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Ice

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Contents

Cover picture: Seligman Crystal recipients in attendance at the Limerick Symposium on Dynamics in Glaciology. From left to right: Garry Clarke, Lonnie Thompson, Kolumban Hutter, Hans Röthlisberger. The photograph was taken following the award ceremony at which the Seligman Crystal was presented to Lonnie Thompson.

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

With this double issue of *ICE* we will have caught up with the publication of all IGS publications. It is a great relief but now the challenge is to maintain this. We of course rely on you to supply *ICE* with material you think may be of interest to your colleagues. If you organize a workshop or a meeting of any kind and would like others to know what is going on please write a short report and send it to us. Photographs are welcome; they always brighten things up and make it a more interesting read.

As I mentioned in the last ICE editorial we have been looking into the possibility of updating our membership software. Council has now decided to go ahead with this and we are hoping that parts of it will be operational in early 2009 in order for you to process your membership renewals online. This should enable us to have the majority of the membership renewals processed by the time we ship the first issue of *Journal of Glaciology* volume 55. In the past we have been processing membership renewals throughout the year and as a result we have incurred quite substantial shipping charges as it is much more expensive to ship individual copies of the *Journal* than when the bulk mailing is done by the printer, potentially saving us thousands of pounds. I would thus like you to closely monitor when the online renewal becomes active and then promptly renew your membership.

Not only will you be able to apply for membership or renew your existing one but you will also be able to complete your authorization to publish and offprint order online. The way it will work is that you will receive an e-mail from our production team informing you that the proofs of your paper are available for download. Once you have proofread your paper and have returned the proofs to us you can go on to our website and sign and submit the authorization to publish form and access your offprint order and page charge form. It will inform you about the page charges and the cost of your offprints, if any, and you will be asked how you would like to pay if there are any charges incurred. The options will be *By credit card* or *By invoice*. Should you choose the credit card option, you will be transferred to an encrypted secure site where you can safely enter your credit card details (just like when ordering from Amazon.com). But your payment will automatically be entered into our accounting software and thus show that you have paid whatever charges you have incurred. The other option will be *By invoice*. Should you select this option; an invoice will automatically be generated and raised on our accounting software. You can print out a PDF of this invoice to take to your accounts department. And when you submit the payment, either by cheque or preferably by direct deposit into the IGS accounts, please ensure that you reference the invoice number as indicated. We now have a UK sterling (£) account, a US dollar ($) account and a Euro (€) account so you can select which of those currencies you would like to pay in. The deciding currency is £ sterling and if you choose another currency the amount will be calculated automatically using the exchange for the current week. By doing so, the payment will be matched to the invoice and any confusion avoided. This 'payment option' process will of course be available for payments of new or renewed membership.

Another important item I can report to you is that Thomson Scientific has decided to include ISI Proceedings in the Web of Science. What this means is that any paper published in the *Annals of Glaciology* will be forward searchable from within your default WoS window, i.e. papers that are in the ISI Proceedings are now a part of Web of Science. See http://isiwebofknowledge.com/currentuser_wokhome/cu_productspecs/proceedings/. All citations made to your papers published in the *Annals* will count towards your citation index.

The ISI Proceedings are still not issued with an impact factor so the fight must continue. As part of that fight, Council has, on the recommendation of the publications committee, adopted a new *Annals* editorial policy. The policy is published in its entirety in the 'News' section of this *ICE* issue. The gist of it is that the *Annals* is now a thematic journal.

It is not only the impact factor that counts towards the 'validity' of your publication but also the visibility of your work. Now that Thomson has conceded on the issue of forward searching, at least half the battle is won. This will enable you to show your peers and superiors that papers that you have published in the *Annals of Glaciology* are being counted towards your overall citation index and thus give them a measure of your productivity.

At the time of this issue of *ICE* going to press, the total number of submissions to the *Journal* is fast approaching another record. This is the third year in a row you will have broken the submission record. This is an extremely well appreciated indication to the IGS staff that we are doing something right. This is also reflected in the fact that the *Journal* impact factor has risen by 31% between 2007 and 2008. We hope this trend will continue and I am confident it will, judging by the quality of papers being submitted.

Magnús Már Magnússon
Secretary General

Recent work

Austria

ALPINE GLACIERS

Long-term monitoring of length changes of Austrian glaciers

Gernot Patzelt (OEAV)

Since 1891 annual measurements of glacier length changes are carried out by the Austrian Alpine Association (OEAV). Specifically educated volunteers monitor the length changes of 105 glaciers located in 19 mountain ranges in the Austrian part of the European Alps. The original reports including photographic documentation are archived. Professional glaciologists compile annual reports comprising the recorded length changes and their classification into advancing/stationary/retreating/new snow covered, the number of markers watched, date as well as visible changes in morphology of the glaciers. Moreover, a summary is compiled across mountain ranges including discussion of the weather conditions during the observation period (normally October until September). For selected glaciers the changes of elevation profiles and velocity measurements based on markers are documented and analysed.

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Long-term mass-balance monitoring on Austrian glaciers

Michael Kuhn, Gerhard Markl, Ekkehard Dreiseitl, Herald Schneider, Astrid Lambrecht, Andrea Fischer, Friedrich Obleitner (IMGI), Wolfgang Gattermayr (HDT), Wolfgang Schöner (ZAMG), Klaus Reingruber (BS), Heinz Slupetzky (US), Hans Wiesenegger (HDS), Ludwig Braun (KGBAM)

In the light of the IPCC assessments, long-term glacier monitoring gained enhanced relevance. Hintereisferner (Ötztal Alps, Austria) is one of the Alpine bench mark glaciers, whose mass balance is monitored by IMGI and HDT according to the direct glaciological method since 1953. The neighbouring glaciers Kesselwandferner and Vernagtferner are monitored since 1953 and 1964, respectively. Meanwhile the Austrian glacier monitoring has been extended to include Jamtalferner (Silvretta, since 1989, HDT and IMGI), Mullwitzkees (Hohe Tauern, since 2007; IMGI, HDT and NPHT), Stubacher Sonnblickkees (Hohe Tauern, since 1964, US and HDS), Hallstätter glacier (Dachstein, since 2007; IMGI, BS, LOO and EA), Goldbergkees, Kleinfleisskees, Wurtenkees (Hohe Tauern, ZAMG and BOKU) and Pasterze (Hohe Tauern, ZAMG and TUV). At some of these glaciers regular measurements of ice velocity, ice thickness and length changes are performed. Moreover, dedicated meteorological stations and precipitation measurement networks in the vicinity of some of these glaciers or measurements of the energy balance provide valuable background for special projects and diverse modelling efforts.

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Glacier change monitoring in the Hohe Tauern Range, Austria

Heinz Slupetzky (HDS and US), Hans Wiesenegger (HDS), Martin Kiskemper (FHUB), Michael Avian (TUG)

Mass balance of the Stubacher Sonnblickkees has been monitored since 1964, using the direct glaciological method until 1981 and from then onwards using a semi-direct method. With extrapolations the series can be extended back to 1959. A considerable mass loss has occurred caused by climate warming and is superimposed by a disintegration of the glacier, due to subglacial caves, rock outcrops and development of proglacial lakes. 3D-terrestrial laser scanning using LMS-Z420i (EGEO) and mapping of the glacier (FGGUS) are carried out repeatedly as well as continuous lake level recordings and discharge measurements of its outlets (HDS).

Since 1965 a nearly uninterrupted long-term series of ice velocity measurements (with FH in recent years) on the Oedenwinkelkees have been carried out giving a unique insight into the reaction of the glacier to mass balance changes.

The Obersulzbachkees is monitored by means of terrestrial Lasers Scanning (EGEO) and aerial photogrammetry (2006). Since 1988 the discharge has been recorded at the hydrological station Kees - Obersulzbach (HDS).

During the hot summer of 2003 in Central Europe, with extreme high equilibrium line positions, an aerial photogrammetric survey (Luftbild Fischer AG Klagenfurt) was initiated covering the Stubacher Sonnblickkees and the Oedenwinkelkees as well as the Pasterze glacier and adjacent glaciers. Photogrammetric analyses (TUG) resulting in DGM's and ortho-images will enable the production of new glacier maps allowing comparisons to the Austrian Glacier Inventory.

The cone of an ice avalanche from Nördliches Bockkarkees was surveyed in 2003 enabling corrections to the recorded avalanches in the last decades, which were only roughly estimated (FGGUS, EGEO, IGRG).

Annual measurements of the length variations of 14 glacier tongues in the Hohe Tauern Range are carried out as part of the OeAV long-term programme.

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Mass balance monitoring on Weissbrunnferner and Langenferner, Italian Alps

Rainer Prinz (ITGG), Georg Kaser (ITGG), Christoph Oberschmied (HAB), Roberto Dinale (HAB), Michela Munari (HAB), Fabio Gheser (HAB)

Since 1991, glacier mass balance is measured on Weißbrunnferner, a glacier situated in the Ortles/Cevedale group in South Tyrol, Italy. Measurements and observations are made in the framework of the Hydrology Department of the Regional Administration of the Autonomous Province of South Tyrol. Weißbrunnferner is an east facing slope glacier with a total surface area of 0.65 km^2. Mass balance is obtained for winter and summer separately from field measurements according to the direct glaciological method. Notably, this glacier lost its entire firn reservoir over the observed period which results in a negative feedback due to low albedo over the glacier surface as soon as winter snow is gone. Stake movement has almost come to zero and, moreover, the glacier has started to disintegrate and will soon consist of two separate units. For this reason and in order to provide a series that overlaps the Weißbrunnferner one, mass balance studies have been initiated on Langenferner in the nearby Martell valley in 2003. Both series are reported to WGMS.

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Austrian glacier inventories

Michael Kuhn, Astrid Lambrecht, Andrea Fischer, Jakob Abermann (IMGI), Rainer Würländer, Konrad Eder (TUM)

Ongoing effort is related to surveying Austrian glaciers for a new inventory (Austrian glacier inventory 1998, IMGI). As a basis, aerial photographic surveys have been carried out between 1996 and 2002. Semi-automatic methods are used for photogrammetric analysis providing digital elevation models, glacier objects and digital ortho-images as basic results. Comparison with a former Austrian glacier inventory from 1969 yields differences in glacier surfaces, which forms the basis for detailed investigations of the development of the Austrian glaciers during the last 35 years. Moreover, ice thicknesses were measured at a number of 52 Austrian glaciers.

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Glacier Inventory 1997 for South Tyrol

Hanns Kerschner, Christoph Knoll (IGUI), Roberto Dinale (HAB)

Based on air photographs from 1997, a glacier inventory for the Italian province of South Tyrol has been compiled according to the standards of the World Glacier Inventory. In autumn 1997, 259 glaciers covered an area of 109.7 km^2, 26.9 km^2 less than in the last inventory from 1983. As glaciers in 1997 were in a clear imbalance with climate, a further rapid retreat of the glacier covered area can be expected in the near future. The inventory, which is entirely GIS-based, can be used for modelling future scenarios. It is not unlikely that by the middle of the 21st century only few glaciers with much reduced areal extent will still exist.

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Development of Operational Monitoring System for European Glacial Areas (OMEGA)

Petri Pellikka (UTF), Henrik Haggren (HUT), Johann Stötter (IGIU), Maaria Luukkonen (NS), Aleksey Sharov (JOAN), Kjell-Arild Høgda (NORUT), Miriam Jackson (NWR), Michael Kuhn (IMGI)

The aim of OMEGA was to develop an operational monitoring system for glacial areas using all the potential earth observation data of the past, present, and future. The Austrian partners (IMGI, IGIU, JOAN) contibuted to monitoring of the changes in glacier topography and area by the use of old terrestrial and aerial photographs applying stereophotogrammetric techniques and by the use of modern techniques applying radar data, laser scanner data and optical data remote sensing data, respectively. Hintereisferner (Austria) was one of the two test glaciers.

The first approach aimed on developing new methods for remote sensing of glaciers. Delineation of glacial areas and glacier zones is based on optical satellite imagery and construction of digital surface models of the study glaciers using all the potential data. The accuracy of the surface models is validated by the comparison of the models constructed from different sources and by field measurements. Radio-echo sounding is applied in order to define the bedrock topography and to study the changes in glacier volume. In addition, the changes of the test glacier will be represented by the use of computer cartography, visualization and animation. The resultant algorithms and program tools for georeferencing, co-registering, combining, interpreting and integrating multisensor and multitemporal image and non-image remote sensing data will be implemented. Together with glaciological and meteorological records the results can be combined in regional glacier databases. The result of the project is a

glacier monitoring system, which can utilize remote sensing data from various sources and an open glacier database over several European glaciers. The monitoring system and glacier database is aimed at the support of natural exploration, socio-economic activities and environmental protection in European mountainous areas. It will be also useful in operational glacier mass balance monitoring and in global change studies, since the changes in glacier volume can be indicators of global change.
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Integral glacier monitoring system
Andrea Fischer (IMGI)
In 2005 a project on developing an integral glacier monitoring system (IGMS) has been launched investigating the volume differences between the geodetic and direct glaciological method on Hintereisferner and Kesselwandferner, respectively. A method including webcam data and using data assimilation will be developed to improve spatial interpolation of point measurements of mass balance.
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Future scenario Pasterze
Wolfgang Schöner (ZAMG)
Pasterze is the largest glacier within the Austrian Alps with high public and economical interest because of local tourism and use of melt water for storage power station. The glacier is strongly retreating since the end of the 19th century and is still far away from equilibrium to climate. Measurements of mass balance, ice flow and and ice thickness are used to calibrate and validate a statistical mass balance model and an ice flow model. The calibrated model will be used to compute future glacier scenarios. To test the stability of statistical transfer functions used in the statistical model modelled mass balances are compared to the output from a physical based mass balance model.
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TROPICAL GLACIERS

Quantifying climate change in the tropical mid-troposphere from glacier recession on Kilimanjaro (East Africa)
Thomas Mölg, Michael Winkler, Georg Kaser (ITGG), Nicolas Cullen (UOTA),
Douglas R. Hardy (UMASS), Tharsis Hyera (TMA), Juliana Adosi (TMA)
Information on climate change from the mid troposphere (~5–6 km above sea level) is still scarce, and simulations with global climate model disagree in that region. High-altitude glaciers in the tropics, like those on Kilimanjaro, provide a chance to reconstruct climate change in the mid-troposphere if the processes of the present glacier-climate interaction are understood. This project combines four different tools in terms of the methods: high-altitude field measurements (con ducted with automated weather stations between 5700 and 5900 m a.s.l.), process-based glacier mass balance modeling, numerical atmospheric modeling and global climate model output. This powerful mix is analysed along with climate proxy data from the literature (e.g., lake levels, lake sediments), in order to quantitatively reconstruct the change in climate between stable glaciers on Kilimanjaro around 1880, and retreating glaciers at present. This will provide an independent validation data basis for palaeoclimate simulations with global climate models.
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Calibrating and validating of a low latitude glacier mass balance model and its application for climatological and hydrological studies.
Irmgard Juen, Christian Georges, Martin Hölzli, Michael Winkler, Georg Kaser (ITGG), Patrick Wagnon (IRD-LGGE), Mathias Vuille (UAlb), UGRH-IRD
A glacier mass balance model was developed that meets both the particularities of tropical climate regimes and the limited availability of data input in tropical mountain regions. It was calibrated and evaluated on 1953–97 time series of monthly temperature and precipitation data from the Cordillera Blanca (CB), Peru, and from detailed measurements of automatic weather stations, stake measurements, and precipitation and runoff measurements carried out in the field since 1999. The CB is the most intensive glacierized tropical high mountain range with a glacier area of 618 km? in 1990. During the dry season, water availability in the intensively populated Rio Santa valley mainly is from glacier melt water runoff. Based on respective runoff information from differently glacierized sub-catchments of the CB, the mass balance model was extended to the powerful runoff model ITGG-2.0-R. Past and present seasonal runoff is successfully simulated and variations are attributed to respective climate variations, namely of atmospheric moisture content and temperature. From various IPCC 2001 climate change scenarios potential future changes in runoff from fife differently glaciated catchments was modelled. Accordingly, glaciers will shrink but not disappear at all by 2080. Runoff in the catchment of e.g. Parón (highest glacierization of 41% in 1990) is expected to increase by 18–42 % in the core wet season and to decrease by 20–28 % in the core dry season. Particularly the dry season runoff decrease will conflict with the steadily increasing water

demand. For improving the model and in order to understand the governing processes, distributed radiation schemes were explored, detailed sublimation measurements carried were out, and analyses of mass balances and large scale climate patterns are made.
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Modelling the energy balance of a tropical glacier in the Cordillera Blanca and the implications for regional water resources
Javier G. Corripio, Georg Kaser, Irmgard Juen (ITGG), UGRH-INRENA
We have extended the monitoring of two glaciers in the Cordillera Blanca, while applying a distributed energy balance model to one of them: Glacier Artesonraju, 9S, 78W, in the Andes of Peru. The model is fed with data from three automatic weather stations situated on and in the vicinity of the glacier, plus atmospheric profiles from general circulation models. The fitness of the model is assessed by daily photographic records of snow cover, monthly ablation measurements on a limited number of ablation stakes and by measured volume changes in a lake draining the entire basin. We assess the effect of changing climatic parameters on the glacier from the historical record over the last 50 years (reanalysis data). From this assessment we found that temperature can explain only less than 50% of energy input variations, while cloud cover and humidity are responsible for most of the rest. The aim is relating the regional climatic setting to the evolution of the glacier and therefore to the available water resources in the Cordillera Blanca.
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Dynamical downscaling above tropical glaciers (Cordillera Blanca, Perú)
Marlis Hofer, Georg Kaser, Thomas Mölg (ITGG), Patrick Wagnon (IRD, LGGE), Mathias Vuille (UAlb), UGRH-INRENA.
Since low-latitudinal glaciers are located at high altitudes, they represent a unique source for climatologic reconstructions in the tropical troposphere, where measurements are sparse and controversial. From a socio-economic point of view, however, glacier mass balance studies in the outer tropical Cordillera Blanca (CB) are of particular interest: they provide the basis for runoff reconstructions and projections in the highly populated Rio Santa valley (Perú), where glacier melt is the primary water source during the dry season. The goal of this project is to provide input data for process-based glacier mass balance studies in the CB, required at high spatial and temporal resolutions. For meeting this scope, regional climate models (RCMs) are applied to extract spatially detailed patterns of the diurnal climatology in the CB from coarse scale reanalysis data (e.g., NCEP/NCAR), a method denoted dynamical downscaling (DD). Since 2004, automatic weather stations have been maintained in the CB (Glaciar Artesonraju and Glaciar Shallap). Hence observational data sets are available now for the validation of the RCM results. So-called statistical downscaling (SD) has been performed and will be tested further. Given their low computational demand, SD represents an attractive alternative to the computationally expensive DD.
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HIMALAYAN GLACIERS

