernon A. Squire*

Erica L. Key and Peter J. Minnett
Implications of shortwave cloud forcing and feedbacks in the Southern Ocean

Christophe Kinnard, Christian M. Zdanowicz, David A. Fisher, Bea Alt and Steve McCourt
Climatic analysis of sea ice variability in the Canadian Arctic from operational charts, 1980–2004

Margaret A. Knuth and Stephen F. Ackley
Summer and early fall sea ice concentration in the Ross Sea: comparison of in situ ASPeCt observations and satellite passive microwave estimates

Allison L. Kohout and Mike H. Meylan
A model for wave scattering in the marginal ice zone based on a two-dimensional floating elastic plate solution

Thorsten Markus and Donald J. Cavalieri
Interannual and regional variability of Southern Ocean snow on sea ice

Torge Martin
Comparison of different ridge formation models of Arctic sea ice with observations from laser profiling

Torge Martin and Thomas Martin
Anomalies of sea ice transports in the Arctic

Robert A. Massom, Anthony Worby, Victoria Lytle, Thorsten Markus, Ian Allison, Theodore Scambos, Hiroyuki Enomoto, Kazutaka Tateyama, Terence Haran, Josefino C. Comiso, Andreas Pfaffling, Takeshi Tamura, Atsuhiro Muto, Pannir Kanagaratnam and Barry Gile
ARISE (Antarctic Remote Ice Sensing Experiment) in the East 2003: validation of satellite-derived sea-ice data products.

Walter N. Meier and Mingrui Dai
High-resolution sea ice motions from AMSR-E imagery

Walter N. Meier, Julienne Stroeve and Shari Gearheard
Bridging perspectives from remote sensing and inuit communities on changing sea ice cover in the Baffin Bay region

Kazuki Nakamura, Hiroyuki Wakabayashi, Shotaro Uto, Kazuhiro Naoki, Fumihiko Nishio and Seiho Uratsuka
Sea-ice thickness retrieval in the Sea of Okhotsk using dual-polarization SAR data

Marcel Nicolaus, Christian Haas, Jörg Bareiss and Sascha Willmes
A model study of differences of snow thinning on Arctic and Antarctic first-year sea ice during spring and summer

Dirk Notz and M. Grae Worster
A 1-D enthalpy model of sea ice

Toshinori Ogasawara and Shigeki Sakai
Numerical analysis of the characteristics of waves propagating in arbitrary ice-covered sea

Donald K. Perovich
The interaction of ultraviolet light with Arctic sea ice during SHEBA

Donald K. Perovich and Jacqueline A. Richter-Menge
From points to poles: extrapolating point measurements of sea ice mass balance

Roberta Pirazzini, Timo Vihma, Mats A. Granskog and Bin Cheng
Surface albedo measurements over sea ice in the Baltic Sea during the spring snowmelt period

Simon J. Prinsenberg, A. van der Baaren and Ingrid K. Peterson
Ice ridging and ice drift in southern Gulf of St. Lawrence, Canada, during winter storms

Craig R. Purdie, Patricia J. Langhorne, Greg H. Leonard and Tim G. Haskell
Growth of first year land-fast Antarctic sea ice determined from winter temperature measurements

J. E. Reid, A. Pfaffling, A. P. Worby and J. R. Bishop
In-situ measurements of the direct-current conductivity of Antarctic sea ice: implications for airborne electromagnetic sounding of sea ice thickness

Jacqueline A. Richter-Menge, Donald K. Perovich, Bruce C. Elder, Keran Claffey, Ignatius Rigor and Mark Ortmeyer
Ice mass balance buoys: a tool for measuring and attributing changes in the thickness of the Arctic sea ice cover

Ted A. Scambos, Terry M. Haran and Robert Masssom
Validation of AVHRR and MODIS ice surface temperature products using in situ radiometers

Lars H. Smedsrud, W. Paul Budgell, Alastair D. Jenkins and Bjørn Adlandsvik
Fine scale sea ice modelling of the Storfjorden polynya

Gunnar Spreen, Stefan Kern, Detlef Stammer, Rene Forsberg and Jörg Haarpaintner
Satellite-based estimates of sea ice volume flux through Fram Strait

M. Steffens, M.A. Granskog, H. Kaartokallio, H. Kuosa, K. Luodekari, S. Papadimitriou and D.N. Thomas

Spatial variation of biogeochemical properties of landfast sea ice in the Gulf of Bothnia (Baltic Sea)

Julienne Stroeve, Thorsten Markus, Walt Meier and Jeff Miller
Recent changes in the Arctic melt meason

Shuki Ushio
Factors affecting fast-ice breakup frequency in Lützow-Holmbukta, Antarctica

Shotaro Uto, Haruhito Shimoda and Shuki Ushio
Characteristics of sea ice thickness and snow depth distributions of the summer land-fast ice in Lützow-Holmbukta, East Antarctica

Shotaro Uto, Takenobu Toyota, Haruhito Shimoda, Kazutaka Tateyama and Kunio Shirasawa
Ship-borne electromagnetic induction sounding of sea ice thickness in the south Okhotsk Sea

Jari Uusikivi, Jens Ehn and Mats A. Granskog
Direct measurements of turbulent momentum, heat and salt fluxes under landfast ice in the Baltic Sea.

Gareth L. Vaughan and Vernon A. Squire
Scattering of ice-coupled waves by an ice sheet with arbitrary thickness

Carola von Saldern, Christian Haas and Wolfgang Dierking
Parameterisation of Arctic sea ice surface roughness for application in ice type classification

Keguang Wang
Pack ice as a two-dimensional granular plastic: a new constitutive law

Sascha Willmes, Jörg Bareiss, Christian Haas and Marcel Nicolaus
The importance of diurnal processes for the seasonal cycle of sea-ice microwave brightness temperatures during early summer in the Weddell Sea

J. Zhu, A. Jabini, K. M. Golden, H. Eicken and M. Morris
A network model for fluid transport through sea ice

Notes from the production team

Submitting papers to the IGS

Once your paper has been accepted for publication, please then send a complete electronic version, with the text in Word or LaTex, to igsoc@igsoc.org, journal@igsoc.org or annals@igsoc.org.

Illustrations
Please send your illustrations in a design platform such as tiff, eps or ai. Although we can process figures in jpeg, Word or pdf, we are not able to improve the quality of these figures or make corrections without losing definition, so we would prefer not to receive figures in those formats. Ideally, your figures should be 1 or 2 column widths: up to 85 mm or up to 178 mm. Please use SI units and Optima, Arial or a similar sans serif font in labels.

For printing, raster graphics (colour or halftone) have to be set to a resolution of 300 dots per inch, and vector graphics (line drawings) have to be set to a resolution of 600 dots per inch. Sizing your figures to these resolutions will give you a clear idea of the final, printed quality of your illustrations.

If you are taking pictures with a digital camera with a view to publishing them, ensure your camera is set to the highest possible quality as well as the highest resolution. You can then save the material in raw format using the software that comes with all digital cameras.

Equations
Equations should be set in MathType or advanced equation editor if using Word. They should not be embedded in the text as illustrations, as they then have to be rekeyed in-house.

Offprints
You can request an electronic (pdf) offprint of your paper via email. Authors who have paid full page charges can also request up to 100 free printed offprints. Additional offprints can be purchased at the rates shown on the order form.

Nordic Branch Annual Meeting
3–5 November 2005

In early November 2005, the annual meeting of the IGS Nordic Branch was hosted by the Technical University of Denmark, University of Copenhagen and the Geological Survey of Denmark and Greenland in the Geocenter Copenhagen, Denmark. From the very first coffee through to the concluding luncheon, the delegates were made to feel incredibly welcome by the wonderful efforts of our hosts and in particular Andreas Ahlstrøm who put in a prodigious amount of effort (on minimal sleep) to ensure the meeting ran smoothly.

The meeting was held in the finest tradition of 'informal' IGS branch meetings with relaxed chairmanship enabling all the speakers to conclude their offerings without resorting to the deadly 'countdown' (although most speakers kept impeccable time). The programme was excellent and included numerous postgraduate and post-doctoral talks as well as several keynote talks from invited speakers. Each session was themed which kept the meeting coherent throughout.

After the informal hellos and the formal welcome from Andreas, Johannes Oerlemans kicked off the first session, themed around mass balance, with a typically convincing offering concerning climate signals extracted from observations of glacier length change. Over the three days, there were numerous excellent talks and the following simply gives an indication of the breadth of the science on offer. Gaute Lappegard reported on field experiments investigating the role of stress bridging around subglacial channels in the subglacial observatory at Engabreen, adding to the body of ground-breaking work emerging from that excellent facility. Veijo Pohjola delivered his usual mix of mysterious humour and incisiveness in providing a fine summary of the value of isotopes and ice cores for climatic reconstructions. Carl Bøggild's talk was a real highlight as he presented a very compelling case for enhanced melt in Greenland as a result of impurities in the ice reducing albedo. Finally, Anne Munck Solgaard presented results from a numerical model suggesting extremely high rates of bottom melting at Nioghalvfjerdsfjorden Glacier, the largest outlet glacier in North East Greenland.

Each evening, our hosts put on a convivial drinks reception with free beer (Carlsberg of course) and nibbles whilst the presence of a füssball table ensured that Andreas continued his ritual humiliation of all comers (see Gordon Hamilton's Geilo report – *ICE 136*). On the Thursday night, Carl Bøggild's local knowledge led a group to a fine cheap eatery while John Moore played the role of pied-piper for the thirstier delegates and disappeared into the night in search of some hostelries. The informal 'conference dinner' on the Friday was generously subsidised by our hosts and ended, for some, in the early hours with Danish, Swiss, Norwegian and English glaciologists comparing dubious dance moves. The conference concluded with an amazing video of a Polish team ice-caving in Svalbard and a visit to the ice core repository of the University of Copenhagen, a fascinating tour of a remarkable active archive.

Overall, I cannot praise the organisers or indeed the participants highly enough for hosting and participating so fully in such an excellent meeting. It was as friendly a conference as I've attended whilst maintaining an excellent intellectual standard and clearly demonstrated that the glacial community in the Nordic countries is in rude health. So thanks once again to our hosts and to Andreas in particular. Copenhagen 2005 may have been my first Nordic Branch meeting but I am already planning my return in Autumn 2006 when the meeting will be hosted by Jack Kohler at the Norwegian Polar Institute in Tromsø. In the meantime, I'm off to practice my table footie…

Pete Nienow

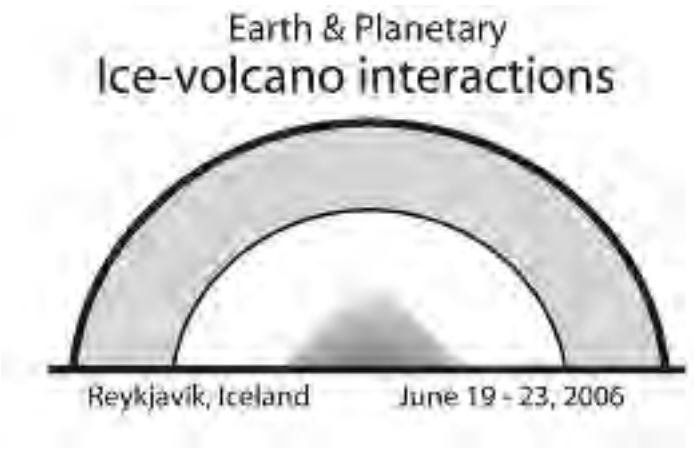
Notes:
The abstracts from the Nordic Branch meeting were published as GEUS Report 2005/67 which can be downloaded directly from the meeting website http://server.oersted.dtu.dk/igsnb. Paper copies can be ordered from the Geological Survey of Denmark and Greenland (www.geus.dk).

We are grateful to acknowledge our sponsors: The International Glaciological Society, Ørsted-DTU/Technical University of Denmark, Institute of Geography/University of Copenhagen and the Geological Survey of Denmark and Greenland.

INTERNATIONAL GLACIOLOGICAL SOCIETY

International Symposium on Earth and Planetary Ice–Volcano Interactions

Reykjavík, Iceland
19–23 June 2006



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SECOND CIRCULAR

November 2005

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INTERNATIONAL GLACIOLOGICAL SOCIETY
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IMMEDIATE PAST PRESIDENT: E.M. Morris

SYMPOSIUM ON EARTH AND PLANETARY ICE–VOLCANO INTERACTIONS
The International Glaciological Society will hold an International Symposium on Earth and Planetary Ice–Volcano Interactions in 2006. The symposium will be held in Reykjavík, Iceland, with registration on 18 June and sessions from 19 to 23 June 2006.

SYMPOSIUM ORGANIZATION
Magnús Már Magnússon (International Glaciological Society)

LOCAL ARRANGEMENTS COMMITTEE
Þröstur Þorsteinsson (Chairman), Bryndís Brandsdóttir, Freysteinn Sigmundsson, Helgi Björnsson, Hreinn Haraldsson, Magnús T Guðmundsson, Matthew Roberts, Óli Grétar Blöndal Sveinsson, Sveinn Jakobsson, Tómas Jóhannesson, Þorsteinn Þorsteinsson

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INFORMATION ABOUT THE SYMPOSIUM MAY BE OBTAINED FROM:
International Glaciological Society, Scott Polar Research Institute,
Lensfield Rd, Cambridge CB2 1ER, UK.
Tel: +[44] (0)1223 355 974
Fax: +[44] (0)1223 336 543
Email: igsoc@igsoc.org
Web: http://www.igsoc.org/symposia/
http://www.vedur.is/igs2006/
available 1 January 2006

PARTICIPATION
This circular includes forms for registration and instructions for arranging accommodation. These can also be found on the symposium website. The registration form and accompanying payment should be returned by 1 April 2006. There is a surcharge for late registration. The participant's registration fee includes organisation costs, a set of abstracts, the icebreaker function, coffee breaks and lunch, the banquet, and a copy of the *Annals of Glaciology*.

Registration fees	**ISK**
Participant (IGS member)	38 000
Participant (not IGS member)	43 000
Student or retired IGS member	15 000
Accompanying person over 18	13 000
Late registration surcharge (after 1 April 06)	13 000
Symposium study tour (estimate)	55 000

Registration refunds will be made according to date of notification. Cancellations made before 1 May 2006 will receive a full refund. Cancellations between 1 May and 3 June 2006 will be eligible for a partial refund. After 3 June it may not be possible to make any refund.

THEME
Ice-covered volcanoes pose many interesting challenges to scientists. Numerous interesting phenomena arise from the thermal interaction between hot volcanic materials and ice, here on Earth and elsewhere in the Solar System; examples include the triggering of jökulhlaups, the effect of internal layers of volcanic origin on radar signals, and the relationship between older subglacially erupted volcanoes and the glaciers in which they formed. Furthermore, ice–volcano interactions may cause major hazards such as lahars, jökulhlaups, and explosive eruptions. An improved understanding of these topics can only be advanced through multidisciplinary research, drawing together such diverse fields as remote sensing, fieldwork, and modeling. This symposium provides a forum for researchers from a variety of backgrounds to discuss the science of interactions of volcanoes and ice.