Glaciological characteristics of the ablation zone of Baltoro Glacier, Karakoram, Pakistan
Claudio Smiraglia, C. Mihalcea, M. Belò and G. Diolaiuti (SDUM), Christoph Mayer (CGBAS), Astrid Lambrecht (IMGI)
Baltoro Glacier is one of the world´s largest valley glaciers, draining an area of about 1500 km? and showing a total length of more than 60 km. In 2004 a joint expedition carried out a glaciological field program on the ablation zone of the glacier, focussing on the determination of the recent mass balance state of the glacier. These modern conditions then can be related to earlier available measurements, esp. from the A. Desio expedition of 1954.

In combination with remote sensing imagery new techniques were developed for the determination of sub-debris ablation over larger regions. Also the mass fluxes from the upper parts of Baltoro glacier have been estimated on the basis of these measurements. The future work will focus on the evaluation of historical changes in relation to climatic conditions and the temporal development of the debris cover and its role in the overall mass balance.
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Reactions of Eurasian glaciers to climate variations, a zonal comparison study
Astrid Lambrecht (IMGI), Christoph Mayer (CGBAS), Wilfried Hagg (LMU), M. Shahgedanova (UR) and G. Glazirin (HRIT)
Alpine type glaciers show a strong reaction to observed climatic changes worldwide. For many regions in continental Asia melt-water from glaciers is an important source during dry periods. A comparison between well studied glaciers in the Alps and the glacier evolution along the Eurasian mountains from the Alps to Southern Siberia will provide a new insight into the influence of climatic conditions on glaciation.

For most regions historic data are available which will be combined with modern field

observations and remote sensing data to determine changes in the glacier systems during the last 30–40 years, with a focus on the development of supraglacial debris cover. The comparison of the regions allows the evaluation of regional ice cover conditions and its potential future development. The significance of the glacier systems for the seasonal and long-term water production will be investigated.
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Stability conditions of the ice dam of Merzbacher Lake, Inylchek Glacier, Kyrgyzstan
Christoph Mayer (CGBAS), Astrid Lambrecht (IMGI), Wilfried Hagg (LMU), H.U. Wetzel, A. Helm (GFZP) and W. Michajljow (ZAIAG)
Southern Inylchek Glacier (42° 11′ N, 79° 50′ E) forms a natural dam for Merzbacher Lake situated in a tributary valley to the North of the main glacier. This lake regularly drains in the peak melt season through the 15 km long glacier tongue of Southern Inylchek Glacier, creating massive glacier outburst floods with outflow rates of more than 1000 m^3/s. In a joint effort, the conditions of the lake and especially the reaction of the ice dam to filling and discharge of the reservoir have been investigated.

During refilling of the lake after the onset of the melt season, large amounts of ice are discharged into the lake. This leads to a strong mobilization of the glacier dam. Detailed measurements aimed at the determination of the mass budget of the ice dam (ice flux and ablation conditions) and the dynamic reaction connected with the sudden lake drainage. This lake/glacier system is now selected as a focus for mass balance-climate and hazard investigations in the coming years.
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SUBARCTIC/CANADA

Investigations on the Cathedral Massif Glacier, B.C. Canada
Heinz Slupetzky, Walter Gruber (FGGUS), M.M. Miller (JIRP-logistics)
On the Cathedral Massif Glacier, situated on the east slope of the Boundary/Coast Range, a resurvey was carried out in 1999 to provide a new map/DGM for the calculation of the mass change since the survey of 1977. The PhotoModeler Pro software was applied for glaciological purposes for the first time (W. Gruber). The glacier lost considerable mass in the above mentioned period. The mass balance was measured in detail in 1977 and 1978, using the direct glaciological method. In 2004 the changes of the terminus were mapped again by means of terrestrial photogrammetry. Glaciomorphological investigations provide very new insights into the variations of the Cathedral Massif Glacier in late and post glacial time (in cooperation with Robert Krisai, US).
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POLAR GLACIERS AND ICE SHEETS

Stable isotopes of snow and ice in Antarctica
Elisabeth Schlosser (IMGI)
For a correct climatic interpretation of firn and ice cores, a thorough knowledge of the atmospheric processes that formed the snow/ice is necessary. The precipitation regime of Dronning Maud Land (DML), Antarctica, is studied in cooperation with NCAR, Boulder, CO, using data from the Antarctic Mesoscale Prediction System (AMPS) archive. A high-resololution precipitation map of DML was created that shows good agreement with a recently published accumulation map of Western DML. Interannual variability of monthly sums of precipitation was found to be fairly high due to the influence of cyclone activitiy on precipitation, which affects not only the coastal regions, but also the interior regions of the continent much more than previously thought. The results of the precipitation study will be used for an extensive investigation of stable isotope ratios from about 60 firn cores, which were drilled during the EPICA pre-site survey expeditions by German, Scandinavian, and British expeditions. This investigation is carried out in close cooperation with NPI and AWI.
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Climate sensitivity of glacier mass balance: the effect of topographic barriers
Johannes Oerlemans, J. De Wolde (IMAU), H. F. Vugts, Paul Smeets (FUA), Helgi Björnsson, Finnur Pallson (SIUI), Michael Kuhn, Friedrich Obleitner (IMGI)
A network of 16 automatic weather stations was operated within a comprehensive meso-scale glaciometeorological experiment on Vatnajokull ice cap (Iceland) during a whole summer period (TEMBA). The project aimed at determining the mass and energy balance of the ice cap, their spatial and temporal variability and their sensitivity to climate change. IMGI contributed to the project by measurements of the mass and energy balance close to the equilibrium line of Breiðamerkurjökull, a major outlet glacier of Vatnajökull. The atmospheric boundary layer was intensively probed by mast profiles and tethered balloon measurements. The energy budget components were related to distinct regimes of meso-scale atmospheric flow. Special emphasis was given to the investigation of lee effects and an associated low cloudiness phenomenon.
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The response of arctic ice masses to climate change
Jon Ove Hagen (UO), Johannes Oerlemans (IMAU), Helgi Björnsson (SIUI), Julian Dowdeswell (UB), L. Reynaud (LGGE), P. Holmlund (SU), E. Isaksson, J. Kohler (NPI), Michael Kuhn, Friedrich Obleitner, Ulrike Nickus (IMGI)
ICEMASS aimed on enhanced observation of a representative set of Arctic glaciers and modelling of their climate sensitivity. IMGI contributed to the project by meteorological and glaciological investigations on Franz-Josefs-Land (snow chemistry on Ziegler Island), on Severnaya Zemlya (meteorological measurements on Academia Nauk ice cap) and Spitzbergen (mass and energy balance measurements on Kongsvegen glacier with special focus on superimposed ice).
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Kongsvegen Automatic Weather Stations (KAWS)
Friedrich Obleitner (IMGI)
KAWS supports the long-term maintenance of a network of automatic weather stations along the centerline of Kongsvegen glacier, Svalbard. The network is operated in close cooperation with Norwegian partners (NPI) aiming on long-term measurements of the energy balance components including snow/ice temperatures and surface height changes. Data are available since the year 2000, which have been used for analysis of the mass and energy balance of the glacier, validation of remote sensing retrievals (albedo) and investigation of the formation of super imposed ice. Moreover, the data are valuable in context of regional environmental monitoring and education.
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Franz Josef Land Environmental Research and Assessment Project
Andreas Richter, Michaela Panzenböck (UV), Birgit Sattler, Roland Psenner, Andreas Fritz (IEI), Ulrike Nickus, Michael Kuhn (IMGI), Wolfgang Schöner, Bernhard Hynek (ZAMG), Aleksey Sharov (JOAN)
This project is a pilot study for a longer-term research programme called FERMAP, which encompasses about 45 scientists from 5 Austrian universities and 3 non-university organizations which have agreed develop a joint programme within the framework of the International Polar Year (IPY 2007/2008). FERMAP is a research initiative which is part of the IPY COMAAR (Consortium for coordination of Observation and Monitoring of the Arctic for Assessment and Research) project that has recently been approved by ICSU as part of the IPY 2007/2008. Since the target region Franz Josef Land is closed for scientific intentions the project has been transferred to Greenland.
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ICE CAVES IN THE AUSTRIAN ALPS

Austro-ice-caves 2100
Christoph Spötl (IGPI), Dietmar Wagenbach, Barbara May (UHEI), Wolfgang Schöner, Gernot Weyss (ZAMG), Friedrich Obleitner (IMGI), Rudolf Pavuza (MNHV), Michael Behm (IGGV), Walter Kutschera, Peter Kutschera (AMS), Sepp Kipfstuhl (AWI), Norbert Pfeiffer, Thomas Geist (IGIU), Sigmar Bortenschlager (IBI)
The Eastern Alps host a great number of underground glaciers. AUSTRO-ICE-CAVES 2100 is a multi-disciplinary project which aims on establishing an overview about the existence and distribution of ice caves in Austria, to get a basic physical understanding of the atmospheric circulation and relationships to the development of ice within the caves, to develop constraints on their future development and to assess the unexplored potential of this ice as a paleo-climate archive in the central European Alps. The basic investigations consider a dynamically ventilated ice cave (Eisriesenwelt, the largest known ice cave in the Austrian Alps) where several weather stations, energy and mass balance measurements as well as geological, mineralogical and isotopic analyses are performed. Moreover, analysis of long-term temperature records is performed, laser scanning and geo-radar methods have been applied and an ice core has been retrieved, which is subject to chemical analysis and age dating.

Following a similar concept, meteorological and glaciological monitoring has been initiated on the Hundalm ice cave, which is located in western Austria (Tyrol).
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Ice radar in ice caves
Michael Behm (IGGV), Helmut Hausmann (TUV)
Several caves in high elevated alpine regions host massive ice fillings and underground glaciers. We applied ground penetrating radar (GPR) to determine the ice thickness in three ice caves in the Northern Calcareous Alps of Austria. It could be shown that shielded antennas with relatively high frequencies (500 MHz) are sufficient to penetrate the ice up to 15 m depth. In almost all radargramm sections, the lower boundary of the ice body is identified by the onset of strong and sharp reflections. We attribute this to either increased humidity at the ice - rock contact (due to melting) or to a sedimentary layer between ice and rock. Pronounced layering of the ice body

itself is clearly seen at some locations, which may results from alternating air content or thin sedimentary layers. The maximum thickness is 15 m. The propagation velocity of the electromagnetic waves (0.165 m/s) is close to the velocity of temperate glaciers. Additionally, DC resistivity methods were applied to estimate the electric conductivity of the ice bodies.
Contact: mbehm@mail.tuwien.ac.at

REMOTE SENSING

Remote sensing of glaciers, ice sheets and snow
Helmut Rott (IMGI, ENVEO), Thomas Nagler (ENVEO), Markus Heidinger (ENVEO), Eyjolfur Magnússon (IMGI), Petra Malcher (ENVEO), Florian Müller (ENVEO), Gabriele Bippus (ENVEO)
Methods for extracting glaciological information from Earth observation (EO) satellite measurements are developed. EO data are applied for glacier research and snow hydrology. The focus of the ongoing methodological work is on scientific preparations for a new dual frequency (Ku- and X-band) radar satellite mission (CoreH2O) for snow and ice monitoring for which feasibility studies are going on at the European Space Agency (ESA). Field campaigns on Ku- and X-band radar backscattering of snow and glaciers have been carried with airborne and ground based radar sensors in cooperation with international partners. In addition, theoretical work on radar propagation in snow and studies on data assimilation techniques for integration of satellite products in snow and ice process models are performed.

Application of EO data for glaciological studies is based on in-house developed software for radar (SAR) data processing, including interferometry and on analysis of optical imagery. Ice dynamic studies, based on SAR data from ERS; Envisat and TerraSAR-X are carried out in Iceland (Vatnajökull), on Larsen Ice Shelf and outlet glaciers of the Antarctic Peninsula, and on glaciers of the Southern Patagonia Icefield. A glacier mass balance model that uses EO (SAR and optical) and meteorological input data has been developed and applied to glaciers in the Austrian Alps, in Norway, and in Patagonia. Snowmelt runoff simulations and real time forecasting has been carried out for drainage basins of the Austrian and Italian Alps, using snow cover information from satellites in synergy with meteorological observations and forecasts. In addition, ENVEO contributes to GlobGlacier, a project supported by EA and lead by WGMS (University of Zürich) aimed at exploiting satellite data archives for closing major gaps in the global glacier data base.
Contact: helmut.rott@uibk.ac.at

Airborne laser scanning data sets and studies
Thomas Geist (IGIU), Bernhard Höfle (AlpS), Martin Rutzinger, Norbert Pfeifer (AlpS), Johann Stötter (IGIU), Kathrin Bucher (IGIU), Martinus Kodde (TU Delft), Phillip Rastner (IGIU)
At IGIU an unique airborne laser scanning data collection exists, consisting of 14 data sets from Hintereisferner and Kesselwandferner (Ötztal Alps, Austria) acquired between 2001 and 2007 and of 4 data sets from Engabreen (Svartisen, Norway) acquired between 2001 and 2003. The following studies were carried out with these data sets: Annual (and partly intra-annual) analysis of glacier surface elevation changes; Comparison of laser DEMs (Digital Elevation Models) with DEMs from other data sources; Derivation of ice flow directions and flow velocities, which are the basic inputs for mass balance models; Differentiation of the glacier surface into crevasses, snow, firn and ice by segmentation and classification of the laser point cloud using geometry and the amplitude of the backscattered ALS signal; dynamic 3D-visualization of Hintereisferner and Kesselwandferner. A recently started project will compare laser scanner information with products of the TerraSAR-X radar satellite mission at Hintereisferner.
Contact: thomas.geist@ffg.at

APPLIED GLACIOLOGY

Foundations of cable car towers upon alpine glaciers
Wolfgang Fellin, Bernhard Lackinger (IIE)
A design approach for strip footings upon glacier ice has been developed. Safety against ultimate limit state is proved by the geotechnical slip-line field solution by Prandtl. Glacier ice at melting temperature is modelled as purely cohesive material. Statistical evaluation of uniaxial compression tests with high strain rate revealed characteristic values of the cohesion. An approximate solution for estimating the creep settlement rate has been developed to check the serviceability limit state. Experiences on Stubai glacier with grate shaped footings showed that creep settlements occurring per year due to maximum foundation pressures did not influence the operation and the maintenance of the cable cars.
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Investigation of technical measures to reduce ice ablation at glacier skiing resorts
Michael Kuhn, Andrea Fischer, Friedrich Obleitner (IMGI), Roland Psenner, Heribert Insam, Birgit Sattler (IEI)
The project considered the investigation of measures to reduce ablation at glaciers hosting skiing resorts, which gained considerable public outreach. Based on two years of observation at four

Austrian glacier skiing resorts, IMGI developed scientifically based recommendations regarding the effect and practical application of artificial compaction, covering and injection methods, respectively. There have been accompanying investigations of potential ecological and biological effects of different measures.
Contact: michael.kuhn@uibk.ac.at

Climatology of artificial snow production (2007)
Andrea Fischer, Marc Olefs, (IMGI), Josef Lang (ZAMG)
Up to 40 years of wet-bulb temperature time series on 14 locations in Austria were analysed. Aim was to investigate variability of conditions for artificial snow production.
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Mass balance in ski resorts
Andrea Fischer, Marc Olefs (IMGI)
Volume and volume change data is used fort the development of plans for local glacier conservation in ski resorts. Local change of mass balance due to wind drift is investigated.
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Alpine snow and air pollution
Friedrich Obleitner, Johannes Vergeiner, Esther Griesser (IMGI), Stefan Emeis (IMK-IFU)
During winter 2005/2006 a comprehensive measurement campaign has been performed in the Unterinntal valley (Austria) focussing on air pollution and noise in relation to the specific meteorological and topographical conditions in Alpine terrain (ALPNAP). In this context, the evolution of seasonal snow cover plays an important role too, e.g. with respect to the strength and persistence of inversions, which predetermines the distribution of air pollutants. In this context a mass and energy balance model was employed for process-oriented investigation of the seasonal evolution of the snow pack and its interaction with the atmosphere and the underlying soil, respectively. Micrometeorological data enabled for in depth investigation of the inversion structure and implications on modelling turbulent heat fluxes above snow and air pollutant concentration with stably stratified atmospheric conditions.
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GLACIER HYDROLOGY

Transformation of observed and computed ice- and snowmelt data to ungaged basins
Wolfgang Schöner (ZAMG), Hubert Holzmann (BOKU)
The contribution of glaciers to stream flow is modelled by a distributed hydrological model for an about 500km² large glacierized catchment area in the Austrian Alps. The hydrological model (PREVAH) enables not only snow- and ice melt modelling based on a degree-day approach but also a fully physical based modelling of melt processes. For detailed calibration and validation PREVAH is applied to the well monitored Sonnblick region. Model results are validated against measured discharge, snow cover area derived from satellite data and measured glacier mass balance. Our aim is to quantify the contribution of glacier melt to stream flow under different climate conditions including the extraordinary hot summer 2003.
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Effects of glacier change on runoff
Michael Kuhn, Marc Olefs, Andrea Fischer (IMGI)
Within the project STARTCLIM, data from the Austrian glacier inventory 1998 are used to estimate the runoff changes with the OEZ runoff model.
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Integrative techniques, scenarios and strategies for the future of water in the Upper Danube Basin (GLOWA Danube)
Wolfram Mauser, Günther Zängl, Rolf Hennicker, Jürgen Schmude (LMU), Roland Barthel, Jürgen Braun (US), Friedrich Barth (IFOK), Karl Schneider (GIK), Andreas Ernst (CESR), Peter Egger (IFO), Stephan Dabbert (UH), Daniela Jacob (MPIH), Hans Weber (LFUA), Michael Kuhn (IMGI)
The aim of GLOWA is to develop simulation-tools and instruments which will allow developing and realizing strategies for sustainable and future-oriented water management at regional level (river basins of approx. 100,000 km?), while taking into account global environmental changes as well as socio-economic framework conditions. Within GLOWA five large cluster projects have been started, focussing on catchment areas in Europe (Danube, Elbe), North and West Africa (Drâa, Ouémé, Volta) as well as in the Middle East (Jordan). The sub-project GLOWA-Danube is targeted to hydrological simulation of the catchment areas of the rivers Inn and Salzach, which are partly glacierized. These simulations cover an area of 73,000 km² on a 1km grid, treating the principal hydrological components (soil, vegetation, feedback to consumers and political and economic decisions). The Austrian partner (IMGI) is mostly engaged in developing modules treating the accumulation and ablation of snow in 1 hourly time steps and parameterizing the impact of glacier run off in response to climate change scenarios.
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PERMAFROST

Permafrostmonitoring Sonnblick
Wolfgang Schöner, Michael Staudinger (ZAMG)
In 2006 a permafrost monitoring was started in the Sonnblick region (Austrian Alps) close to the Sonnblick Observatory. The monitoring includes spatially distributed measurements of ground surface temperature, snow temperature, snow depth, snow depletion (by an automatic camera) and a rock-glacier monitoring. This distributed monitoring approach completes the permafrost monitoring programme at the summit of Sonnblick which covers three boreholes (each borehole is about 20m deep equipped with temperature sensors and 1 borehole is equipped with geophones), a geoelectrical profile and ground (rock) surface temperature measurements.
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Permafrost in Austria
Karl Krainer (IGPI), Ewald Brückl, Helmut Hausmann (TUV), Günther Blöschl (TUV), Michael Staudinger (ZAMG)
The objectives of this project are a quantitative documentation of alpine permafrost in a well defined high alpine catchment, the reaction of alpine permafrost on climate change, and the modelling of the discharge pattern under scenaria of changing permafrost. The project is divided into two parts.

Part 1 focusses on the Weißsee peak (Kaunertal, Ötztal Alps) where active rock glaciers and patterned ground indicate the presence of extensive alpine permafrost. The present distribution, thickness, and ice content of alpine permafrost will be investigated by applying a combination of different methods including mapping, study of aerial photographs, geophysical surveying, ground temperatures etc. Data on the local climate, precipitation and discharge pattern in the study area will be included.

Part 2 covers the peak of the Sonnblick (Hohe Tauern), where a GAW observatory provides climate data since 120 years. The influence of climate change on permafrost will be investigated by monitoring during the project (4 years) and by analysing maps and photographic documents. The monitoring program will include meteorological, hydrological, geophysical and geodetic measurements. The reactions of alpine permafrost on climatic changes and the resulting changes in the discharge pattern will be described on the basis of models. The inclusion of future climatic scenaria should reveal the significance of alpine permafrost on the hydrological regime.

The new results from the study area will be compared with data from other areas covered with alpine permafrost. It is planned to achieve criteria for the transformation of the perceptions to other areas of alpine permafrost. Finally, the results shall be valued in a global context and combined with objectives of ISDR or the IPY.
Contact: karl.krainer@uibk.ac.at

Hochebenkar rock glacier monitoring program
Karl Krainer (IGPI), Heralt Schneider, Ulrike Nickus, Jakob Abermann, Michael Kuhn, Andrea Fischer (IMGI)
Rock glacier Hochebenkar (Ötztal Alps) is monitored since more than 60 years. Measurements of runoff, flow velocity and geomorphological mapping are carried out. The chemistry of runoff water is investigated.
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Climate change and its impacts in southern Austrian alpine regions
Andreas Kellerer-Pirklbauer, Gerhard Karl Lieb (IGRG), Michael Avian (TUG)
The project ALPCHANGE investigates the interaction of present climatic conditions and high mountain processes and ground thermal regime (e.g. effect on glaciers and permafrost) by use of an upgraded monitoring network established for the very first time in southern Austria. Focus is laid on the analysis of signals from various dynamic landscape parameters - permafrost, geomorphodynamics, glaciers and snow - for the ongoing climate change by a series of methods and by looking at different time scales (in total the period between end of Little Ice Age c.1850 AD and today). The four landscape parameters react in differing time scales to climate change and therefore provide different information: snow cover instantly, glaciers within years to decades (depending on size), geomorphic features within years to decades and permafrost within decades to centuries. The interdisciplinarity of the project requires usage of different methods – automatic monitoring, field work, GIS, laboratory work, conceptual and numerical modelling and remote sensing – and makes the co-operation of a number researcher with backgrounds in glaciology, geography, geophysics, atmosphere as well as climate physics, geology and remote sensing necessary.
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AVALANCHE RESEARCH

Snow and avalanche test site
Lambert Rammer, Rudolf Sailer, Peter Höller, Andreas Schaffhauser, Philipp Jörg, Reinhard Fromm, Marc Adams (BFW)
Since 2005 the Department of Natural Hazards and Timberline operates a test site in Wattener Lizum close to Innsbruck (Tyrol, Austria). The test

site is equipped with several automatic weather stations. Additionally to regular weather information temporarily snow cover investigations are carried out. Particularly remote monitoring with a terrestrial laser scanner (TLS) and a ground based interferometric synthetic aperture radar (GB SAR) deliver supplementary information about snow cover properties. These data are used for the improvement of snow avalanche models.
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Test site for investigating snow loads on defensive snow net systems
Elisabeth Rainer, Lambert Rammer and Thomas Wiatr (BFW)
Net systems are active safety devices that ensure the stability of the snow cover in avalanche starting zones. Snow load on snow nets is a complex system that is influenced by several factors. On a test site at 2254m a.s.l. above Innsbruck/Tyrol two different types of snow net systems have been equipped with gauges to measure the loading applied to the different net components. In addition to the pressure forces on the posts and the tension forces in the anchors, in the base perimeter wires and the up- and downstream wires, also the continuous change of the net geometry during winter is recorded.

The temporal variation of snow depth is recorded by means of a terrestrial laser ranging system. Two automatic weather stations are providing continuous measurements of wind, snow height and temperature. In addition, especially the snow load variation due to changing of snow depth and snow density can be derived from these observations.

Finally static calculations according to a method proposed by Haefeli in 1954 and the Swiss guidelines but also by means of more sophisticated static and finite element models and a comparison between the calculated and the measured forces on the snow nets are performed. The project is carried out in cooperation with WLV.
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Snow avalanche mass balance calculation and simulation model verification
Rudolf Sailer (BFW), Wolfgang Fellin (IIE), Reinhard Fromm (BFW), Philipp Jörg (BFW), Lambert Rammer (BFW), Peter Sampl (AVL), Andreas Schaffhauser (BFW)
Two and three dimensional avalanche simulation models offer a wide range of applications; however a challenging model verification process is demanded, accompanied by a reliable determination of model input parameters. For the verification of the models BFW has been applied remote sensing equipment like TLS (terrestrial laser scanner) and ground based SAR (synthetic aperture radar). Numerical methods has been implemented to increase the quality of the parameter fit and to reduce computational effort caused by the number of simulations. The quality of the simulation results has been verified by comparing measured and simulated runout lengths as well as the mass balance. Measured avalanche velocities from our mobile Doppler radar permit a crosscheck.
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Avalanche Warning Centre Tyrol
Rudolf Mair (AWCT)
The Avalanche Warning Centre Tyrol, which has existed since 1960, is responsible for a forecasting area of 12.648 km?, which is strongly avalanche-endangered. On average 15 people are killed in avalanches each winter.

Therefore, a daily avalanche report is provided by AWCT, which is based on analysis of comprehensive data. The inherent information is based on reports by specially educated observers, and online transmitted data from a specifically designed network of weather and snow monitoring stations. Right now there are more than 60 stations in the country of Tyrol (Austria), which is one of the highest intensities of such stations in the world. An overview about the development of snow cover, temperature, wind speed and wind direction is operationally distributed to the public. Recently, the internet has also been used to gather additional information from the public recounting their experiences and outside observations. Further support comes from so-called avalanche commissioners, specifially trained people supporting communities in security related questions, e.g whether a road has to be closed, a house to be evacuated or explosives to be used. Their duties are regulated by law and the education of those people as well as support during their work is a further responsibility of AWCT.

Recent research developments respond to specific investigation results that maps of weather and snow cover data are much better understood by the public than line graphics. Therefore, in cooperation with UV, maps of total and new snow height during the last 24 hours are developed, which will be renewed 3 times daily on the internet and include data from the adjacent countries, too. It is planned to provide an increased number of maps not only for Tyrol but for all the avalanche warning centres in Europe, as far as providing data from automatic weather stations.
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ECOLOGICAL STUDIES

Microbial communities of cryoconites as sensitive indicators for radioactive impact on Alpine glaciers

Birgit Sattler (IEI), Herbert Lettner (US), Wolfgang Schöner (ZAMG), Peter Bossew (ISPRA)

Since vast snow and ice fields of the Earth´s cryosphere have been recognized as habitats for different organisms, life in ice is no longer a paradox. According to the latest trend in cryoresearch, cryoconites are now seen as micro-ecosystems with high ecological relevance for glaciers worldwide. In alpine glaciers cryoconites are often found to contain rather high concentrations of radioactive remnants from atmospheric atomic bomb tests and the Chernobyl accident, suggesting a distinct microbial community capable to cope with higher radioactive doses as usual.

In this project, radionuclides will be used as tracers for airborne pollutants which accumulate in the cryoconite. Microbial communities seem to be relevant for the formation of cryoconites and, thus, determine the chemical milieu which in turn is responsible for the efficient accumulation, retention and release of radionuclides and other pollutants which requires intensive studies on the functional biodiversity of microbes in cryoconites.

Since glaciers are retreating worldwide the accumulated radionuclides may be washed out, thus a better understanding of the processes involved in storage and release of radionuclides is needed.

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Cryoconites and glacial surfaces as habitat for airborne microorganisms

Birgit Sattler (IEI), Alexandre Anesio (UB)

It is well known that the atmosphere is a conveyor of microorganisms, and that bacteria can act as ice or cloud condensation nuclei, but clouds have not been considered as a site where organisms can live and reproduce. Since ~60% of the earth surface is covered by clouds, cloud water can be considered as a microbial habitat. Otherwise isolated and remote habitats like glaciers on Polar Regions are subject to inoculation by airborne microorganisms which are transported with the atmosphere and get deposited onto glacial surfaces. In this project airborne bacteria above polar (Arctic and Antarctic) and alpine glaciers will be identified and enumerated in dependence to the catchment area.

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Impact of coverage of glacial areas with geotextiles on cryobiota

Heribert Insam, Birgit Sattler, Roland Psenner, Andreas Fritz (IEI)

Tourism is most vulnerable to the impact of climate change. Especially in regions where tourism is based on sensitive environments such as glaciers and snow-covered mountains, the massive impact on socio-economic levels is predictable.

As a first measure to cope with glacial retreat in skiing areas, extensive areas of geotextiles have been exposed onto neuralgic sites, which enhanced the albedo and thus successfully decreased melting processes.

With ongoing warming it is anticipated that local tourism will apply this method more extensively in future, which will require elaborate studies to investigate the ideal material in terms of a balance between increase of albedo, compatibility of the used material and permeability of nutrients for the microbiota in snow and ice.

So far, covered areas are still restricted but will most likely expand with the warming scenario. This measure will imply ethical questions which will certainly hamper the tourist trade.

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Cryoconite holes as sensitive functional ecosystems

Birgit Sattler, Irina Antlinger, Judith Oberleiter (IEI), Alexandre Anesio (UB)

Life in ice is no longer a paradox – on the contrary, vast snow and ice fields of the Earth´s cryosphere are increasingly recognized as habitats for a number of adapted organisms.

Cryoconite holes on polar and alpine glaciers have recently been documented as microhabitats with high ecological relevance for glaciers worldwide. Cryoconites are depressions on glacial surfaces filled with organic and inorganic matter where highly active microbial communities thrive, providing biomass for grazers and contributing to the carbon budget of glaciers and their runoff.

An investigation of the biodiversity of both structural and functional sense of GLIMCOs (glacier ice microbial communities) and metazoa is therefore crucial for the understanding of nutrient flows and alterations of functional biodiversity in the cryosphere, giving glaciers an ecological relevance as active ecosystems with carbon links coupled to other environments.