TOPICS
The suggested topics include:
1. Effects of ice cover on volcanic systems:
   a. Extraction of heat from magma to meltwater: subglacial and supraglacial melting
   b. The effect of glacier overburden and water pressure on volcanic activity, seismic activity and subglacial geothermal systems
   c. Older subglacially formed volcanoes as evidence for past ice cover thickness and extent
2. Effects of geothermal and volcanic systems on glaciers and ice caps:
   a. Mass balance (subglacial melting, the effect of tephra on albedo)
   b. The effect of subglacial geothermal activity and eruptions on glacier flow
   c. Effects on the atmosphere and the ocean
   d. Subglacial lake studies
3. Geophysical exploration of ice-covered volcanoes:
   a. Looking through the ice (radio echo soundings, etc.)

b. Detection of subglacial geothermal activity (surface depressions; chemicals in meltwater)
4. Information from internal acid layers and tephra layers:
   a. On volcanic activity
   b. On mass balance
5. Volcano–glacier hazards:
   a. Monitoring of ice-covered volcanoes and geothermal areas (inflation of volcanoes, seismicity, meltwater chemistry, thermal activity, lake levels)
   b. Jökulhlaups, lahars
6. Extraterrestrial ice–volcano interaction

SESSIONS AND POSTERS

Oral presentations will be held on four full days and one half-day. There will also be a poster session. The size of poster presentations will be given on the website.

PUBLICATION

Selected papers from the symposium will be published by the Society in the *Annals of Glaciology*. All papers (including those based on posters) will be refereed and edited according to the Society's regular standards before being accepted for publication.

PAPERS

(1) SUBMISSION OF ABSTRACTS

Participants who want to contribute to the Symposium should submit an abstract of their proposed presentation. This abstract must contain sufficient detail for its scientific merit and relevance to the symposium theme to be judged by the Editorial Board. A web site will be available from December 2005 where authors can upload their abstract and all the relevant contact information. The abstract itself should not exceed 400 words. References and illustrations should not be included.

You will be required to enter all your details with the submission and in particular to state whether you intend to submit a paper for publication in the *Annals of Glaciology*. We will only solicit referees for abstracts that have explicitly stated that they intend to submit a paper. Referees are a scarce commodity and we do not want to trouble them unnecessarily.

Those who are unable to submit their abstract via the internet can submit electronic files on a CD or diskette to the IGS office where a member of staff will upload them on to the web site.

LAST DATE FOR RECEIPT OF ABSTRACTS: 27 JANUARY 2006

Final versions of papers accepted for publication should not exceed five printed pages in the Annals of Glaciology. Extra pages will be charged at the rate of UK £90 per page. Papers with colour figures will accrue page charges, at the colour rate of UK £150 for all pages. Honouring page charges (also £90 per page) for the first five pages in encouraged.

(2) SELECTION OF ABSTRACTS

Each abstract will be assessed on its scientific quality and relevance to the Symposium theme. Authors whose abstracts are accepted will be invited to make either an oral or poster presentation at the Symposium and submit a paper for publication in the *Annals of Glaciology* (included in the ISI Science Citation Index®). First or corresponding authors will be advised by 5 March 2006 of the acceptance or otherwise; other authors will not be informed separately. Authors who have not received notification by that date should contact the IGS office in Cambridge in case their abstract was not received. Acceptance of an abstract means that a paper based on it can be submitted to the *Annals of Glaciology*. Papers submitted for consideration in the *Annals* cannot be submitted to another publication as well. Note: abstracts alone will not be published in the *Annals of Glaciology*.

(3) DISTRIBUTION OF ABSTRACTS

A set of the accepted abstracts will be provided to participants upon registration on 18 June 2006.

(4) SUBMISSION OF PAPERS AND PUBLICATION

Manuscripts should be submitted as a PDF file to the IGS office by e-mail annals@igsoc.org stating clearly the abstract number in the file name and in the subject line of the e-mail. Papers should be prepared in accordance with the instructions sent to authors with the abstract acceptance notification and must be submitted as PDFs (portable document format). Authors who submit in other electronic formats will be asked to re-submit as PDF. All manuscripts should be submitted by 10 May 2006. ALL AUTHORS ARE EXPECTED TO ADHERE TO THIS DEADLINE. Papers will be refereed according to the usual standards of the Society before being accepted for publication. Final papers, based on presentations at the Symposium, which have been submitted and accepted by the Editorial Board following review, will be published in English in the *Annals of Glaciology* (Vol. 45). Final, revised versions of papers must be submitted by 31 July 2006. Timely publication of the *Annals of Glaciology* will depend upon strict adherence to deadlines.

LAST DATE FOR RECEIPT OF PAPERS: 10 May 2006

LAST DATE FOR RECEIPT OF REVISED PAPERS: 31 July 2006

EXCURSIONS

MID WEEK FIELD TRIP:
Excursion to Þingvellir parliament plains, Gullfoss and Geysir. Dinner at Hotel Geysir included. Cost approx. ISK 8000.

Other options: Various short excursions are available from Reykjavík Centre, for instance to the Blue Lagoon. Information will be available at the conference desk.

BANQUET to be held on Thursday evening, 22 June in Viðey.

SYMPOSIUM STUDY TOUR – THREE DAYS
24–26 June 2006: SOUTHERN-ICELAND
Several sites displaying the products and effects of glacio-volcanic interaction will be visited during this trip. Examples include: Mýrdalsjökull ice cap and the Mýrdalssandur outwash plain formed in large jökulhlaups resulting from eruptions in the subglacial volcano Katla; Vatnajökull ice cap, the Skeiðarársandur outwash plain (flooded during the subglacial eruption in Gjálp 1996), the glacier-capped volcano Öræfajökull and the Jökulsárlón (Glacier Lagoon).

Approximate cost is ISK 55 000 per person, including bus transfer, guide, all meals, overnight stays in double rooms at Hvolsvöllur and Skaftafell, admission to visitor centers, flight from Höfn to Reykjavík. Price based on 30 participants.
More details are available at
http://www.vedur.is/igs2006/.

ACCOMPANYING PERSONS PROGRAMME

The accompanying person registration fee includes the ice-breaker, city sightseeing tour with lunch, and the banquet. Staff from Iceland Travel will be on the registration/information desk during the conference and will assist with further arrangements.

LOCATION AND WEATHER

Iceland is an island of 103 000 km^2 (39 756 sq miles). Its highest peak, Hvannadalshnjúkur, rises to 2111 m and over 11% of the country is covered by glaciers, including Vatnajökull.

Owing to the Gulf Stream the Icelandic climate is mild. The average temperature for January, the coldest month, is –0.6°C (30°F).The summers are fairly cool, with lowland temperatures between 12° and 15°C (54–60°F). The climate is considerably cooler higher up in the mountains.

TRAVEL AND ACCOMMODATION

Iceland is a member of the Schengen Treaty. Information about which nationalities need Visa, where and how to apply is to be found at www.utl.is

VENUE

The conference is to be held at the Conference and Culture Center, Háskólabíó

The Local Organizing Committee has reserved accommodation at the following hotels, which are situated close to the venue:

Radisson SAS Saga Hotel (www.radissonsas.is)
A first class hotel located 10 minutes walk from downtown and 2 minutes from conference venue. All guests have free access to the swimming pools in Reykjavik.
Price per night w/breakfast
Single room ISK 14 400
Double room ISK 17 600

Fosshotel Sudurgata (www.fosshotel.is)
University campus during the winter, used as hotel in the summer. Small apartments with private facilities.
Price pr. night w/ breakfast
Single room ISK 10 200
Double room ISK 13 600

Fosshotel Gardur Inn (www.fosshotel.is)
University campus during the winter, used as hotel in the summer. Rooms without private facilities.
Price per night w/breakfast
Single room ISK 6900
Double room ISK 9100

B & B

There are several small guesthouses in the centre of town that offer bed & breakfast
Prices are from ISK 7500 for a single room and ISK 9500 for a double room.