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EDUCATIONAL PROGRAMMES

BIPOLAR (2007–2009)

Andreas Richter, Michaela Panzenböck (UV), Birgit Sattler, Roland Psenner, Andreas Fritz (IEI), Ulrike Nickus, Michael Kuhn (IMGI), Wolfgang Schöner, Bernhard Hynek (ZAMG), Aleksey Sharov (JOAN)

Science goes School (a programme within FERMAP) is giving the scientific frame to build up a cooperation and bridge between scientific institutions such as universities and schools of

various types. Kids will be the scientists of the future and will be part of this interdisciplinary programme, where they need to fulfil objectives given by FERMAP and will present their results in a kid´s conference (KINGKONG) at the end of the project. The aim of this project is to involve schools in IPY-relevant topics where climate change will be a focus. Kids will also learn to interact with common media.
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OTHER

Innsbruck University Network on Climate and Cryospheric Research (ICCR)
At Innsbruck University different working groups contribute to a wide field of research related to snow, ice and climate. Worldwide changes of glaciers and climate in different time scales as well as energy, ice, and water balances are investigated. Methods cover a wide range including field experiments, advanced remote sensing techniques and modelling in different scales of time and space and study sites are to be found in polar, mid latitude, and tropical ice masses. Within a recent restructuring of Innsbruck University, ICCR was established in order to focus and strengthen this potential. Currently, the participating institutions comprise IMGI, IGUI, IGPIU, IBI, IIE and ITGG.
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Zeitschrift für Gletscherkunde und Glazialgeologie (ZGG)
Michael Kuhn (IMGI)
ZGG is dedicated to publications on snow and ice in all forms of their appearance and at any time. It aims to provide a forum for manuscripts with results of original research, but also summaries, reports, proceedings and reviews. The journal is published annually in two issues or in one volume.
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ABBREVIATIONS

AlpS	Centre of Natural Hazard Management, Innsbruck, Austria
AVL:	AVL-List, Graz, Austria
AWCT	Avalanche Warning Centre Tyrol, Austria
AWI	Alfred-Wegener Institute for Polar and Marine Research, Germany
BFW	Department of Natural Hazards and Alpine Timberline, Innsbruck, Austria
BS	BLUE SKY Wetteranalysen Technisches Büro für Meteorologie, Attnang-Puchheim, Austria
HDS	Hydrographischer Landesdienst Salzburg, Austria
CESR	Center for Environmental Systems Research, Universität Kassel, Germany
CGBAS	Commission for Glaciology, Bavarian Academy of Sciences, Munich, Germany
EA	Energie AG, Oberösterreich, Austria
EGEO	e:geo informatics Gerhard Ehgartner, Austria
ENVEO	Environmental Earth Observation Information Technology GmbH, Innsbruck, Austria
FGGUS	Fachbereich für Geographie und Geologie der Universität Salzburg, Austria
FHNB	Fachhochschule Neubrandenburg, Germany
FUA	Department of Earth Sciences, Free University, Amsterdam, The Netherlands
GFZP	GeoForschungsZentrum Potsdam, Germany
GIK	Geographisches Institut, Universität zu Köln, Germany
HAB	Hydrology Department of the Autonomous Province of South Tyrol, Italy
HDT	Hydrographischer Dienst der Abteilung Wasserwirtschaft des Amtes der Tiroler Landesregierung, Innsbruck, Austria
HRIT	Hydrometeorological Research Institute, Taskent, Uzbekistan
HUT	Helsinki University of Technology, Finland
IBI	Institute of Botany, Innsbruck University, Austria
IEI	Institute of Ecology, Innsbruck University, Austria
IFO	Ifo-Institut für Wirtschaftsforschung Universität München, Germany
IFOK	IFOK GmbH - Institut für Organisationskommunikation, Bensheim, Germany
IGEW	Institute of Geography and Earth

	Sciences, University of Wales, UK
IGIU	Department of Geography, Innsbruck University, Austria
IGPI	Institute for Geology and Palaeontology, Innsbruck University, Austria
IGRG	Institute of Geography and Regional Sciences, University of Graz, Austria
IIE	Institute of Infrastructure, Unit of Geotechnical and Tunnel Engineering, University of Innsbruck, Austria
IMAU	Institute for Marine and Atmospheric Research, Utrecht University, The Netherlands
IMGI	Institute of Meteorology and Geophysics Innsbruck, Austria
IMK-IFU	Institut für Meteorologie und Klimaforschung , Garmisch-Partenkirchen, Germany
IPY	International Polar Year 2007-2008
IRD	Institute de la Recherche pour le Développement, Montpellier, Genoble, France
ISPRA	European Commission Joint Research Center, Ispra, Italy
ITGG	Tropical Glaciology Group, Institute of Geography, Innsbruck University, Austria
IUHEI	Institut für Umweltphysik, University of Heidelberg, Germany
JIRP	Juneau Icefield Research Project, Canada
JOAN	Joanneum Research, Graz, Austria
KGBAM	Kommission für Glaziologie, Bayrische Akademie München, Germany
LFUA	Bayerisches Landesamt für Umwelt, München, Germany
LGGE	Laboratoire de Glaciologie et Géophysique de l'Environnement, Université de Grenoble, France
LMU	Ludwig-Maximilian University, Munich, Germany
LOO	Land Oberösterreich, Austria
MNHV	Division of Karst and Cave Science at the Museum of Natural History, Vienna, Austria
AMS	AMS facility VERA at Vienna University, Austria
MPIH	Max-Planck-Institut für Meteorologie, Hamburg, Germany
NCAR	National Center for Atmospheric Research, Boulder, USA
NORUT	NORUT Information Technology, Norway
NPHT	Nationalpark Hohe Tauern, Austria
NPI	Norwegian Polar Institute, Tromsoe, Norway
NS	Novosat Ltd., Finland
NWR	Norwegian Water Resources and Energy Directorate, Norway
OEAV	Österreichischer Alpenverein e.V, Austria
SDUM	Earth Sciences Department, University of Milan, Italy
SIUI	Science Institute, University of Iceland, Reykjavik, Iceland
SU	Dept. of Physical Geography, Stockholm University, Sweden
TMA	Tanzanya Meteorological Agency, Tanzanya
TU Delft:	Technical University, Delft, the Netherlands
TUG	Institute of Remote Sensing and Photogrammetry, Graz, University of Technology, Austria
TUM	Technical University of Munich, Germany
TUV	Technical University, Vienna, Austria
UALBS	Department of Earth and Atmospheric Sciences, University at Albany, SUNY, USA
UB	University of Bristol, Bristol, UK
UGRH-INRENA	Unidad de Glaciologia y Recursos Hidricos, Instituto Nacional de Recursos Naturales, Huaraz, Peru
UH	Institut für Landwirtschaftliche Betriebslehre, Universität Hohenheim, Germany
UMASS	Climate Research Center - University of Massachusetts, Amherst, USA
UO	University of Oslo, Norway
UOTA	Department of Geography, University of Otago, Dunedin, NZ
UR	Geography Department, University of Reading, Reading, UK
US	University of Salzburg, Austria
US	University Stuttgart, Germany
UTF	University of Turku, Finland
UV	Department of Geography and Regional Research at the University of Vienna, Austria
UV	University of Vienna, Austria
WLV	Forest Engineering Service for Avalanche and Torrent Control, Innsbruck, Austria
ZAIAG	Central Asian Institute of Earth Science, Bishkek, Kyrgyzstan

Friedl Obleitner

International Glaciological Society

ANNUAL GENERAL MEETING 2008

MINUTES OF THE ANNUAL GENERAL MEETING OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY

Thursday 12 June 2008, Salón de Actos del edificio C ETSI de Telecomunicación, Universidad Politécnica de Madrid Av. Complutense, 30 (Ciudad Universitaria) 28040 Madrid, Spain

The President, Professor Atsumu Ohmura, was in the Chair.
46 persons from 13 countries were present of whom 37 were IGS members.

1. *The previous AGM's minutes*
The Minutes of the last Annual General Meeting, published in ICE, 2007, No 145, p. 15–18, were approved on a motion by D. Drewry, seconded by F. Pattyn and signed by the President.

2. *The President's report*
The President gave the following report for 2007–2008:

Dear members, Ladies and Gentlemen:
The International Glaciological Society has completed its 72nd year. It is a privilege to present a report on the society's activities and status for the past year.

The IGS's core contribution, the *Journal of Glaciology*, is receiving an ever-increasing number of articles; 147 were submitted in 2007, and by the beginning of June 2008, the number of received manuscripts was greater than for the same period last year. The key developments are (1) a significant reduction in the time from manuscript submission until to publication, now less than one year. The publication of PDFs on the web has certainly contributed to this success; (2) the introduction of profiled articles of high quality dealing with topical themes. The society received extremely exciting news in September. The Association of Learned and Professional Society Publishers (ALPSP)/Charlesworth Awards for the Best Learned Journal was presented to the *Journal of Glaciology*. Quoting the announcement made by the association: 'In a highly competitive field, the winner of this award is the *Journal of Glaciology*, published by the International Glaciological Society, selected by the judges for its excellent demonstration of design and production standards, and an overall dynamic feel'. This is one of the most significant events in the 61-year history of the *Journal*. I would like to congratulate all who have contributed to the achievement of this award, the Chief Editor and members of the Editorial Board, the Cambridge office team headed by the Secretary General, assisted by the Production Manager, and above all the members who contributed scientific articles of a high standard.

Annals of Glaciology has succeeded in publishing a collection of selected peer reviewed articles within a year of the affiliated symposium. *Annals 46*, the Cambridge Symposium on Cryospheric Indicators of Climate Change, was published in August; *Annals 48*, the Perugia IUGG Symposia on Glaciology, was published in April. *Annals 49*, the Moscow Symposium on Snow Science and *Annals 50*, the Skeikampen Workshop on Mass Balance, will be published before the end of the year. Our main goal of speeding up publication to within one year after submission has been accomplished. This year the *Annals*, starting with 50, will change its scope. *Annals* which to date had been affiliated to a symposium will become thematic periodicals. This transition was brought about by the policy change of ISI Thomson to drop conference proceedings from the Web of Science and thus lose our impact factor. We are confident that *Annals* will become an attractive complement to the *Journal*. The success of the change will depend greatly on the contributions from the glaciological community.

And it is with great pleasure that I am able to announce that the IGS President and the Council, acting on recommendations of the Awards Committee, has decided to bestow Honorary Membership of the International Glaciological Society upon three of its members. This is in recognition of their eminent contributions to the aims of the Society. The persons thus awarded are: emeritus professors Garry Clarke, Hans Röthlisberger and John Glen. I have been in contact with all of them and informed them of the decision and they send their heartfelt thanks to the members of the Society.

The society co-sponsored 13 sessions at the 24th IUGG General Assembly in Perugia, and organized an attractive symposium on snow in Moscow. The workshop on glacier mass balance in Skeikampen had 100 presentations.

The present symposium in Madrid has 99 registered participants from 22 countries, and 99 abstracts have been contributed.

This year there will be another symposium on Glacier Dynamics in August and a workshop on World Glacier Inventory in September. The commitment and enthusiasm at the headquarters, the Society's sound financial condition and the increasing glaciological projects on a global scale will ensure a continued level of high activity in the glaciological society.

Atsumu Ohmura

The Secretary General invited members to discuss the President's report. There was no discussion.

C. Hulbe proposed, and R. Hindmarsh seconded, that the President's report be accepted. This was carried unanimously.

3. *The Treasurer's report*

The Secretary General, on behalf of the treasurer, Dr I.C. Willis, presented the following reported with the Financial Statements for the year ended 31 December 2007.

The state of the Society's finances is best summarized by considering the changes from 1 January 2007 to 31 December 2007, as shown on page 9 of the accounts. In the table, the Accumulated Fund refers largely to costs associated with running the *Journal*, the Designated Fund refers to costs associated with running Symposia and the *Annals*, and the Restricted Fund is money earmarked specifically for costs associated with the Seligman Crystal.

Restricted Fund: increased very slightly from £7945 to £8245 as a consequence of accrued interest of £300.

Designated Fund: increased slightly by £1175 from £174 188 to £175 363 showing that the income to IGS from symposia attendance, *Annals* pages charges and *Annals* sales roughly matched expenditure associated with *Annals* printing and publication, and office support for activities related to running Symposia and production of *Annals*. This compares to a small loss of £1946 last year.

Accumulated Fund: increased by £9852 from £386 619 to £396 471 showing that income from membership, sales of the *Journal*, and page charges slightly exceeded expenditure associated with *Journal* printing and publication, and associated office support. This compares to a bigger profit of £31 707 last year.

Total: The Society made a net profit of £11 327 in 2007 compared to a net profit of £29 799 in 2006

In more detail, income is itemized in note 2, p. 13 and expenditure is listed in notes 3 & 4, p. 14.

Income

Membership dues dropped significantly compared with 2006 from £38 819 to £16 741. The Society should be reassured that this is not because members are choosing to leave in large numbers, but because the mechanism whereby the IGS office sends out invoices to members and processes payment is no longer working as well as it used to.

Journal sales were up by £11 413 (2006–7) compared to a rise of £15 753 the year before (2005–6). Sales of *Journal* reprints by authors not paying page charges continued to fall this year by £1012 to just £98! This compares to a fall of £165 the year before (2005–6). This partly reflects authors choosing not to receive reprints (presumably because of the rise of the 'pdf') but may also reflect a backlog in the processing of invoices. Page charge income dropped by £18 659 (2006–7) compared to a rise of £28 675 the year before (2005–6) and a rise of £25 533 the year before that (2004–5). As with membership dues above, this does not reflect a drop in the number of authors paying page charges, but rather a backlog in the processing of invoices. Income from *Annals* is healthy, although again there is a backlog associated with invoice processing.

Expenditure

Large expenditure is associated with printing and publishing the *Journal* and *Annals*. These costs decreased by £34 860 (2006–7) compared to a decrease of £12 269 in 2005–6 and the massive increase of £107 739 in 2004–5. This reflects the good management and efficient work practices of the publications team at the IGS office, together with recently negotiated reduced printing costs. Other major expenditure comes from the costs of supporting the *Journal* and *Annals*. This was actually comparable to last year (2006). (The drop from £212 246 to £155 164 (i.e. £57 082) is largely due to the drop of £62 516 under the 'Symposia – Other Costs' heading. But this is counteracted by an increase of £59 103 under the 'Incoming Resources – Symposia' heading on page 9. These differences in accounting procedures between years reflect the fact that the IGS functioned as the local organizing committee for the Cambridge meeting in 2006 but not for the meetings in 2007). Travel expenses have increased by £8169 (2006–7) due largely to the greater ambassadorial role played by the Secretary General visiting local branch meetings and other glaciological functions.

Journal* and *Annals

In 2007, the Society published 908 pages in the *Journal of Glaciology* and 1114 pages in the *Annals of Glaciology* (44, 45 & 46). In 2006 the figures were 807 for the *Journal* and 1319 for the *Annals*.

This continues to reflect the reorganization of the production procedures, which have considerably improved the efficiency of the production

process so that the Society publications are now seen as very viable and prompt. As a result we are seeing a considerable increase in paper submissions to the *Journal*. In 2006 we had a record 122 submissions, an increase of 17% over the previous 10-year average and a 24% increase over the 1988–2005 average. In 2007 we surpassed this record by 25, 147 submissions in total. This is an increase of 39% over the previous 10-year average and a 48% increase over the 1989–2006 average. And this year, we are already 6 weeks ahead of last year's submissions and hopefully heading for another record year.

As of the second week of June we have already published about 540 pages of the *Journal* this year. We have almost finished publishing the third issue of 2008 and are well on our way with the production of what is supposed to be the last issue of 2008

However, we have suffered a setback with the *Annals* in that Thomson ISI decided unilaterally to remove it from the Web of Science and thus the impact factor that is associated with WoS. The Council is in the process of redefining the *Annals* editorial policy and we are hoping to regain our status within WoS within the next year or so. This has resulted in slimmer *Annals* volumes as authors are reluctant to publish in a non-ISI publication. Indeed, it is the requirement of some funding agencies that funded authors must publish in ISI publications.

Summary

The Society's finances are in fairly good shape but some changes must be made in the coming months as summarized below. We ran at a profit in 2007 (~2% of total funds) cf. a slightly bigger profit last year (~5.5% of total funds). It is important for us to maintain our inputs as well as operate carefully and efficiently to minimize our costs.

On the outputs side, we are continuing to benefit from recent improvements in the efficiency of printing and publishing the *Journal* and *Annals*. Under Magnús's management, we have seen continued growth in the number of submissions to the *Journal* in particular and improved turnaround times from submission to publication. The Society will shortly be moving over to an online automated submission and review system, which should improve this aspect of its operations still further.

On the inputs side, we are particularly grateful to all those authors who have been both able and willing to support the Society by the provision of page charges. If you can, please build page charges into your grants in order to support the Society. Also, I would make a plea to IGS members to do all in their power to increase the membership. Please encourage your colleagues and students to join. Also, please ensure that libraries in any institutions over which you have influence either maintain their subscriptions to the *Journal* and *Annals* or take them out. Against the backdrop of climate change, research into all aspects of the cryosphere is increasing and so we should be seeing an increase in both membership and subscriptions to our publications

However, the major challenge for the Society now is to improve the procedure for sending and processing invoices. This is inadequate at present and the Society accrued £126 212 of debtors in 2007, although this was even worse the year before (£162 755) (see note 10 of the accounts). Debtors include members who have not paid their dues, authors who have not paid their page charges, and libraries that have not paid their subscriptions.

I will shortly be recommending to Council that new software is purchased for the IGS office to enable: (1) improved management of the Society's database (members, authors, libraries, etc); (2) greater automation of invoicing; and (3) online debit or credit card payment and the ability to set up standing orders. This should considerably improve the ability of the Society to generate income, which should ultimately allow us to drive down costs.

Ian C. Willis, Treasurer

The Secretary General invited members to discuss the Treasure's report. There was no discussion.

F. Pattyn proposed, and F. Navarro seconded, that the Treasurer's report and the draft accounts be accepted and he and the Secretary General be authorized to sign off the accounts on behalf of Council. This was carried unanimously.

4. *Election of auditors for 2008 accounts.*

D. Drewry asked what the present cost of the audit was and whether the SG has tested the market for auditors. The SG replied that the present audit costs approximately £10 000 and that his perception was that this represents excellent value. He said that the market for auditors has not been looked into but that he would initiate an investigation.

The Secretary General proposed, and Andre Glazovskiy and Ruth Mottram seconded, that Messrs Peters Elworthy and Moore of Cambridge be elected auditors for the 2008 accounts. This was carried unanimously.