For further information and booking of accommodation please contact:
Björk Bjarkadóttir
Iceland Travel
bjorkb@icelandtravel.is
Phone +354 585 4374.

IMPORTANT DATES

Abstracts due	27 Jan 06
Notification of acceptance	28 Feb 06
Pre-registration due	1 April 06
Deadline for full refund	1 May 06
Papers due	10 May 06
Deadline for partial refund	3 Jun 06
Registration	18 Jun 06
Conference starts	19 Jun 06
Post-symposium tour starts	24 Jun 06
Final revised papers due	31 Jul 06

REGISTRATION

On the web at http://www.vedur.is/igs2006/
See also the attached form.

WCRP CLIMATE AND CRYOSPHERE (CliC), IUGG – COMMISSION FOR CRYOSPHERIC SCIENCES (IUGG – CCS) and INTERNATIONAL GLACIOLOGICAL SOCIETY

International Symposium on Cryospheric Indicators of Global Climate Change

Cambridge, UK
21–25 August 2006
CO-SPONSORED BY

British Antarctic Survey
Scott Polar Research Institute

SECOND CIRCULAR

November 2005

Registered Charity

INTERNATIONAL GLACIOLOGICAL SOCIETY
PRESIDENT: A. Ohmura
VICE PRESIDENTS: E. Brun, E. Wolff, I Allison
IMMEDIATE PAST PRESIDENT: E.M. Morris

SYMPOSIUM ON CRYOSPHERIC INDICATORS OF GLOBAL CLIMATE CHANGE
The International Glaciological Society will hold an International Symposium on Cryospheric Indicators of Global Climate Change in 2006. The symposium will be held in Cambridge, UK, with registration on 20 August, and sessions from 21 to 25 August..

SYMPOSIUM ORGANIZATION
Magnús Már Magnússon (International Glaciological Society)

LOCAL ARRANGEMENTS COMMITTEE
Tom Lachlan-Cope (Chairman), Gill Alexander, Liz Crilley, Hilmar Gudmundsson, Glenda Harden, Victoria I. Lytle, Magnús Már Magnússon, Ian Willis, Eric Wolff

SCIENCE STEERING AND EDITORIAL COMMITTEE
Martin Sharp (Chief Scientific Editor), Maria Ananicheva, Roger Barry, Cecilia Bitz, Ross Brown, Chad Dick, Julian Dowdeswell, Claude Duguay, Greg Flato, Duane Froese, Wouter Greuell, Jon Ove Hagen, Ola Johannesson, Andreas Kääb, Seymour Laxon, Ellsworth LeDrew, Victoria I. Lytle, Vin Morgan, Ellen Mosley-Thompson, Tony Payne, Mark Serreze, Koni Steffen.

INFORMATION ABOUT THE SYMPOSIUM MAY BE OBTAINED FROM:
International Glaciological Society, Scott Polar Research Institute,
Lensfield Rd, Cambridge CB2 1ER, UK.
Tel: +[44] (0)1223 355 974
Fax: +[44] (0)1223 336 543
Email: igsoc@igsoc.org
Web: http://www.igsoc.org/symposia/
http://www.antarctica.ac.uk/igs
Available beginning February 2006

PARTICIPATION
This circular includes forms for registration and instructions for arranging accommodation. These can also be found on the symposium website. The registration form and accompanying payment should be returned by 27 May2006. There is a surcharge for late registration. The participant's registration fee includes organisation costs, a set of abstracts, the icebreaker function, coffee breaks, the banquet, the mid-week excursion and a copy of the Annals of Glaciology.

Registration fees	**UK£**
Participant (IGS member)	270
Participant (not IGS member)	320
Student or retired IGS member	100
Accompanying person over 18	80
Late registration surcharge (after 27 May 06)	50
Post-symposium tour (estimate)	450

Registration refunds will be made according to date of notification. Cancellations made before 27 May 2006 will receive a full refund. Cancellations between 27 May and 19 July 2006 will be eligible for a partial refund. After 19 July it may not be possible to make any refund.

THEME
The cryosphere, consisting of snow cover, sea-, lake- and river-ice, glaciers, ice caps and ice sheets, and frozen ground including permafrost, is a fundamentally important part of the global climate system. Many components of the cryosphere respond sensitively and very visibly to climate changes. Cryospheric changes provide important information about past climatic conditions in regions where other climate observations are sparse, and they have significant implications for global sea level, regional water resources and both terrestrial and aquatic ecosystems. Feedbacks between the cryosphere and other components of the climate system play a key role in how the climate system evolves over time. In situ observations, remote sensing, the analysis of proxy records and numerical modeling all contribute to understanding the dynamics of cryospheric change and cryosphere/climate interactions. Building on the foundation laid by the 1st CliC International Science Conference, held in Beijing in April 2005, this symposium will promote discussion of the evidence for changes in all components of the global cryosphere, their interdependence and causes, our current ability to model these changes, and what they tell us about changing global climate.

TOPICS
The suggested topics include:
1. Observed historical changes in the cryosphere
2. Processes that lead to changes in the cryosphere and how these make interpretation difficult
3. Actual records of climate in cryospheric regions and their relation to changes in the cryosphere, including statistical/model interpretation
4. Extension of climate records back in time, using observations of cryospheric changes
5. Synthesis of records by geographical region, and ultimately globally
6. Linkage of historical cryospheric records to palaeo-records of climate
7. Modeling of all of the above. How well do models capture the observed changes?

SESSIONS AND POSTERS
Oral presentations will be held on four full days and one half-day. There will also be a poster session. The poster boards will accommodate A0 size (90 cm×120 cm.).

PUBLICATION
Selected papers from the symposium will be published by the Society in the *Annals of Glaciology*. All papers (including those based on posters) will be refereed and edited according to the Society's regular standards before being accepted for publication.

PAPERS
(1) SUBMISSION OF ABSTRACTS
Participants who want to contribute to the Symposium should submit an abstract of their proposed presentation. This abstract must contain sufficient detail for its scientific merit and relevance to the symposium theme to be judged by the Editorial Board. A web site will be available at the beginning of 2006 where authors can upload their abstract and all the relevant contact information. The abstract itself should not exceed 400 words. References and illustrations should not be included.

You will be required to enter all your details with the submission and in particular to state whether you intend to submit a paper for publication in the *Annals of Glaciology*. We will only solicit referees for abstracts that have explicitly stated that they intend to submit a paper. Referees are a scarce commodity and we do not want to trouble them unnecessarily.

Those who are unable to submit their abstract via the internet can submit electronic files on a CD or diskette to the IGS office where a member of staff will upload them onto the web site.

LAST DATE FOR RECEIPT OF ABSTRACTS: 28 FEB 2006

Final versions of papers accepted for publication should not exceed five printed pages in the *Annals of Glaciology*. Extra pages will be charged at the rate of UK £90 per page. Papers with colour figures will accrue page charges, at the colour rate of UK £150 for all pages. Honouring page charges (also £90 per page) for the first five pages is encouraged.

(2) SELECTION OF ABSTRACTS
Each abstract will be assessed on its scientific quality and relevance to the Symposium theme. Authors whose abstracts are accepted will be invited to make either an oral or poster presentation at the Symposium and submit a paper for publication in the *Annals of Glaciology* (included in the ISI Science Citation Index®). First or corresponding authors will be advised by 17 April 2006 of the acceptance or otherwise; other authors will not be informed separately. Authors who have not received notification by that date should contact the IGS office in Cambridge in case their abstract was not received. Acceptance of an abstract means that the paper based on it should be submitted to the *Annals of Glaciology* and not to another publication. Note: abstracts alone will not be published in the *Annals of Glaciology*.