5. *Elections to Council.*

After circulation to members of the Society of the Council's suggested list of nominees for 2008–11, no further nominations were received, and the following members were therefore elected unanimously:

President	Eric Brun (France)
Vice Presidents:	Kumiko Goto-Azuma (Japan)
	Martin Funk (Switzerland)
Elected Members:	Regine Hock (US/Sweden)
	Massimo Frezzotti (Italy)
	Andres Rivera (Chile)
	Sergey Sokratov (Russia)

The appointment of the new IGS officers and Council members was confirmed by the AGM.

6. *Other business*

D. Drewry encouraged those present to make appropriate nominations for the fourth award of the European Geosciences Union's Louis Agassiz medal (for individuals in recognition of their outstanding scientific contribution to the study of the cryosphere on Earth or elsewhere).

7. *The President is retiring*

The Secretary General thanked the retiring IGS President for a very enjoyable 3 years of working together. During the reign of President Ohmura the IGS has been able to catch up on its publications and is now seen as a prompt and prestigious publisher. The SG then asked the AGM to show its appreciation of the service the now Immediate Past President has given to the Society by giving him a round of applause.

The AGM was adjourned at 14:50 on a motion from R. Hindmarsh seconded by O. Eisen.

JOURNAL OF GLACIOLOGY

Papers accepted for publication between 1 September 2008 and 5 January 2009. The papers are listed in alphabetical order by first author. Some of these papers have already been published.

Jinho Ahn, Edward J. Brook and Kate Howell
Instruments and Methods: A high-precision method for measurement of paleoatmospheric CO_2 in small polar ice samples

Vladimir B. Aizen, Paul A. Mayewski, Elena Aizen, Daniel Joswiak, Arzhan Surazakov, Susan Kaspari, Bijorn Grigholm, Michael Krachler, Mike Handley and Alexander Finaev
Stable-isotope and trace element time series from Fedchenko Glacier snow/firn cores (Pamir Mountains)

David Bahr
On fundamental limits to glacier flow models: computational theory and implications

Douglas Benn, Jason Gulley, Adrian Luckman, Artur Adamek and Piotr S. Glowacki
Englacial drainage systems formed by hydrologically driven crevasse propagation

Othmar Buser and Perry Bartelt
Production and decay of random kinetic energy in granular snow avalanches

Marco Carenzo, Francesca Pellicciotti, Stefan Rimkus and Paolo Burlando
Assessing the transferability and robustness of an enhanced temperature-index glacier melt model

Daniel Farinotti, Matthias Huss, Andreas Bauder, Martin Funk and Martin Truffer
A method to estimate ice volume and ice thickness distribution of alpine glaciers

Helen Amanda Fricker and Ted Scambos
Connected subglacial lake activity on lower Mercer and Whillans ice streams, West Antarctica, 2003–2008

G. H. Gudmundsson and A. Jenkins
Ice flow velocities on Rutford Ice Stream are stable over decadal time-scales

Ilka Hamann, Sepp Kipfstuhl, Sérgio H. Faria, Nobuhiko Azuma and Atsushi Miyamoto
Subgrain boundaries and related microstructural features in EPICA-Dronning Maud Land (EDML) deep ice core

Martin Heggli, Esther Frei and Martin Schneebeli
Instruments and Methods: Snow replica method for three-dimensional X-ray microtomographic imaging

T. Hughes
Thermal convection and the origin of ice streams

Angelika Humbert, Thomas Kleiner, Chris-Oliver Mohrholz, Christoph Oelke, Ralf Greve and Manfred A. Lange
A comparative modeling study of the Brunt Ice Shelf–Stancomb-Wills ice tongue system

Yoshinori Iizuka, Takayuki Miyake, Motohiro Hirabayashi, Toshitaka Suzuki, Sumito Matoba, Hideaki Motoyama, Yoshiyuki Fujii and Takeo Hondoh
Constituent elements of insoluble and non-volatile particles during the Last Glacial Maximum of the Dome Fuji ice core

Martin Kern, Perry Bartelt, Betty Sovilla and Othmar Buser
Measured shear rates in large dry and wet snow avalanches

Michèle Koppes, Bernard Hallet and John Anderson
Synchronous acceleration of ice loss and glacier erosion, Marinelli Glacier, Tierra del Fuego

Kirsty Langley, Pascal Lacroix, Svein-Erik Hamran and Ola Brandt
Sources of backscatter at 5.3 GHz from a superimposed ice and firn area revealed by multi-frequency GPR and cores

Liu Shiyin, Zhang Yong, Zhang Yingsong and Ding Yongjian
Estimation of glacier runoff and future trends in the Yangtze River source region, China

Douglas R. MacAyeal, Emile A. Okal, Richard C. Aster and Jeremy N. Bassis
Seismic observations of glaciogenic ocean waves (microtsunamis) on icebergs and ice shelves

Sarah Mager, Sean Fitzsimons, Russell Frew, Denis Samyn and Reginald Lorrain
Composition of amber ice and its influence on the behaviour of cold glaciers in the McMurdo Dry Valleys, Antarctica

L. W. Morland
Age-depth correlation, grain growth and dislocation energy evolution, for three ice cores

L. W. Morland
A three-dimensional ice-sheet flow solution

L. W. Morland
Primary, secondary and tertiary creep of ice modelled as a viscoelastic fluid

Reginald R. Muskett, Craig S. Lingle, Jeanne M. Sauber, Austin S. Post, Wendell V. Tangborn, Bernhard T. Rabus and Keith A. Echelmeyer
Airborne-spaceborne dem and laser altimetry derived surface elevation and volume changes of the bering glacier system, 1972 through 2006

Thomas Mölg, Nicolas J. Cullen, Georg Kaser
Solar radiation, cloudiness and longwave radiation over low-latitude glaciers: implications for mass balance modelling

Thomas Opel, Diedrich Fritzsche, Hanno Meyer, Rainer Schütt, Karin Weiler, Urs Ruth, Frank Wilhelms and Hubertus Fischer
115-year ice core data from Akademii Nauk Ice Cap (Severnaya Zemlya): a high resolution record of Eurasian Arctic climate change

G. Picard, L. Brucker, M. Fily, H. Gallée and G. Krinner
Modelling timeseries of microwave brightness temperature in Antarctica

D.J. Quincey, A. Luckman and D. Benn
Quantification of Everest-region glacier velocities between 1992 and 2002, using satellite radar interferometry and feature tracking

Alan W. Rempel
Effective stress profiles and seepage flows beneath glaciers and ice sheets

J.A. Rial , C. Tang and K. Steffen
Glacial rumblings from Jakobshavn Ice Stream, Greenland

Hinrich Schaefer, Vasilii V. Petrenko, Edward J. Brook, Jeffrey P. Severinghaus, Niels Reeh, Joe R. Melton and Logan Mitchell
Ice stratigraphy at the Pakitsoq West Greenland Ice Margin derived from gas records

J. M. Shea, R. D. Moore and K. Stahl
Derivation of melt factors from glacier mass-balance records in western Canada

A. Shukla, R. P. Gupta and M.K. Arora
Instruments and Methods: Estimation of debris-cover and its temporal variation using optical satellite sensor data: a case study in Chenab basin, Himalayas

K.E. Sinclair and S.J. Marshall
Temperature and vapour trajectory controls on the stable isotope signal in canadian rocky mountain snowpacks

Ragnheid Skogseth, Frank Nilsen and Lars H. Smedsrud
Supercooled water in an arctic polynya: observations and modeling

R. Thomas, E. Frederick, W. Krabill, S. Manizade and C. Martin
Recent changes in Greenland outlet glaciers

J. Wuite and K. C. Jezek
Evidence of past fluctuations on Stancomb-Wills Ice Tongue, Antarctica, preserved by relict flow stripes

Xiang Li, D. Iliescu and Ian Baker
On the effects of temperature on the strength of H_2SO_4-doped ice single crystals

Rodrigo Zamora, David Ulloa, Gonzalo Garcia, Ronald Mella, José Uribe, Jens Wendt, Andres Rivera, Guisella Gacitúa and Gino Casassa
Airborne radar sounder for temperate ice: initial results from Patagonia

Zongxing Li, Yuanqing He, Honxi Pang, Wenxiong Jia, Xianhong He, Ninnin Zhang, Baoying Ning, Linlin Yuan, Bo Song and Wilfred H. Theakstone
The chemistry of snow deposited during the summer monsoon and in the winter season at Baishui No.1 Glacier, Mt Yulong, China

ANNALS OF GLACIOLOGY, VOLUME 47

The following paper from the 6th International Workshop on Ice Drilling Technology, held at the National Conservation Training Center, Shepherdstown, West Virginia, USA, 17–23 September 2006, has been accepted for publication in Annals of Glaciology *Vol. 47, edited by Frank Wilhelms and Joan J Fitzpatrick*

S. Panichi, M. Querci, C. Arrighi, E. Lefebvre, F. Frascati, M. Armeni, G. Benamati , L. Augustin, A. Antonelli, S. Nucci
EPICA Dome C Electronic Control System

Annals 47 is now complete and has been published.

ANNALS OF GLACIOLOGY 50(50)

The following selected papers from the International Workshop on Mass Balance Measurements and Modelling, held at Skeikampen, Norway, 26–28 March 2008, have been accepted for publication in Annals of Glaciology *50(50), edited by Peter Jansson and Jon Ove Hagen*

H. Elvehøy, M. Jackson and L.M Andreassen
The influence of drainage boundaries on specific mass balance results, a case study of Engabreen, Norway

Matthias Huss and Andreas Bauder
Twentieth century climate change inferred from four long term point observations of seasonal mass balance

J. Nemec, P. Huybrechts, O. Rybak and J. Oerlemans
Reconstruction of the Annual Balance of Vadret Da Morteratsch since 1865

L. Wake, P. Huybrechts, J. Box, E. Hanna, I. Janssens, and G. Milne
Surface mass balance changes of the Greenland ice sheet since 1866

M. Zemp, M. Hoelzle and W. Haeberli
Six decades of glacier mass balance observations – a review of the worldwide monitoring network

Annals 50(50) is now complete.

ANNALS OF GLACIOLOGY 50(51)

The following selected papers from the International Symposium on Radioglaciology and its Application, held in Madrid, Spain, 9–13 June 2008, have been accepted for publication in Annals of Glaciology *50(51), edited by Richard Hindmarsh*

JSteven A. Arcone, Karl Kreutz
GPR reflection profiles of Clark and Commonwealth glaciers in the Dry Valleys, Antarctica

D. Binder, E. Brückl, K.H. Roch, M. Behm, W.Schöner
Determination of total ice volume and ice thickness distribution of two glaciers in the Hohen Tauern (Eastern Alps) by ground penetrating radar (GPR)

John H. Bradford, Joshua Nichols, T. Dylan Mikesell, Joel T. Harper
Continuous profiles of electromagnetic wave velocity and water content in glaciers: An example from Bench Glacier, AK

Matthew J. Burke, John Woodward, Andrew J. Russell, P. Jay Fleisher
Structural controls on englacial esker sedimentation: Skei∂arárjökull, Iceland

Howard Conway, Ben Smith, Pavan Vaswani, Kenny Matsuoka, Eric Rignot and Paul Claus
A low-frequency ice-penetrating radar system adapted for use from an airplane: test results from Bering and Malaspina Glaciers, Alaska

O. Eisen, A. Bauder, M. Lüthi, P. Riesen,M. Funk
Deducing the thermal structure in the tongue of Gornergletscher, Switzerland, from radar surveys and borehole measurements

Robert W. Jacobel, Brian C. Welch, David J. Osterhouse, Rickard Pettersson, Joseph A. MacGregor
Spatial variation of radar-derived basal conditions on Kamb Ice Stream

E.C. King
Flow dynamics of the Rutford Ice Stream ice-drainage basin, West Antarctica from radar stratigraphy

Yu. Macheret, J. Otero, F. Navarro, E. Vasilenko, M.I. Corcuera, M.L. Cuadrado, A. Glazovsky
Ice thickness, internal structure and subglacial topography of Bowles Plateau ice cap and the main ice divides of Livingston Island, Antarctica, by ground-based radio-echo sounding

Ruth Mottram, Claus Nielsen, Andreas P. Ahlstrøm, Niels Reeh, Steen S. Kristensen, Erik L. Christensen, René Forsberg, Lars Stenseng
A new regional high-resolution map of basal and surface topography for the Greenland ice sheet margin at Paakitsoq, West Greenland

F.J. Navarro, J. Otero, Yu.Ya. Macheret, E.V. Vasilenko, J.J. Lapazaran, A.P. Ahlstrøm, F. Machío
Radioglaciological studies on Hurd Peninsula glaciers, Livingston Island, Antarctica

Brian C. Welch, Robert W. Jacobel, Steven A. Arcone
First results from radar profiles collected along the US-ITASE traverse from Taylor Dome to South Pole (2006-2008)

John Woodward and Edward C. King
Radar surveys of the Rutford Ice Stream onset zone, West Antarctica: Indications of flow (in)stability

More papers for *Annals* 50(51) will be listed in the next issue of ICE

Notes from the President Elect

Dear IGS members

I would like to thank all of you for your confidence in me. Serving as President of the Society is an immense honour, in particular at the time when a broad community of scientists, of decision-makers and of citizens focus their attention on the recent and future evolution of the cryosphere. Glaciers, ice caps, sea-ice, seasonal snowcover and permafrost are key agents in the current climate change but they are also witnesses and potential victims.

As a prestigious academic society, the IGS has an essential role in the present debate about the evolution of the Earth. The IGS Symposia offer a unique opportunity to present the very latest knowledge of various aspects of glaciology, as we saw in Limerick three months ago.

For more than half a century, the *Journal* and *Annals of Glaciology* have collected and diffused the constantly growing scientific knowledge on snow and ice. In recent years, the Secretary General, the Chief Editor, the Publications Committee and the IGS staff have made a considerable effort to reduce the time between submission and the publication of papers, while preserving the very high quality of the *Journal*. They have encouraged online access to the *Journal*, too. Rewarded by the 2007 ALPSP award, the *Journal of Glaciology* saw the number of published papers increasing considerably in 2008 and prospects are very good for 2009.

Even if the financial state of the IGS is very healthy, I believe we have to pay particular attention to the recent decrease in membership. The Society should at least recover the number of members it had a few years ago. That obviously requires modernization of the process for managing membership and the payment of the fees. After a sound analysis of the situation, the IGS Treasurer and the Secretary General proposed the purchase of appropriate software, which was approved by Council and should be operational by the beginning of 2009. But increasing the membership also requires the promotion of the IGS's activities, especially among young glaciologists. During the meeting in Limerick, the Council decided to investigate whether creating a new type of membership could be an appropriate solution for attracting new members. Proposals are expected by the middle of 2009.

Most snow and ice scientists have the rare opportunity to work on topics which are considerable challenges as well as a way of indulging their personal passions for mountains or for polar regions. This is a unique asset for encouraging new members to take part in IGS activities and attend our rewarding and friendly Symposia. What an exciting challenge for an IGS President!

Eric Brun

2008 Seligman Crystal Award

The Society's Council agreed unanimously in 2007 that a Seligman Crystal be awarded to Lonnie Thompson. The Crystal was presented at the International Symposium on Glacier Dynamic held in Limerick in August 2008 after the following introduction by the IGS President, Eric Brun.

Lonnie, ladies and gentlemen:

On the unanimous proposal of the Awards Committee, the Council of the International Glaciological Society has awarded Lonnie Thompson the Seligman Crystal. Lonnie is University Distinguished Professor at Byrd Polar Research Center and Department of Geological Sciences of the Ohio State University.

Awarding a Seligman Crystal is a rare and very important event in the life of the Society. I am very thankful to the Awards Committee, chaired by Pat Langhorne, for the relevance of their choice. I will now deliver some extracts from the citation of the Awards Committee.

The Crystal is awarded for Lonnie's pioneering work in the reconstruction of past climate from high-altitude ice cores in tropical and subtropical ice caps and glaciers. Professor Thompson has also been active in communicating the urgency and importance of global warming to policy makers and the general public.

Professor Thompson obtained his PhD from the Institute for Polar Studies, The Ohio State University. On completion of his PhD in 1976, he became a research scientist at the Byrd Polar Research Centre.

In 1974 Thompson's party had been the first to set foot on the remote high-altitude Quelccaya ice cap in the Southern Andes of Peru. It took 9 years of inventiveness and persistence before the 1983 team, led by Thompson, collected a 1500-year ice-core record of tropical precipitation. This core was drilled using an innovative solar powered drill carried up to 19 000 ft by pack animals.

Over his career Thompson has worked on the ice fields and glaciers of the Central Tibetan Plateau, the Southern and Central Andes of Peru and the Bolivian Altiplano, Alaska and Franz Josef Land in the Russian Arctic, Western Greenland and the Eurasian Arctic ice caps, Western China and the Tien-Shan and Pamir Ranges, Kilimanjaro, as well as the South Pole and Antarctic Peninsula. As a result of his leadership and perseverance, the world has evidence of an alarming warming trend in the tropical and subtropical regions that exceeds any normal variation seen in past centuries.

Figure 1. The Thompsons and the Seligman Crystal.

Approximately 50 research expeditions have been led by Prof. Thompson to the remote highlands of 15 countries in five continents – this is an average of more than one per year!

To support this work he has been awarded over 50 research grants from the NSF, NASA, NOAA and NGS. The results of the research teams have been disseminated in more than 200 refereed scientific publications and reports.

He has been an outstanding role model for the highest achievement in science, for example, being chosen as America's Best in Science and Medicine by Time Magazine and CNN in 2001, and highlighted in an article by Krajick in Science in 2002 entitled: Ice Man: Lonnie Thompson Scales the Peaks for Science. Lonnie Thompson has participated in over 20 major projects concerned with communication of science to the public, including a book, Thin Ice, which is his biography as well as an introduction to climate-change science.

Such high profile success has resulted in popularity as a speaker and Prof. Thompson gave more than 120 invited lectures in the six years between 2001 and 2006.

In spite of the demands that public attention has placed on his time, Prof. Thompson has served on numerous national and international panels on climate change, as well as on the editorial boards of Quaternary Science Reviews, Geology and The Holocene.

He has been elected to the Council of the International Glaciological Society and was the co-chief editor of *Annals of Glaciology* 43 in 2005. Remarkably he also finds time to serve on numerous internal committees of the Ohio State University.

Professor Thompson already has an impressive array of distinctions. In July 2007 he was awarded the National Medal of Science, an honour bestowed by the President of the United States on the recommendation of the NSF to individuals in science and engineering who have made outstanding contributions to the advancement of knowledge.

Also in 2007 he was awarded (jointly with his wife, Ellen Mosley-Thompson) the Distinguished Explorer Award of the Roy Chapman Andrews Society. He was elected a member of the American Philosophical Society in 2006.

In 2005 he was elected to the membership of the National Academy of Sciences[1] and the fellowship of the American Association for the Advancement of Science. He also received the prestigious Tyler Prize, sometimes called the Nobel prize for Environmental Achievement.

In the past six years he has won accolades from other nations, accepting the Dr A.H. Heineken Prize for Environmental Science from the Royal Netherlands Academy of Arts and Sciences, the Vega Medal from the Swedish Society for Anthropology and Geography and the Commonwealth Award for Science and Invention. He has also received various honours from the universities with which he has been associated.

However, perhaps most impressive of all that bears testimony to Thompson's skills as a scientific motivator, politician and diplomat is that he has worked collaboratively for 30 years with Tibetan, Chinese, South American and Russian researchers in a way that is only possible if affairs are conducted with considerable international sensitivity and broad-mindedness. A measure of the respect with which he is held is shown by his appointment, in 2005, as the Co-director of Academics, Tibetan Plateau Research Institute, Beijing, China.

Dear Lonnie, you understand that it is an immense honour for me to present to you, on behalf of the International Glaciological Society, this Seligman Crystal.

Eric Brun

Figure 2. The IGS President, Eric Brun, presents Lonnie with the Crystal.

Seligman Crystal acceptance speech

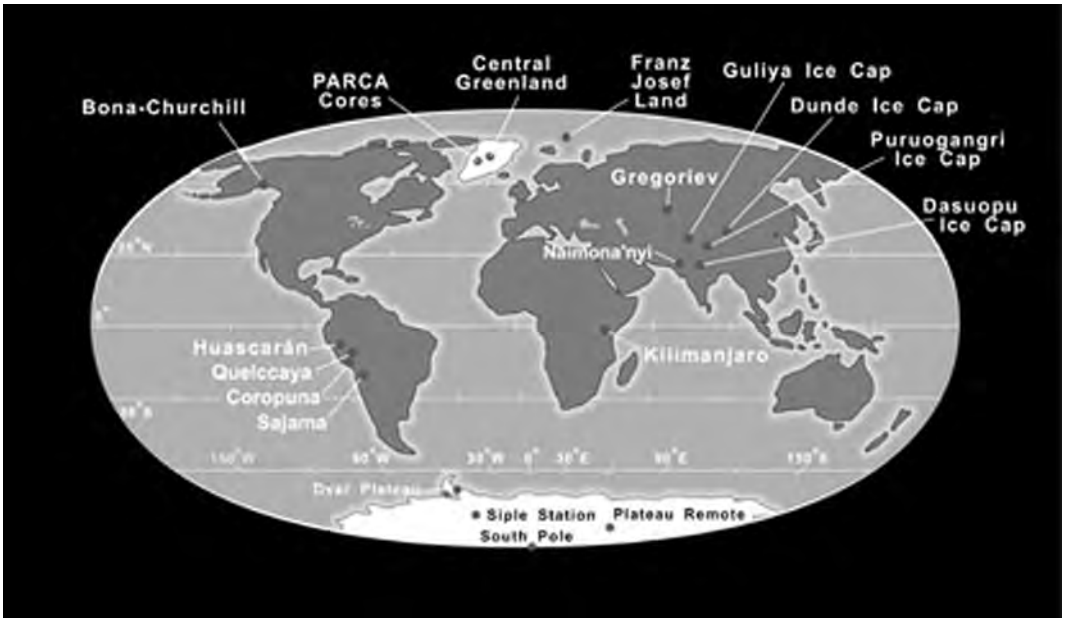
I have been most fortunate to live in a time when it is logistically possible to conduct 54 expeditions to 15 different countries in the span of one lifetime. At no other time in human history would it have been possible to move 6 tons of equipment to 23 000 feet in the Himalayas and bring down 10 tons, including 4 tons of frozen ice cores that eventually arrive in Columbus Ohio still frozen. I am exceedingly honored to accept the Seligman Crystal, but it also honors the efforts of the dedicated research team that Ellen and I have built over the last 30 years.

I am very fortunate to have been able to spend my life working on something about which I am very passionate – that is, collecting unique climate histories from Earth's highest mountains and most remote locations. These projects present extreme challenges but success brings extreme personal satisfaction. Although my career in glaciology began in Antarctica, I find the tropics most fascinating and challenging. Understanding climate variability requires many different records and observations from the equator to both poles. Predicting how the climate system is likely to change over the next few centuries requires deep and broad knowledge of the system – now and in the past. One of our team's key missions is to recover the vanishing climate histories stored in the ice fields atop the highest mountains. Many of these lie between 30°N and 30°S, a region covering 50% of Earth's surface area, where most of the solar energy driving the Earth system is absorbed and where roughly 70% of the 6.7 billion people on Earth reside. Clearly, this is an area where we must understand both natural and human-induced climate changes.

I must confess that if you had told me 35 years ago that I would still be studying ice cores at age 60, I would have said you were crazy because who is going to fund that type of work and how can ice cores be very important since glaciers exist primarily where people do not live? But as you know glaciology and ice core research have made the transition from a 'boutique' area of inquiry 35 years ago to center stage in contemporary discussions of global climate change. Glaciers, ice sheets and ice caps archive histories of climate variability and provide insight into the mechanisms responsible for the changes, but they may also raise sea level and impact water resources if they melt.

In 1973, before leaving on my first field project to Byrd Station, Antarctica, I attempted to secure funding to explore the potential of the Quelccaya ice cap in Peru to provide an interpretable climate history. But times were hard and the National Science Foundation had no office or division with a mission to study ice in the tropics. In collaboration with John Mercer, a glacial geologist at what was then called the Institute of Polar Studies (now the Byrd Polar Research Center), we approached Jay Zwally, the program manager at NSF's Office of Polar Programs. We proposed that an ice core record from the tropics could be integrated with ice cores from the Arctic and Antarctic to develop a more global picture of past climate variability. We outlined our plans using aerial photos of the Quelccaya ice cap. While Jay was intrigued with the idea, he noted that, as a tropical ice cap, Quelccaya fell outside the OPP's mandate, which was limited to regions poleward of the Arctic and Antarctic Circles. With this opportunity apparently lost, I headed to Byrd Station in Antarctica for the 1973/4 summer season. Toward the end of the season I received a telex from Jay. He said he had funded all his real polar projects and had $7000 left and he asked what we might do on that tropical ice cap for $7000. My response was; 'I think we can get there'. Thus, during summer of 1974, we made our first visit to the Quelccaya ice cap. Our team consisted of John Mercer, a Chilean glaciologist, Cedomir Marangunic, a Canadian mountaineer, John Ricker, and me. Such began the career that brings me here today.

As you can imagine, there are many interesting and entertaining stories associated with each of these 54 projects. The figure below shows the locations of the major ice core drilling programs we have conducted over the years. The early days were the most physically and logistically demanding as we were pushing the envelope by attempting to drill the first cores from a tropical ice cap. In the mid 1970s it was a 2 day journey by foot and/or horse from the end of road to the margin of Quelccaya. This presented the unique challenges of getting the ice core drill to the summit of the ice cap, extracting the cores and returning them to Ohio State from these remote sites. Our first attempt to use the conventional heavy drill and generator used in Antarctica and Greenland failed when the helicopter could not get close to the 18 760 ft high ice cap. We went



back to the drawing board and with the help of Bruce Koci we designed and constructed a light-weight solar-powered ice core drill. Using this new drill, we drilled two ice cores to bedrock, 164 and 166 meters deep, during a 3 month field campaign in 1983. Quelccaya was our greatest success because it was accomplished by dedicated young people, with no porters or sophisticated logistical support. Yet the record from Quelccaya was the first and remains the longest annually resolved ice core record from the tropics. This one ice record resulted in five papers in *Science* and *Nature* and served as the gateway to our future drilling programs on the world's highest mountains. In brief, we have recovered cores from three ice fields in Peru, the Sajama ice cap in Bolivia, five ice caps and glaciers in Tibet, from the Windy Dome in Franz Josef Land in the Russian Arctic, from the col on Bona-Churchill in Alaska, and from the three remaining ice fields on Kilimanjaro in Tanzania. The highest site we have drilled is Dasuopu (7200 meters, 23 622 feet) in the Himalayas. Currently, we are funded to recover new ice cores from the remaining ice fields in New Guinea (Irian Jaya), from Hualcán in northern Peru, and from the Bruce Plateau in the Antarctic Peninsula.

Each project has a special story and each was fraught with its unique logistical challenges of getting up to these sites and getting frozen ice cores out! However, the common thread among these stories is the way in which the most incredible people from different nations can come together in very remote places to do what many told us years ago would be impossible. Without these friends and colleagues, our team we would not have accomplished its goals and I would not be here today. As I write the draft of this speech, I am sitting in the base camp at the Quelccaya ice cap where my story began 35 years ago. I have returned to the ice cap 29 times in the last 35 years, like a doctor making increasingly more frequent house calls to a sick patient. Unfortunately, in as little as 50 years Quelccaya, Earth's largest tropical ice cap, will likely disappear along with the frozen history of our past.

In closing I would like to share a few lessons I have learned along the way. You should expect to experience failure and then learn from it and continue your quest. Time will often show that your harshest critics may prove to be your best friends as they challenge you to do better. Scientists, more so than those in other areas of endeavor, have learned to work together across national borders to accomplish tasks that can only be achieved by working together. Those in business, politics, government, social services and medicine urgently need to do this as the stakes are higher than at any other time in human history.

Our greatest challenge in the 21st century will be dealing with unprecedented environmental issues that are global in scale. I am optimistic that we as a global society can rise to the challenge. My optimism arises from our 54 successful international expeditions with colleagues from the US, China, Russia and Peru, among others. We worked together, shoulder to shoulder, often above 20 000 ft where it is cold, windy and at the end of the food chain with very little oxygen. Here the team focused on its mission and accomplished it. Today our challenge is to inspire all people, young and old alike, to achieve their full potential. If millions can be thus inspired, then humanity will be successful in meeting and overcoming the challenges of today and tomorrow.

Thank you once more for affording me the honor of receiving the Seligman Crystal.

Lonnie G. Thompson
Distinguished University Professor and Senior Research Scientist, School of Earth Sciences and Byrd Polar Research Center, The Ohio State University

New IGS Honorary Members

Honorary Membership for Glen, Röthlisberger and Clarke

At its Annual General Meeting the IGS members unanimously approved the recommendations made by the IGS Publication Committee and approved by the President and the Council to bestow IGS Honorary Memberships upon three of its long standing member who have contributed enormously to the Society.

The IGS Constitution states 'Honorary Members shall be elected by the Council in recognition of eminent contributions to the objects of the Society, and shall not exceed twelve in number.'

Sadly, quite a few honorary members have died recently and their number had dwindled down to eight. The awards committee has been reviewing potential candidates for some time now and sent its recommendations to the President last spring and he brought their proposal before Council at the Madrid Council meeting. Council approved unanimously to award honorary membership to John W Glen, Hans Röthlisberger and Garry K C Clarke.

All three are well known to IGS members.

John Glen is a Seligman crystal awardee. One of his major contributions to the science of glaciology is the law that bears his name, Glen's law. But John's contribution to the IGS has been as an editor of *Journal of Glaciology*. He joined the Journal Editorial Board (or Journal Advisory Committee as it was known then) in 1953 and has been on the board ever since or more then half a century. In addition he has been a proponent of the IGS British Branch, attending all their meetings. And he has been acting as the main judge for the John Glen Prize, a prize given to students judged to have the best poster presentation and the best oral presentation at the BB meetings and thus giving valuable encouragement the next generation of glaciologists.

Hans Röthlisberger, is a Seligman awardee and was president of the IGS during 1984–87 and a past scientific editor of the *Journal of Glaciology*. As an accomplished scientist and as a staunch supporter of the IGS he has given the Society a sophisticated and friendly front for a long time, and rarely has there been an IGS symposium that he has not attended.

Hans Röthlisberger was employed at Lab Hydraulics, Hydrology and Glaciology (VAW) for most of his career and was a leader of Glacier Hydraulics and Glacier Hydrology. In 1964 the Alalin ice avalanche with 88 casualties threw him into a very difficult and delicate problem of insurance responsibilities and breaking off of ice from glaciers. He devoted himself to the analysis, understanding and mitigation of potential glacier catastrophes. This resulted in the development of his forecast hyperbola for the break-off of ice avalanches. This work has a significant human dimension and there is no question that Hans's contribution has saved lives. It is in glacier hydrology, however, that he made his monumental contribution to the science of glaciology epitomized by the Röthlisberger channels. His 1972 *Journal of Glaciology* paper (in which he describes the physics of Röthlisberger channels) remains as rewarding to contemporary readers as it was to its original readers some 35 years ago.

To quote another Seligman awardee, Barclay Kamb: 'Hans is a true sage of glaciology, whose wisdom stems from a special combination of physical understanding and abundant practical observation with a real concern for using that theoretical and practical understanding for the good of humanity'.

Garry Clarke is also a Seligman awardee. He was a president of the IGS during 1990–93. Apart from his considerable scientific achievements, Garry has contributed substantially to the Society in numerous ways. In the late 1980s and 1990s Garry was active in establishing TeX for the Society's journals and incorporating it into the IGS desktop publishing system, a system we still use today. As president of the IGS he saw the Society through some very difficult times and has probably saved it from an early demise. He worked tirelessly to bring the IGS production procedures up the standard of the day. He has spent months and months in the IGS Cambridge office working on various projects set up to increase the efficiency of the IGS operation and thus setting the foundation of latter day IGS publication successes. He also gave valuable support to Hilda Richardson during a difficult period before her retirement.

A REPORT FROM THE MADRID SYMPOSIUM

The International Symposium on Radioglaciology and its Applications
Madrid, Spain, 9–13 June 2008

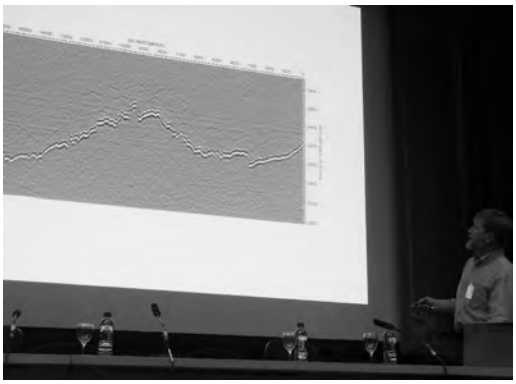


Figure 1. The theme was radioglaciology.

Figure 2. A relaxing icebreaker held in the faculty club.

Ninety-nine participants representing 24 countries gathered in early June at the Universidad Politecnica de Madrid to consider 107 presentations on all aspects of radar and its applications to the study of snow and ice. Superbly hosted by Francisco Navarro of the Escuela Tecnica Superior de Ingenieros de Telecommunication (Telecommunications Engineering School), participants enjoyed a comfortable and stimulating venue at ETSI. Daily we were served a wide variety of delicious tapas and beverages during our breaks and lunches, surrounded by displays of early telecommunications equipment, some of it dating back to the first days of the telephone. Readily apparent in the displays was the systematic miniaturization and increase in speed of electronic components over the years, paralleling developments in our own field of radar. Most participants commuted to the university daily on the efficient metro and we quickly became used to the system as a convenient way to explore the sights of Madrid.