(3) DISTRIBUTION OF ABSTRACTS
A set of the accepted abstracts will be provided to participants upon registration on 20 August 2006.

(4) SUBMISSION OF PAPERS AND PUBLICATION
Manuscripts should be submitted as a PDF file to the IGS office by e-mail annals@igsoc.org stating clearly the abstract number in the file name and in the subject line of the e-mail. Papers should be prepared in accordance with the instructions sent to authors with the abstract acceptance notification and must be submitted as PDFs (portable document format). Authors who submit in other electronic formats will be asked to re-submit as PDF. All manuscripts should be submitted by 19 June 2006. ALL AUTHORS ARE EXPECTED TO ADHERE TO THIS DEADLINE. Papers will be refereed according to the usual standards of the Society before being accepted for publication. Final papers, based on presentations at the Symposium, which have been submitted and accepted by the Editorial Board following review, will be published in English in the *Annals of Glaciology* (Vol. 46). Final, revised versions of papers must be submitted by 2 October 2006. Timely publication of the *Annals of Glaciology* will depend upon strict adherence to deadlines.

LAST DATE FOR RECEIPT OF PAPERS: 19 June 2006

LAST DATE FOR RECEIPT OF REVISED PAPERS: 2 October 2006

EXCURSIONS
MID WEEK FIELD TRIPS:
Option 1: A walking tour around Cambridge visiting some of the magnificent buildings in this historic city, e.g. King's College chapel. It may be possible to take in a chauffeured punting trip on the River Cam.

Option 2: Visit to the historic city of Ely. A short coach trip through the Fens, rich in history and folklore, to Ely Cathedral where you will enjoy a guided tour of this historic and beautiful building. Maybe visit to the home of Oliver Cromwell and round off the trip with tea and cakes in the historic Almonry nearby.

BANQUET to be held on Thursday evening, 24 August at St. John's College.

POST-SYMPOSIUM TOUR: THE LAKE DISTRICT, HADRIAN'S WALL, THE PENNINES AND THE YORKSHIRE DALES
This four day tour of the Lake District, Hadrian's Wall, the Pennines and the Yorkshire Dales is based at Penrith, near Ullswater.

Approximate cost is £450 per person, including breakfasts and lunches, luxury bus travel and accommodation on twin share basis.

25 August: Depart Cambridge for the Lake District – leaving Cambridge at about 5.00pm. The journey will take about 6 hours plus a stop for refreshments en route.

26 August: In the footsteps of Beatrix Potter and William Wordsworth – Hawkshead and Grasmere

Drive over the dramatic Kirkstone Pass, the highest road pass in the Lake District, to Windermere and on to Hawkshead. Here you can join an optional walking tour with your guide and explore the hidden alleyways and squares of this historic village where William Wordsworth attended school. There will be time to visit the Beatrix Potter Gallery and view a selection of her original illustrations and enjoy some time at leisure in the village before continuing on to visit Hill Top, Beatrix Potter's farm. Travel on through the heart of the Lake District to Grasmere for lunch on your own and time to wander around this attractive village. Visit the famous Grasmere Gingerbread Shop, the ancient church of St. Oswald and possibly Dove Cottage, the home of William Wordsworth.

This afternoon drive across Dunmail raise to Keswick on Derwentwater. We shall take a short walk along the lakeshore before driving into the beautiful valley of Borrowdale. Stop for a cup of tea before returning to the hotel.

27 August: The Eden valley, the Pennines and Hadrian's Wall

Discover the hidden and aptly named Eden valley – an unspoilt area of pretty sandstone villages in the lee of the Pennines. Drive by way of Brampton, an old town associated with Bonnie Prince Charlie, to Lanercost Priory. Here we shall stop to visit the evocative monastic ruins and part of the priory church that is intact and in use today. An exciting and fascinating drive now awaits - along Hadrian's Wall. We shall follow the course of this World Heritage Site just over the border into Northumberland stopping to view a Roman fort nearly 2000 years old. After lunch we shall drive up into the Pennines, stopping at Alston, the highest market town in England before descending back to the Eden valley enjoying spectacular views towards the Solway Firth and Scotland, weather permitting!

28 August: Day at leisure

Day at leisure – guide to be on duty to help with suggestions of things to do, places to see, etc.

An optional walk in the Ullswater valley will be offered.

29 August: Dent fault and the Yorkshire Dales National Park

This morning we shall drive through the Yorkshire Dales National Park. We begin with a stop to view the Dent Fault, named after the 19th century geologist Adam Sedgwick, a renowned geologist who attended Cambridge University. We will stop in the market town of Hawes (it is market day) and then drive through Wensleydale, a beautiful limestone valley made famous by the vet James Herriot. This afternoon the journey takes us through Masham and Ripon before joining the A1 and returning to Cambridge for the early evening.

ACCOMPANYING PERSONS PROGRAMME

The accompanying persons registration fee includes the icebreaker, the banquet, the mid-week field trip and the services of the accompanying persons coordinator. The coordinator will be able to assist accompanying persons to make further arrangements through the local tourist office. Tourist information is available at http://www.cam.ac.uk/cambarea/tourist.html

LOCATION AND WEATHER

Cambridge is a city of contrasts – a place where more than 800 years of history are preserved unchanged in stone and brick, but which inspires ideas that have changed the world. The population of this medieval city is around 100 000. Although the area around Cambridge has the lowest rainfall in the UK, these things are relative and you should still pack waterproof clothing. The average temperature during August is 16.3°C but daytime temperatures are more likely to be around 20°C.

TRAVEL AND ACCOMMODATION

Please check with your respective embassies to see if you require a visa to enter the UK. The local organising committee will supply you with an invitational letter if needed.

The Local Organising Committee has reserved accommodation in Downing College (http://www.dow.cam.ac.uk/) at very competitive rates (£48 for a standard room and £57–95 for rooms with ensuite). Those interested MUST confirm their booking by contacting the IGS office BEFORE 10 February. After that date it is not possible to guarantee that rooms will be available. NOTICE that you MUST confirm and pay your deposit for the Downing College accommodation BEFORE the pre-registration deadline.

Alternate accommodation can be found at www.visitcambridge.org/visitors/wheretostay.php

IMPORTANT DATES

Confirmation for accommodation in Downing College	10 Feb 06
Abstracts due	28 Feb 06
Notification of acceptance	17 Apr 06
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Deadline for full refund	3 Jul 06
Deadline for partial refund	5 Aug 06
Registration	20 Aug 06
Conference starts	21 Aug 06
Post-symposium tour starts	25 Aug 06
Final revised papers due	2 Oct 06

INTERNATIONAL GLACIOLOGICAL SOCIETY
SYMPOSIUM ON CRYOSPHERIC INDICATORS OF GLOBAL CLIMATE CHANGE
Cambridge, England, 21–25 August 2006

REGISTRATION FORM

Family Name: _____

First Name: _____

Address: _____

_____

Tel: _____ Fax: _____ E-mail: _____

Accompanied by: Name: _____ Age (if under 21) ____

Name: _____ Age (if under 21) ____

REGISTRATION FEES	**£**	**£**
Participant (member of the IGS)	270	_____
Participant (not a member of the IGS)	320	_____
Student or retired IGS member	100	_____
Accompanying person aged 21 or over	80	_____
Late registration surcharge (after 24 April)	50	_____
Post-symposium tour (estimate)	450	_____
TOTAL REGISTRATION FEES		_____

ACCOMMODATION

The Local Organising Committee has reserved accommodation in Downing College at very competitive rates (£48 for a standard room and £57 to £95 for rooms with en-suite). Those interested MUST confirm their booking by contacting the IGS office BEFORE the 10 February. After that date it is not possible to guarantee that rooms will be available. Notice, that you MUST confirm and pay your deposit for the Downing College accommodation BEFORE the pre-registration deadline.

Alternative accommodation can be found at www.visitcambridge.org/visitors/wheretostay.php

Payment of registration fee, in pounds sterling drawn on a UK bank, may be made by cheque to:

INTERNATIONAL GLACIOLOGICAL SOCIETY

or by Access/Eurocard/MasterCard or VISA/Delta

Card No.																Expires				

Security code (the last three digits on the signature strip on the back of the card)

Name of card holder as shown on card:_____

Signature: _____

Payment may also be made to: National Westminster Bank plc, 56 St. Andrew's Street, Cambridge CB2 3DA, UK.
Account no: 54770084, Sort Code 52-10-46
IBAN number: GB83 NWBK 5210 4654 7700 84 SWIFT/BIC code: NWB KGB 2L
(ANY BANK OR TRANSFER CHARGES MUST BE INCLUDED).
Mail or fax to: Secretary General, International Glaciological Society, Scott Polar Research Institute, Lensfield Road, Cambridge CB2 1ER, UK
If payment made after 27 May 2006, add £50 for each person

PLEASE RETURN AS SOON AS POSSIBLE TO:
Secretary General, International Glaciological Society, Scott Polar Research Institute,
Lensfield Road, Cambridge, CB2 1ER, UK
Tel: +44 (0)1223 355 974 Fax: +44 (0)1223 354 931 E-mail: igsoc@igsoc.org Web: http://www.igsoc.org

News

Obituary – Robert P. Sharp

Robert Phillip Sharp, an Honorary Member of the Society, died at his home in Santa Barbara, California, on May 25, 2004. He was 92 years old.

Bob Sharp made major contributions to glaciological research, and the mentoring of two generations of students who have subsequently achieved success in the field. In addition, his research, generally related to earth surface processes, extended broadly from desert geomorphology to isotope geochemistry to planetary landforms. His studies in 1941 on the Wolf Creek glaciers in Yukon territory were classic examples of insight into glacier structure and dynamics. His work in the early 1950s on the huge Malaspina and Seward Glaciers on the Alaska/Yukon border was a triumph of innovative science in a difficult and hazardous environment. At the start of the International Geophysical Year he helped develop the US IGY glaciological program, and led the Caltech glacier dynamics program project on Blue Glacier, Washington. He was mentor to at least four. Three of his former students were Seligman Crystal winners; several others won medals in related fields.: (list these?)

Bob did his undergraduate study at the California Institute of Technology, received his PhD from Harvard, taught at the Universities of Illinois and Minnesota, and came to Caltech in 1947 where he taught and became department head until semi-retirement in 1979. Perhaps his greatest accomplishment was his success in expanding the concept of a 'classic' geology department into one embracing first seismology and geophysics, then geochemistry, then planetary science by active suasion of faculty, administrators, trustees and potential donors. Largely due to these efforts, the Division of Geologic and Planetary Sciences is now an outstanding model of an interdisciplinary faculty. One of his favorite techniques to enlighten donors, as well as to reward staff, was to take them on field trips to neat places such as the Grand Canyon, Alaska, and Hawaii. He had impact on the public's understanding of the Earth's surface through his writings, both in books such as *Glaciers* and *Living Ice*, and his several guidebooks. He contributed at all levels, and challenged the rest of us to do the same.

Bob Sharp received his nation's highest scientific honor, the National Medal of Science, as well as being elected to the National Academy of Sciences, was nationally cited as an outstanding teacher as well as a football star who went on to achieve a significant career, and received other honors too numerous to mention in this short note. On a personal note – in 1950, in the throes of preparing my masters thesis on Wind River Glaciers, I knew that I wanted to pursue a career in glaciology, and I sought out Bob Sharp to study with him. He taught me how to think and question authority; he often asked, 'How do you you know?' It was a marvellous experience and shaped my professional life from then on. Going to Caltech to study with Bob Sharp was one of the best decisions of my life, and I'm sure that a number of others feel the same way. We miss him dearly.

Mark F. Meier

What to call a subglacial lake?

Assigning names to features in areas of continuing discovery presents challenges. Initial, informal names often work their way into collegial usage and, eventually, into the published scientific literature. This informal process can sometimes conflict with the formal processes most countries have to approve names for official governmental use.

Antarctica is a unique case because signators of the Antarctic Treaty have agreed to suspend all territorial claims and attempt to reach consensus in naming new features to ensure that maps produced by different countries use a consistent set of feature names. This can avoid confusion that, in extreme cases such as

rescue efforts, could be have life-threatening consequences.

One region of Antarctica receiving increasing attention is the subglacial environment. Geologists, biologists, climatologists and glaciologists are involved. New lakes are being found and named.

It is prudent at this relatively early stage in subglacial exploration to make widely known the nomenclature for subglacial features adopted by most national bodies responsible for standardizing and promulgating official geographic names. The following principle for subglacial nomenclature was adopted by the US, UK and SCAR in 1960 and reaffirmed in 2001 by the United Kingdom Antarctic Place-name Committee and the United States Advisory Committee on Antarctic Names (ACAN):

> **Subglacial nomenclature**
> Place-names for subglacial features should be easily recognizable and distinct from those of surface features. It is normally preferable to show sub-surface and surface topography on separate maps but, when shown on the same map, there must be no confusion between sub-surface and surface place-names. Subglacial features should not be used to delimit surface place-names, unless the features are conspicuously reflected in the surface topography. In 1960, the Scientific Committee on Antarctic Research recommended that subglacial place-names should be composed of a specific and a generic part, the latter drawn from the accepted terms for surface features but with the prefix 'subglacial', the abbreviation of this prefix on maps being 'sg'.
> (G. Hattersley-Smith. 1991. *History of Place-names in the British Antarctic Territory*, Part 1, pp. 46–47.)

Thus, an appropriate usage is 'Subglacial Lake Vostok' or 'Vostok Subglacial Lake' (ACAN prefers the latter) but not 'Lake Vostok' or 'Vostok Lake'.

The publications of the IGS will be consistent with this convention. All IGS member and authors submitting to GIS publications are requested to adhere to this convention, as well.

For more information, names approved by the US Board on the recommendation of ACAN can be found at http://geonames.usgs.gov/antform.html. These names are considered official for use on (US) Federal maps and documents (including websites). There is also a link to a policy statement covering the treatment of Antarctic names, which includes a PDF version of the Antarctic Placename Proposal.

There is also the SCAR Composite Gazetteer at http://www3.pnra.it/SCAR_GAZE, which contains names approved by all countries. It is important to note, however, that not all of these names are recognized by the US and those that are not cannot be used by US government employees or their contractors in reports, maps or other official federal documents.

The British Periglacial and Permafrost Association

The British Periglacial and Permafrost Association (BPPA) has just been formally established to serve as the British arm of the International Permafrost Association. The object of the BPPA is the advancement of research and public education in the cold, non-glacial regions, as pertaining to subjects including geomorphology, engineering geology, quaternary science and global environmental change, and in their application. The first meeting of the BPPA was held at Cardiff University on 14 December 2005, and further meetings are being planned. Anyone interested in periglacial phenomena, permafrost science or glacier–permafrost interactions is welcome to join the Association and should contact Charles Harris or Julian Murton:

Professor Charles Harris
Department of Earth Sciences
Cardiff University
PO Box 914
Cardiff CF1 3YE, UK
E-mail: harrisc@cardiff.ac.uk

Dr Julian Murton
Department of Geography
University of Sussex
Brighton BN1 9QJ. UK
E-mail: j.b.murton@sussex.ac.uk

Recent meetings (of other organizations)

International Symposium: Glacier caves and glacial karst in high mountains and polar regions, 5–11 September 2005, Azau, Kabardino-Balkariya, Russia

This symposium was organized by the international commission GLACKIPR, UIS – UNESCO, with the support of the Russian Glaciological Society, Institute of Geography RAS, Geographical Department of Moscow State University, Moscow Center of Russian Geographic Society, Arctic and Antarctic Commission of Russia and Russian Union of Speleologists.