The idea for the symposium began more than 5 years ago when Francisco and Richard Hindmarsh began talking about the possibility for a symposium on the practice and applications of radar to glaciology and Francisco offered to host the event in Madrid. Francisco has been active in Antarctic radar and modeling research since the mid-80s when he wintered at South Pole and subsequently spent time at the Spanish base on Livingstone Island, where he first started doing experiments with radar. Thus Francisco as host and the venue at ETSI were a perfect match for a symposium with this theme.

Figure 3. Speakers lined up to give their presentation.

Figure 4. The welcoming committee at the villa where the banquet was held.

Figure 5. Admiring the welcoming committee.

The afternoon session brought talks about imaging ice on Mars and the results from recent orbital missions. Meeting participants were enthusiastic about the opportunity to bring together the space and terrestrial radar communities and to explore the synergies that have driven developments in both areas. The final lecture of the evening was a highly entertaining retrospective (with wonderful slides!) about the early radar surveys of the large ice sheets given by Dave Drewry, key participant in the SPRI, TUD, NSF missions to Antarctica and Greenland in the late 1960s to 1970s. David's talk was followed by an 'ice breaker' including beverages and delicious tapas of many varieties.

Tuesday morning featured sessions on radar surveys and novel techniques and structures imaged within the ice, starting with an invited talk by Hugh Corr on the uses of high-resolution synthetic pulse radars. Following lunch, an invited talk by Steve Arcone described the genesis and deformation of stratigraphy in the firn based on surveys from US-ITASE traverses. This was followed by a session on studies of shallow ice and then the first poster session of the week featuring nearly 20 presentations, most reporting results from radar studies around the world.

On Tuesday evening participants traveled by coach about 30 km outside of Madrid to the fabulous Restaurante Torresol, a former hilltop estate converted to a magnificent venue for dining and cultural entertainment. Upon arrival we were greeted by a handsome couple in traditional Spanish equestrian costume mounted on Arabian horses. We were shortly treated to a superb display of equestrian skill with practised riders and horses performing precision routines. Following a sumptuous dinner with excellent Spanish wines, we were entranced by a sensuous

Figure 6. And the sherry flowed – not a drop was spilled.

Figure 7. The banquet hall itself was an old stable – the Spaniards certainly cherish their horses!

Figure 8. We were treated to some spectacular after dinner entertainment.

Figure 9. Banquet or not, we had our noses back to the grindstone the following day.

Figure 10. The poster session was held in the entry hall, which also housed a telecommunications museum.

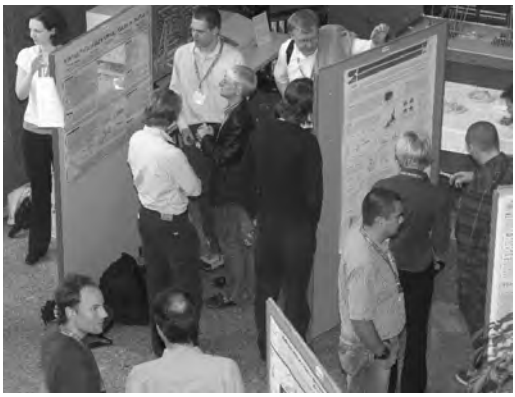


Figure 11. Lots to see and discuss.

performance of Flamenco dancers set to the music of a classical guitarist and vocalist.

On a difficult-to-arise Wednesday morning we heard an invited lecture by Dorthe Dahl-Jensen on links between radar investigations of the deep Eemian ice in Greenland and climate change. This 'big picture' presentation began a session on modeling radar data and paleoclimate, followed later in the morning by a second session on radar studies of the firn.

On Wednesday afternoon we traveled again by coach to the ancient capital city of Toledo on the banks of the Tagus River in the heart of the Castilian plateau and one of the principal historic monuments in Spain, designated a World Heritage site by UNESCO. Known as the city of three cultures, it was home for many years to Judaism, Islam and Christianity and all have left their mark. Immense cultural wealth makes Toledo a city of many attractions with over 2000 years of history, starting with the Romans in the 4th century BC and reaching a peak in mid 16th century during the reign of Carlos I.

Figure 12. Refeshments were served against a backdrop of an old telephone exchange.

Figure 13. The midweek excursion was to the fabulous city of Toledo.

Our tour started at the Cathedral of St Mary of Toledo, one of the three 13th century Spanish High Gothic cathedrals and considered to be the *magnum opus* of the Gothic style in Spain. Begun in 1226 during the reign of Ferdinand III, it is built with white stone from Olihuelas, close to Toledo. The last Gothic contributions were made in the 15th century when the vault of the central nave was finished, during the reign of the Catholic Monarchs.

Walking through the narrow streets with our guides we next came to Iglesia de Santo Tome where we viewed the famous masterpiece by El Greco, El Entierro del Senor do Orgaz (The Burial of the Count of Orgaz). Widely considered among El Greco's finest works, it illustrates a popular local legend from the beginning of the 14th century. The painting complements the larger exhibit of El Greco's works in the Museo del Prado which many participants visited at other times during the week.

Returning again to narrow winding streets, we reached Sinagoga de Santa Maria La Blanca, one of three Jewish Temples preserved in Toledo. Founded in 1203, the synagogue was designed and decorated by Mudejar architects (Moors working on Christian soil) and the Islamic influence is readily apparent. Stormed in the early 15th century by Christians, it was converted into a church and more recently restored as a museum.

Finally we found our way to the beautiful Monasterio de San Juan de los Reyes, a 15th century monastery founded by King Ferdinand and Queen Isabella to commemorate their triumph over the Portuguese at Toro in 1476. An example of Gothic–Spanish-Flemish style, San Juan de los Reyes was restored after the damage caused during Napoleon's invasion.

After some time to wander the intertwining streets of Toledo, where remarkably no one was lost – at least not permanently – we regrouped at Hostal del Cardinal with its beautiful gardens for

Figure 14. We wandered between cultural and religious sites along the narrow Toledo streets.

Figure 15. The evening meal was at the residence of the Cardinal.

Figure 16. Our gracious hosts.

another fine evening of food and beverage, returning to Madrid in the early morning hours.

Up again for a full day of radar and science on Thursday morning, many of us began to realize that the late evening dining (most restaurants not opening until 9 pm) and subsequent late bedtimes were wisely designed to create space for an afternoon siesta during the warmest hours of the day. But for us there was just too much going on to nap. We started the day with Christina Hulbe's invited talk on the stagnation of Kamb ice stream from flow features within the ice. This began a session on ice flow inferences and analysis techniques based on radar data from a variety of locations including Antarctica, Alaska and Svalbard. The morning sessions on Thursday concluded with talks on a variety of analysis techniques including polarization and the location of water bodies in temperate glaciers.

Following another scrumptious lunch and the General Meeting, presentations focused on the measurement of ice fabric, starting with an invited talk by Kenny Matsuoka on detecting in-situ ice-crystal alignments using radar. The afternoon concluded with the second poster session featuring 20 presentations on a variety of topics from new radar designs to processing and modeling techniques.

The final half-day of the conference began with an invited presentation by Sridhar Anandakrishnan on combining radar and seismic methods to characterize subglacial properties. Both of the morning sessions focused on identifying water at the basal ice interface including several presentations on the many subglacial lakes now identified in Antarctica.

This concluded an intense week of stimulating presentations, good discussion and visits to cultural venues in and around Madrid. Many participants commented on the well-integrated themes of the meeting, from technical advances in hardware, to novel glaciological results, to applications in data analysis and modeling, and of course the applications of radar on Mars. Both the meeting itself, the local arrangements and our experiences of Spanish culture throughout the week were thoughtfully conceived and superbly well organized, thanks to the efforts of all on the local meeting committee and especially Francisco Navarra.

Bob Jacobel
St Olaf College Department of Physics

Portrait of the Glaciologist as a Young Dynamicist

The International Symposium on Dynamics in Glaciology
Limerick, Ireland, 17–22 August 2008

ABSTRACT: During the recent International Symposium on Dynamics in Glaciology hosted by the University of Limerick, the Mathematics Consortium for Science and Industry and the Science Foundation of Ireland, the Secretary General of the International Glaciological Society, Magnús O'Magnús, had an opportunity to catch up with the master Irish writer Jimmy James Joyce (of Cnoc Ayeal, Co. Dublin) to learn about his experiences as a symposium attendee. In his characteristic style, Jimmy Joyce responded with a stream of consciousness covering the scientific and social aspects of the symposium, the mid-week excursion and the post-symposium tour. His last sentence begins his first sentence, and what follows is his story.

Quotes of the symposium:
Don't worry, Lonnie, these are what grass-fed animals produce... – Ellen Mosley Thompson to Lonnie Thompson, the Society's most recent Seligman crystalist, while walking across a cow pasture on the flank of a *droim* near Drumandoora on the mid-week excursion.

Thus the unfacts, did we possess them, are too imprecisely few to warrant our certitude... – James Joyce (describing the science of glaciology in *Finnegans Wake*, 1939)

Present at interview:
IGS Secretary General: Magnús O'Magnús
Irish author: Jimmy Joyce

Magnús O'Magnús:
Jimmy, you're looking pretty cabbaged now. Did all that dynamics at the symposium put the devil in ya?

Jimmy Joyce:
Aye Magnús, quit acting the maggot, I'm not the only one circling over Shannon tonight; so bring up your pint and let me tell you a story:

riverrun, past Eve and Adam's, past Shannonside, from swerve of shore to bend of bay, brings us by a commodious vicus of recirculation back to Bunratty Castle, Limerick and environs. There we began the symposium on the ice's dynamic to be played out by Powerpoint, projector and large sheets of poster paper, with colouring schemes that are sometimes jet and sometimes grey like jet's contrails. All the regular jacks were there, including the feens of mathematical and theoretical glaciology (especially those from Eire) that give handy explanations for all that the rest see and measure. Also there were the lovely crayturs who had more than a touch of the poet when it came to fluid dynamics. What was best of all was the meeting venue next to the Stables, where many would gather for a pint after a long day of arguin' about the wee parameters.

No sooner did I jump up from my *scratcher* on the rainy Monday mornin' did the new president of the IGS, Eric Brun, get the brakes off, and the talks and posters of the symposium kicked right in: ranging from subglacial hydrology, to ice sheets and climate change... from basal freeze-on, to the impact of present warming. Garry K.C. O'Clarke gave the lead-off talk which was absolutely *lethal*, and concerned the circulation of Lake Vostok and the ice on the roof of that lake. And then there were more talks about advances in ice-flow modeling. At one point, a tribe of numerical modelers gave a full tribute – one appropriate for a Celtic hero – to a man named Stokes. (We couldn't tell if it was an investiture or a wake.) So finally, by Tuesday, we

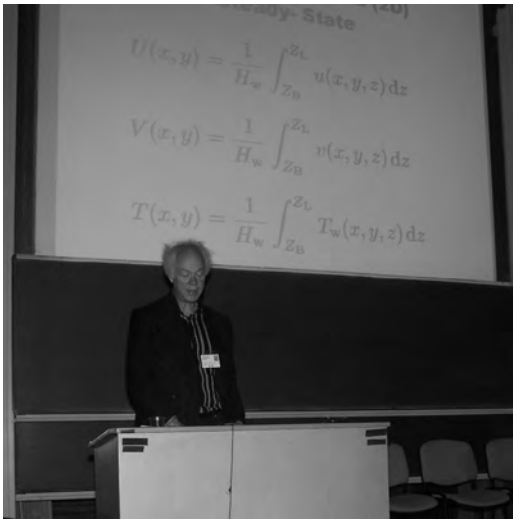


Figure 1. It all started with Garry Clarke and a lethal bunch of equations

Figure 2. There was a wonderful reception following the Seligman ceremony.

Figure 3. A healthy pint of Guinness was the staple diet after an exhausting day in the lecture theatre.

Figure 4. And stimulating conversations also took place in the pub.

made it to the Seligman Crystal Award Presentation and Lecture followed by Barbeque, all made enjoyable by the opening of wine bottles and pouring of creamy Guinness.

Now the *oul' lad* who they gave the Crystal to was no *eejit*, but was a real legend who'd done more than 50 expeditions in high mountains and other desperate places all in the name of glaciology and ice-core science. His lecture was class, and the poets got started working their craft to honor him later in the week at the banquet. For example:

Lonnie Thompson is one of those guys
whose career is a series of highs,
for salvaging scraps
of some shrinking ice caps
They gave him the Seligman Prize.

There once was a young man named Lonnie
Who exclaimed, 'My, those glaciers look bonny.
I'll climb them and see
what the climate might be
Back when mammoths were woolly and brawny.'

But when he got up there he found
The glaciers were now mostly ground
They'd melted way back...
A greenhouse attack!
'This land should be white and not brown!'

He went back to his wife, lovely Ellen.
And said, 'At this rate there's no way of tellin'
How bad it might get –
I've started to fret
that the oceans will soon start a-swellin'.'

So you'd think that the meeting had us all *knackered* by this point, but *jakers*, that's when the fun just started, and we headed out on the mid-week excursion through Co. Clare and the Burrens. Now this was a lovely day, in a light rain as usual, and it began with a bus ride along the river Shannon and across the bridge at Killaloe where we could look over Lough Derg and see the whitecaps and feel the wetness that keeps the island so green. The morning was devoted to the area between Ennis and Gort, and we stopped several times to walk across the *droims* and see the wavy landscapes molded by the ice that flowed across the fair island in ancient times. That was where we noticed what the cows were leaving behind for us to step on. Ellen, the *bonnie wan* of Lonnie, explained that these cows, being grass fed, were leaving behind nothing for us to act the *cod* over. OK, so you step in a few.

After more drumlins and lunch, the Burrens were shocking. This landscape was occupied in ancient times and was dusted with *cashels* and *ráth*, dolmens and portal tombs . What they used to say about the Burren was: *it is a country where*

there is not water enough to drown a man, wood enough to hang him, nor earth enough to bury him..., but there were enough grikes and clints along the way to twist an ankle. The place was first settled in neolithic times, and you could see old walls made of stone that enclosed fields with no soil, nothing but bedrock limestone surface. This place was part of the neolithic farming revolution that suffered from soil erosion and environmental degradation at the very outset of human influence on the globe.

Along the way, we stopped and hiked up to Cathair Chomáin, a ring fort or *cashel* perched on the edge of a steep ravine. We could imagine the time, probably before the fifth millennium B.C.E. when the thick walls of this stone fort protected a wise king and beautiful princess, and where water was kept for travelers bringing grain and other trade goods. Beyond Cathair Chomáin, we stopped at the site of a portal tomb, Poulnabrone, dating from 3800 B.C.E. where the disarticulated bones of 22 adults and six children were placed before the Bronze Age.

Then it was on to Gus O'Connor's pub in Doolin to have our supper and a pint to quell our thirst. This was the place made famous by Irish music (and where the Playstation-3 game Folklore sites the portal to the realm of the dead). From there it was on to the steep, windswept cliffs of Moher and O'Brien's castle, where we saw the dark night of the North Atlantic slip its veil across the green island.

After another day of talk about ice streams, surging glaciers and glacial geomorph, we got on with a party at a place near Bunratty Castle. And here we learned about limerick poetry, a few examples of which are included:

If you seek enhanced lubrication
Your till needs liquid stimulation
for a bed that's not wet
needs more friction to get
the maximum sliding sensation.

There once was an ice stream that got
an embarrasing wet sticky spot
'If it's not too much trouble,
I'd like to decouple
And surge once again while I'm hot.'

Well, you get the picture, and a selection of these poems will be published elsewhere. But after the fine evening's celebration, we returned to our last morning of talks on Friday. A small tear welled in my eyes as Heike Gramberg gave the last talk on 'The Formation of Drumlins', expressing an idea that she and Andrew Fowler, organizer of this great symposium, had managed to put together to help explain the landscape we had seen on the mid-week excursion.

Figure 5. The limerick competition revealed many aspiring poets.

Figure 6. The limerick provocateur exposing himself to glacial geology.

Figure 7. Colleagues from China enjoy another nutritious Guinness and appreciate why Irish Antarctic explorer Sir Ernest Shackleton turned back on his trek to the Suth Pole in 1909. 'A live donkey may be better than a dead lion', as Sir Ernest said to his dear wife, but we suspect that, being that he was an Irishman, he was also rather thirsty.

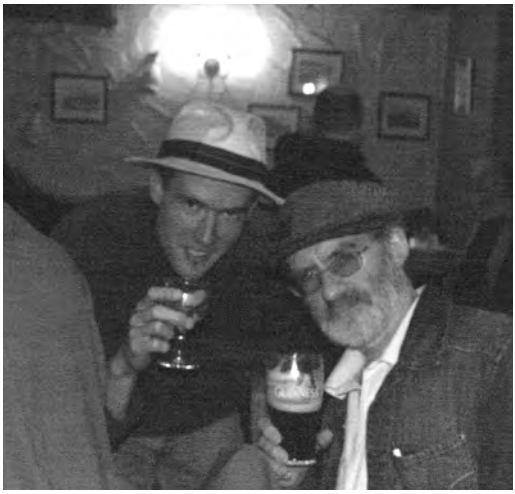


Figure 8. We ran into some very dubious characters in the pub.