Figure 1. Meeting attendees at the Azau glacier

The symposium took place at the bottom of the highest mountain in Europe – Mount Elbrus. Accommodation of participants and sessions took place on Elbrus educational-scientific station of the Geographical faculty of the Moscow State University in settlement Azau. Aleksandr Olejnikov, as the chief of Elbrus educational–scientific station and a member of the organizing committee, received our thanks for help in the organization of the symposium.

One the night of 4–5 September about 10 cm of snow fell. In spite of the fact that this snow disappeared within several days, it added to participants' enjoyment.

Several aspects of the symposium were interesting to glaciologists: we discussed questions which are seldom included in the agenda of glaciological meetings. Firstly, glacial caves and glacial karst, which are studied more often by cave explorers and karstologists, and secondly, ice in karst caves, which is usually only studied by speleologists.

The picturesque meeting place was the ideal venue for excursions. Delegates enjoyed three excursions to glaciers in the valley of the Baksan River and on the slopes of Mount Elbrus. Six participants embarked on a 3-day trip to the moulins of Bashkara Glacier.

Figure 2. Bashkara glacier

Unfortunately, because of the current political situation in the Caucasus only scientists from three countries were able to take part (Italy, Russia, Japan), and other scientists have taken part in a symposium only in absentia (England, Italy, Japan, Norway, Poland, Romania, Spain).

Afterwards, the 7th GLACKIPR Symposium Proceedings were published: *Glacier Caves and Glacial Karst in High Mountains and Polar Regions*. Ed. B.R. Mavlyudov. Institute of Geography of the Russian Academy of Sciences, Moscow, 2005, 178 pp. (in English with Russian abstracts) (ISBN 5-89658-028-2) (softcover).

Figure 3. Exciting fieldwork

All articles, photos, introduction and conclusion from this issue are now available free online. Visit http://www.rgo-speleo.ru/books/glacier7-eng.htm to view the table of contents and access the full content of all articles from this issue.

About this issue

The research published in these proceedings includes articles that were read at 7th CLACKIPR Symposium (Azau, Kabardino-Balkariya, Russia). Articles of the first part are connected with investigations of glacier caves and glacier hydrology in Patagonia, Iceland, Svalbard, Caucasus, glacial karst in Hymalayas and Russian Plain and results of mathematic modelling of englacial channels in cold and temperate ice. Articles of the second part are connected with permanent ice in karst caves of Romania, Italy and Russia (Arkhangelsk, Samara, Perm and Irkutsk regions). Proceedings also contain an obituary of Marian Pulina, a list of his publications connected with glacier caves and glacial karst, contents of previous GLACKIPR commission proceedings and an English–Russian dictionary on glacial hydrology.

Bulat R. Mavlyudov
Institute of Geography RAS

Future meetings (of other organizations)

Periglacial and paraglacial processes and environments, past, present and future
Geological Society, London, UK, 15-16 January 2007
Joint meeting of the Geological Society of London and the Quaternary Research Association

Organizers

Dr Jasper Knight (j.knight@exeter.ac.uk) and Dr Stephan Harrison (Stephan.Harrison@exeter.ac.uk), University of Exeter, UK

Rationale

Periglacial and paraglacial environments, located outside the margins of past and present ice sheets but responding to similar climate forcings, are key to identifying climate change effects upon the Earth system. This is because they are relicts of cold Earth processes and thus are most sensitive to climate-change effects under a presently-warming climate, including changes in humidity/aridity, radiation balance, biodiversity and slope stability. In turn, these landscape effects impact on natural hazards and human activities. This meeting aims to explore some of these issues in an inter- and multidisciplinary framework, and across a range of timescales (from Quaternary to the future).

Present decreases in the distribution and thickness of permafrost, particularly in continental interiors, have implications for ecosystem and landscape stability, human activities and engineering solutions, and CO_2 degassing. This is mirrored in sensitive and marginal periglacial Alpine environments that are experiencing increased rockfall and mass movement, including solifluction, rock glacier instability, and changes in sediment release to downstream rivers. Likewise, a major initiative in sensitive glaciated mountain environments is to understand the processes of geomorphic change, the rate of landscape modification, and the nature of resulting paraglacial landsystems.

Two key questions present themselves. First, given that renewed paraglaciation will accompany future glacier retreat, and decreased extent of periglacial environments under global warming, how will we accommodate such geomorphological instability into our models of economic and social use of both mountain and lowland cold-climate regions? Second, how far can models of paraglaciation, and periglacial slope processes, be used to interpret the geomorphic evolution of these landscapes under future climate scenarios? This meeting will aim to address these questions through studies of both contemporary and Quaternary paraglacial and periglacial environments.

Audience

Because of the wide-ranging scope and interdisciplinary applications to present-day and future management of landscape change in sensitive environments, this meeting will be of interest to: Quaternary and Holocene scientists; mountain, periglacial, glacial, paraglacial geomorphologists; modellers; environmental managers; planners and engineers.

Abstracts

To present at this meeting, please submit an abstract (up to 250 words long, in MS Word format, with the presentation title, author(s) name and contact details) to either Jasper Knight (j.knight@exeter.ac.uk) or Stephan Harrison (Stephan.Harrison@exeter.ac.uk), before the deadline of 15 October 2006. Please specify whether an oral or poster presentation is preferred.

Registration

For registration details, please look at the website at http://www.geolsoc.org.uk/template.cfm?name=Periglacial_and_Paraglacial

Glaciological diary

** IGS sponsored * IGS co-sponsored

2006

30 January–3 February
International Arctic Science Committee, IASC, Working Group on Arctic Glaciology
Workshop on the mass budget of Arctic glaciers and the first planning meeting of GLACIODYN (IPY)
Universitätszentrum Obergurgl, Austria
Contact Carleen Tijm-Reijmer
E–mail: c.h.tijm-reijmer@phys.uu.nl

6–10 February
GLIMS workshop
Twizel, New Zealand
Contact: Shulamit Gordon, s.gordon@antarcticanz.govt.nz AND Jeff Kargel kargel@hwr.arizona.edu

16–18 March
The 36th Annual Arctic Workshop
INSTAAR, University of Colorado Boulder, Colorado, USA
See meeting web site
E–mail: ArcticWS@colorado.edu

2–7 April 2006
European Geosciences Union meeting, cryospheric sessions
Vienna, Austria
See: http://instaar.colorado.edu/meetings/AW2006

2–7 April
European Geosciences Union meeting, cryospheric sessions
Vienna, Austria
See: http://www.cosis.net/members/meetings/programme/view.php?p_id=184 and http://meetings.copernicus.org/egu2006/

8–12 May
2nd International Workshop on Ice Caves (IWIC-II) in Slovakia
Demänovská dolina, Slovak Republic
See http://users.unimi.it/icecaves/IWIC-II

10 May
Commemorative Symposium on the EGIG project initiated by the 1956 Greenland Expedition, 'Expedition Glaciologique Internationale au Grönland'
Eidgenössische Technische Hochschule (ETH), Zurich
Contact: Prof. Dr. Heinz Blatter, heinz.blatter@env.ethz.ch

14–17 May
Open Glaciology Session, Canadian Geophysical Union Annual Meeting
Banf, Alberta, Canada
Web: http://www.acs.ucalgary.ca/%7Ecguconf/
Conveners: Gwenn Flowers, gflowers@sfu.ca and Sarah Boon, boon@unbc.ca

15–16 May
Antarctic Peninsula Climate Variability: Observations, Models, and Plans for IPY Research
Hosted by the National Snow and Ice Data Center at the University of Colorado, Boulder, USA.
Web: http://nsidc.org/events/IPY_APCV
Contact: nsidc@nsidc.colorado.edu

5–9 June
Glacial Sediment Micro-Morphology Workshop
Hamilton College, Department of Geosciences, Clinto, New York, USA
Contact Danelle Parker for registration details (dparker@hamilton.edu) by 1 April 2006

7–9 June
The 63rd Eastern Snow Conference (ESC)
University of Delaware in Newark, DE, USA
See: http://www.easternsnow.org
Contact: Andrew Klein, klein@geog.tamu.edu

19–23 June
****International Symposium on Earth and Planetary Ice–Volcano Interactions.**
Reykjavík, Iceland
Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, UK
Web: http://www.igsoc.org/symposia

28–30 June
Geomorphology and Earth System Science
The British Geomorphological Research Group 2006 annual conference
Loughborough University, UK
See: http://www.lboro.ac.uk/departments/gy/gess/index.htm

5–7 July
***International workshop on Antarctic sea ice thickness**
Hobart, Australia. In conjunction with the SCAR Open Science Conference
Convenors: Dr Tony Worby (Australian Antarctic Division), email: A.Worby@utas.edu.au

Professor Steve Ackley (Clarkson University, USA), email: sackley@pol.net
See: http://www.aspect.aq/workshop2006.html

10–14 July
The 3rd Annual Meeting of the Asia Oceania Geosciences Society (AOGS 2006)
'Open Session on Glacier and Ice Sheet Research (IWG04)'
Singapore
see http://www.asiaoceania-conference.org/ > View Session Listing > Interdisciplinary Working Group (IWG) for more information about the session

12–14 July
Second SCAR (Scientific Committee on Antarctic Research) Open Science Conference on 'Antarctica in the Earth System'
Hotel Grand Chancellor, Hobart, Australia
see
http://www.scarcomnap2006.org/scarosc.php

23–28 July
International Conference on the Physics and Chemistry of Ice (PCI-2006)
Bremerhaven, Germany
Open Session on Glacier and Ice Sheet Research
see http://www.pcice2006.de

7–9 August
Asian Permafrost Conference
Lanzhou, China
see http://www.casnw.net/permafrost

21–25 August
*__International Symposium on Cryospheric Indicators of Global Climate Change__
Cambridge, UK
A joint CliC/IGS/ICSI Symposium
Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, UK
Web: http://www.igsoc.org/symposia

4–8 September
*__III International Symposium on Avalanches and Related subjects__
The contribution of theory and practice to avalanche safety
Kirovsk, Murmansk region, Russia Contact: Pavel Chernous at PChernous@apatit.com
Web: http://www.cas.kirovsk.ru/

13–14 September
*__IGS British Branch Annual Meeting 2006__
Keele University, UK
Contact the organisers at igs06@esci.keele.ac.uk
Web: http:// www.esci.keele.ac.uk/igs2006

14–22 September
9th International Symposium on High Mountain Remote Sensing Cartography (HMRSC-IX)
University of Graz, Austria Contact: Wolfgang Sulzer, wolfgang.sulzer@uni-graz.at
See: http://www.kfunigraz.ac.at/geowww/hmrsc/hmrsc_9/

1–6 October
International Snow Science Workshop, ISSW 2006
Tellurite, Colorado, USA
See: http://www.ISSW.net/

2–6 October
*__The Fourth International Conference on Mars Polar Science and Exploration__
Davos, Switzerland
The purpose of the conference is to assess the current state of Mars polar and climate research; discuss what might be learned from investigations of terrestrial analogs and the data returned from current and future missions; and identify the potential science objectives, platform options, and instrument suites for robotic missions to the Martian poles within the next decade
Conveners: Steve Clifford, Lunar and Planetary Institute; Walter Ammann, Swiss Federal Institute for Snow and Avalanche Research; Kathryn Fishbaugh, International Space Science Institute; David Fisher, Geological Survey of Canada; James Head III, Brown University
See:
http://www.lpi.usra.edu/meetings/polar2006

5–6 October 2006
Alpine 'Snow' Workshop
Munich, Germany
The workshop is organized by the Section Geography of the Faculty of Geosciences, University of Munich, and supported by the Berchtesgaden National Park administration (both Germany). The aim of the meeting is to bring together the snow research community for the exchange of ideas, experiences and visions. Meeting language is English
See: http://www.alpinesnowworkshop.org/

9–15 October
Water, ecosystems and sustainable development in arid and semi-arid zones
Urumqi, China
Organized by Ecole Pratique des Hautes Etudes (EPHE, France), Xinjiang University (China) and University of Tehran Contact: +33 (0)1.53.63.61.63 (Béatrice ARGANT) Watarid@ephe.sorbonne.fr
See: http://www.ephe.sorbonne.fr/watarid.htm

26–28 October 2006
*__IGS Nordic Branch Annual Meeting 2006__
Polar Environmental Center, Tromsø, Norway.
Contact Jack Kohler at jack.kohler@npolar.no

2007

15–16 January
Periglacial and paraglacial processes and environments, past, present and future
Geological Society, London, UK
Joint meeting between the Geological Society of London and the Quaternary Research Association
Organisers: Dr Jasper Knight (j.knight@exeter.ac.uk) and Dr Stephan Harrison (Stephan.Harrison@exeter.ac.uk), University of Exeter, UK
See: http://www.geolsoc.org.uk/template.cfm?name=Periglacial_and_Paraglacial

2–13 July
*__Union Commission for the Cryospheric Sciences (UCCS) symposium__
24th General Assembly of the International Union of Geodesy and Geophysics, titled Earth Our Changing Planet.
Perugia, Italy.
See http://www.iugg2007perugia.it/

27–30 August
Workshop: Representation of glaciers in runoff-models
Obergurgl, Austria
Sponsored by International Commission on Snow and Ice Hydrology (ICSIH) and Commission for the Cryospheric Sciences (CCS) Contact: Regine Hock at regine.hock@natgeo.su.se
See http://www.geo.su.se/Obergurgl2007

29–31 August
Polar Dynamics: Monitoring, Understanding, and Prediction
Open science conference
Geophysical Institute, University of Bergen.
Allegt 70, N-5007 Bergen, Norway
See:
http://www.gfi.uib.no/conference2007/info.htm
E–mail: conference2007@gfi.uib.no

3–7 September
**__International Symposium on Snow Science, Moscow, Russia__
Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, UK
Web: http://www.igsoc.org/symposia

2008

29 June–3 July
9th International Conference on Permafrost.
Celebrating the 25th Anniversary of the formation of the International Permafrost Association
University of Alaska Fairbanks, Fairbanks, Alaska, USA
See: http://www.nicop.orgn

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Books received

A. Kääb. 2005. *Remote sensing of mountain glaciers and permafrost creep*. Zürich, Geographisches Institut der Universität Zürich. *Schriftenreihe Physische Geographie Glaziologie und Geomorphodynamik 48*. 266 pp. (ISBN: 3-85543-244-9)

Bulat R. Mavlyudov. 2006. *Internal drainage systems of glaciers.* Moscow, Institute of Geography of the Russian Academy of Sciences, 396 + xxxii pp. 32 illustrations (16 black and white and 16 color) (in Russian) (ISBN 5-89658-030-4 (softcover)).

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Editor: M.M. Magnússon (Secretary General)

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