Afterward, we enjoyed a fine lunch before saying *Go raibh maith agaibh* and *slán go fóill* to our hosts at Limerick, starting with Andrew Fowler and including Peg Hanrahan and Marguerite Robinson, for doing a magnificent job organizing such a wonderful experience. We'll meet again at Manali. Bussoftlhee, memory of good time! Till thousandsthee drumlins cover the land and small *tulach* too. And boundary layers and lips. The keys to knowledge. Given! A way to a symposium we loved at a place along the

Magnús O'Magnús:
Jakers, Jimmy, was that the end of it?

Jimmy Joyce:
Not the least of it, my friend Magnús, I also went on the post-symposium excursion. Let me tell you about that.

Post-symposium tour

As post-symposium tours go, this one, like the others, was a wonderful time to experience the joy of travel, the collegial company of smart scientists and the warmth of sharing ideas, food and drink in a scenic land touched by ice. The highlight of this trip was the chance to travel with glaciologists and glaciophiles, young and old, like Hans and Doris Rothlisberger, Atsumo Omura and his family, the Viking family from Iceland (currently encamped in Cambridge, UK), Europeans, North Americans, Asians, Aussies (a.k.a. displaced Irish), and the charming, blarney-speaking Irish trip leaders. After boarding a comfortable coach equipped with driver/expert historian, we covered Co. Clare in a quick drive up to Galway on a new superhighway expressing Ireland's entrance into the modern European Union world. In Galway, we picked up our tour co-guide, geologist Paul Dunlop, from the University of Ulster, able assistant to co-guide Andrew Fowler, and visited the Galway crystal factory where small presents were bought for those left at home (and where Timothy Creyts, curiously picking things up that he shouldn't, almost shattered the new Ryder Cup trophy, to be awarded at the golf match held a few weeks later). Then it was on to Derryloney drumlin in Barna and the coral (maerl) beach before turning north toward the Twelve Pins of Connemara to visit Kylemore Abbey. Of particular interest were the excellent glacial geology of the Benna Beola of Connemara National Park, the exposures of wonderful green connemara marble, and the story of the lazy beds, the old way of growing potatoes before the great famine. The final stop of the day was the Tullywee delta, a site of a submarine till deposition parti-cular to grounding line dynamics. This site was scrambled across from top to bottom by both glaciologists and goats.

Figure 9. Post-symposium tour dynamic commentator Christian Schoof reminds us that all dynamic glaciology sometimes means walking a road less traveled. Note the care Schoof takes to achieve proper flux-condition foot placement, possibly in spite of O(1) Guinness-induced stress effects.

After pub, dinner and a good sleep in Letterfrack, Co. Galway, we woke the next morning, bright and early (shaking off the effects of several

Figure 10. In spite of some minor 'dampness' we enjoyed some spectacular vistas. One of these drumlin isles was once owned by former Beatle John Lennon.

fine bottles of wine and an excellent meal the night before), boarded our comfortable bus and headed off to Leenane, to see ice-contact Gilbert-type deltas and the glaciomarine sediments of Askilliaun, Co. Mayo. Passing the site where the 1990 movie The Field was filmed, we drove north, across the Doo Lough Pass, where we encountered a memorial stone dedicated to 400 people who died of famine there in 1847 at the height of *an gorta mor*, after walking from Louisburgh in a vain attempt to obtain help. Approaching Askilliaun, we tested our bus driver by forcing him into an extremely tight roadway, where we drove for several miles with hedges and stone walls mere centimeters from each side of the unblemished paint job of the bus. The nerve-wracking experience was worth it, as we visited massive beach exposures of diamicts left behind by ice flowing into Clew Bay from the east. Then it was on to Westport and Clew Bay, our second overnight destination, passing Croagh Patrick (a tall mountain, 762 m, site of a yearly pilgrimage in the name of St Patrick, the patron saint of Ireland).

Figure 11. The younger generation enjoyed the view as well.

Figure 12. The Hindmarsh twins pose for paparazzi on the summit of a Neolithic fortress, like chieftains of old.

After seeing Drumindoo drumlin, catching ourselves on various barbed wire field fences, and viewing the exposed drumlin section south of Rassakeeran, we settled into Westport Quay, and boarded two intrepid fishing vessels for a twilight voyage into Clew Bay, to see the drumlin islands.

Our third and last day began in a driving rain, as we shifted our attention to the subject of the Connaught esker system and subglacial hydrology. Climbing to the top of a hill near the Collagh esker section, we stumbled across another neolithic ring fort. There, it was decided that Richard and Doug, the Hindmarsh twins, would pose for photographs, allowing all in attendence to reminice on the fact that the imposing stature of these twins reminded us of what ancient kings must have looked like.

From a last lunch together in the rain in an old ruined mansion from the 18th century near Tuam, we drove back to Shannon and concluded our sojurn with a hearty statement of thanks to the organizers: Peg Hanrahan, Jenny Wright and particularly Marguerite Robinson, for invaluable administration, logistical and technical support.

Doug MacAyeal

REPORT ON THE IGS BRITISH BRANCH ANNUAL MEETING SEPTEMBER 2008, SWANSEA

This year, the IGS-BB 2008 Meeting was held in September in Swansea, hosted by the University's Glaciology Group. Talks were distributed over the course of a day and a half, commencing after a buffet lunch of sandwiches and samosas. The two sessions on the first day began with talks focusing upon remote sensing of the cryosphere. This included an equal balance of studies from Greenland and Antarctica: both environments being described by Hamish Pritchard's new data set of interpolated elevation changes. The second afternoon session was devoted to ice dynamics and modelling but was unfortunately reduced to just two talks, Richard Hindmarsh and Ian Willis, who demonstrated the sensitivity of modelling to boundary conditions and *a priori* assumptions. Modellers beware! The session closed with members presenting posters giving very brief outlines of their work, and attention was then turned to the necessary AGM. The lack of minutes from the previous year ensured discussion was devoted to current matters. Of primary concern was British representation within the IUGG's International Association of Cryospheric Sciences (IACS). Expect further briefing on the issue from Andy Hodson if you have not already received it. As Treasurer, John Woodward then reported, the British Branch finances are in good order. Forthcoming IGS-BB meetings were proposed at BAS (2010) and then either Aberystwyth (most probably 2011) and Lancaster (most probably 2012).

Figure 1. The British Branch President discussing with representatives of the local organizing committee where to go for dinner.

Following the closing of the AGM, members were plied with a variety of drinkable wine and had the opportunity to examine the ten or so posters displayed in the spacious foyer of the Geography Department. Transport to Mumbles for the meeting's meal was provided in the form of the Swansea Bay Land Train – a true tourist experience notable for Brian Barrett's 'mobile photography' and a passing 'high-five' with some unknown 5-year-old. The meal was served in the Mumbles Mediterranean Grill Restaurant which could not be faulted for generous servings! A number of voices had felt the first course was nearly enough, and were left silent as huge plates of lamb chops, kebabs, and koftas were deposited on the tables. Proponents of the Atkins diet were hugely satisfied, while vegetarians were most likely bemused!

Figure 2. The delegates travelled by cutting-edge Welsh transport to wherever the President would lead them.

Figure 3. We were treated to a bountiful feast at Mumbles Mediterannean Grill Restaurant.

Unfortunately, the 24-hour licensing laws hadn't quite taken a foothold in Mumbles, and rushed efforts to reach late last orders came to nothing. Nonetheless, as many wended their way to campus, some members made a bold dash for Swansea and a final round in the wee small hours. Surprisingly, a number of the 'usual suspects' were not to be found in tow!

Turn-out for the Tuesday morning was surprisingly high and a total of four sessions took place, all interspersed by sufficient coffee breaks. The first included the derivation of spatially variable snow water equivalent, the geomorphology of debris stripes and biological processes upon ice masses. The second session was devoted to englacial water and hydrology, with field results presented by Jane Hart, Kathryn Rose, Tris Irvine-Fynn and Douglas Mair. Some thought-provoking theoretical problems associated with the derivation of ice water content using GPR were then presented by Tavi Murray. After lunch, the third session covered a range of efforts to examine climate–ice links, which included an assessment of whether the proposed glaciation of the entire Tibetan Plateau is merely science fiction (Jakob Heyman) and a careful derivation of Rutford Ice Stream's surface temperature history from thermistor strings (Brian 'Brain' Barrett). Thereafter, the fourth period of talks was exclusively dedicated to geophysical exploration of ice and mud, including Julian Scott's use of seismic surveying methods to induce ice shelf collapse and, in closing, Andy Smith's description of lake sediments in subglacial Lake Ellsworth.

As is now tradition, the meeting was closed by John Glen's award of Best Student Presentation(s): congratulations therefore to Jennifer Hall (Aberystwyth, now at Sheffield) and Katie Grant (Reading), who were awarded the John Glen Prizes, respectively, for best poster and oral presentation. Katie's presentation reported ice mass dynamics since 1952 in Novaya Zemyla, which appear to be a complex response to climate variations as well as ocean conditions. Jennifer's MSc work focused upon rule-based terrain classification in the glaciated Patagonian Icefield region using satellite-derived imagery. There was a good postgraduate student presence at the meeting that including a number of individuals planning to commence PhD research this coming academic year. Representation of the more senior glaciologists in the British Branch was weaker.

Thanks must be passed to the Swansea Glaciology Group, particularly Tim James, Tavi Murray, Suzanne Bevan, Brian Barrett and Alessio Gusmeroli, for a meeting which, once again, demonstrated the huge variety of research areas being explored, the increasing numbers of scientific questions yet to be answered, and the increasing diversity of skill-sets within the IGS-BB. The event itself was a very relaxed and enjoyable, the food was great and members can now look forward to the IGS-BB in Sheffield next year!

Tris Irvine-Fynn and Andy Hodson

Books received

Shi Yafeng, ed. in chief. 2008. *Concise Glacier Inventory of China*. Shanghai: Shanghai Popular Science Press. 204 pp. (ISBN: 978-7-5427-3115-3, (hardback), ¥210.)

Shi Yafeng, ed. in chief. 2008. *Glaciers and Related Environments in China*. Beijing: Science Press. 551 pp. (ISBN: 978-7-03-017580-9, (hardback), distributed by Elsevier outside the People's Republic of China.)

Shi Yafeng. 2008. *Collectanea of the Studies on Glaciology, Climate and Environmental Changes in China*. Beijing: China Meteorological Press. 850 pp. (ISBN: 978-7-5029-4515-2, (hardback), ¥150.)

Raina, V.K. and D. Srivastava. 2008. *Glacier Atlas of India*. Bangalore: Geological Society of India. viii + 316pp, 179 col., 151 black and white figs., tables. (ISBN: 81-85867-80-9, (hardback), USD $120.) http://www.vedamsbooks.com/no59610.ht

INTERNATIONAL GLACIOLOGICAL SOCIETY

INTERNATIONAL WORKSHOP ON SNOW AND AVALANCHES

Manali, India
6–10 April 2009

CO-SPONSORED BY:

Snow and Avalanche Study Establishment (SASE), Manali, India

SECOND CIRCULAR

September 2008

Registered Charity

INTERNATIONAL GLACIOLOGICAL SOCIETY
PRESIDENT: E. Brun
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SYMPOSIUM ON SNOW AND AVALANCHES
The International Glaciological Society will hold an International Symposium on Snow and Avalanches in 2009. The symposium will be held in Manali, India ON 6–10 April 2009.

WORKSHOP ORGANIZATION
Magnús Már Magnússon (International Glaciological Society).

LOCAL ORGANIZING COMMITTEE
R.N. Sarwade (Chairman), R. Shankar, P. Mathur, A. Ganju, Amod Kumar, Pramod Satyawali, R.R. Seth, K. Srinivasan, P.S. Negi, R.K. Garg, Snehmani, S.S. Lalji, G.R. Panesar, V.D. Mishra, Arun Choudhary.

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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; E-mail: igsoc@igsoc.org
IGS Web: http://www.igsoc.org/symposia/
Local website: http://issa2009.in/

PARTICIPATION
This circular includes instructions for registration and for arranging accommodation, both through the travel agency website. A registration form (available at the symposium website) is also included, although online registration is strongly encouraged. Registration and accompanying payment are due 20 January 2009. There is a surcharge for late registration. The participant's registration fee includes organization costs, a set of abstracts, the icebreaker, coffee breaks and lunch, a copy of the IGS publication, the midweek excursion and the banquet.

REGISTRATION FEES	**£**	**€**	**US$**
Participant (IGS member)	275	350	510
Participant (not IGS member)	325	410	600
Student or retired IGS member	140	177	260
Accompanying person	145/ 110	185/ 140	270/ 205
Late registration surcharge (after 25 February 2009)	50	65	95

Symposium study tour
Bookings will be done through the local website. Details will be posted as they become available. Registration refunds will be made according to date of notification. Cancellations made before 25 February 2009 will receive a full refund. Cancellations between 25 February and 20 March 2009 will receive a 50% refund. After 20 March it will not be possible to make any refund.

THEME
Snow and avalanche science has made fundamental contributions to human safety in mountain regions. It has now evolved into an important branch of glaciology. Initially snow science was aimed at understanding avalanche formation and developing avalanche control measures. These remain important topics. However, now an understanding of how snowy environments throughout the world are affected by global climate change is required. The role of snow in hydrological and ecological earth surface processes is therefore a central theme of the symposium.

TOPICS
The suggested topics include:

1. Snow, including: snow hydrology, snow ecology, snow metamorphism, snow microstructure, snow and climate change: threat perception; snow in the Himalayans; snow, glacier mapping and global climate change
2. Snow avalanches, including: avalanche forecasting; avalanche dynamics; avalanche control and engineering
3. Snowpack, including: snowpack properties and process modelling; snowpack stability and spatial variability
4. Observations and instrumentation, including: observation networks in snowbound regions; cold region instrumentation and measurement networks; remote sensing applications of snow; glaciers and mountain hazards, global connections between cryospheric regions
5. Mountain meteorology.

SESSIONS AND POSTERS
Oral presentations will be held on four full days and one half-day. There will be ample opportunity for poster displays. Poster boards measuring 270 cm wide by 120 cm high will be supplied for the poster presentations. Three A0 portrait poster displays are possible on one board.

ABSTRACTS

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 website will be available from 1 November 2008 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.
   Those 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 website.
   LAST DATE FOR RECEIPT OF ABSTRACTS: 15 JANUARY 2009
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. First or corresponding authors will be advised by 1 February 2009 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. The abstracts will be compiled into a paper or CD format, and may be published on the Internet.
3. DISTRIBUTION OF ABSTRACTS A set of the accepted abstracts will be provided to participants upon registration on 5 April 2009.

THEMATIC PUBLICATION

The Council of the IGS has decided to publish an *Annals* issue whose theme will be Snow and Avalanches. A first call for papers will be in December 2008. Submissions are open to anyone. Deadline for paper submission will be 15 March 2009. All papers should be submitted through the IGS online submission system and will be refereed and edited according to the Society's regular standards before being accepted for publication. Those submitting abstracts to the symposium will be asked to indicate whether they intend to submit a paper for publication in the *Annals*, so that reviewers may be sought in advance. Papers submitted for consideration in the *Annals* cannot be submitted to another publication as well.

EXCURSIONS
(http://issa2009.in/images/Excursion.pdf)

MID-WEEK FIELD TRIPS

NAGGAR Situated on the left bank of river Beas, Naggar was the capital of Kullu for c. 1400 years. Nestling on a wooded slope, it commands a splendid and extensive view of the valley. The paintings of the late Nicholas Roerich (who married famous Indian actress Devika Rani) should be seen at the Roerich museum in a white-washed villa set in a jewel-like garden. Naggar Castle, built in the sixteenth century, is a great tourist attraction.

ROERICH ART GALLERY The art gallery has been housed in the building where the great artist once lived. He bought the building in 1923 from the Rajah of Mandi. In the lower storey there is an art gallery of 45 paintings, one showing the sunset is considered a masterpiece; two paintings show the Ghepan peaks in Lauhal. The stone idols of Shiva Parvathi, Ganesh, Googa pir, Vishnu, Durga, etc. are displayed in the open on the northern end of the courtyard under the tree. The car, a 1928 model once used by Roerich, is also been exhibited.. The upper storey, items in daily use by the Roerich family, have been arranged to depict their way of living. These rooms are usually kept locked, but can be seen through the transparent window/door panels. Roerich died here on 13 December 1947. The gallery is open from 10:00 am to 5:00 pm.

TIBETAN MONASTERIES There are three newly constructed, colourful monasteries in Manali. The Tibetans living around these monasteries sell a wide range of Tibetan handicrafts and carpets to visitors. Two of these monasteries are located in downtown Manali and one is in Aleo. Aleo is located on the left bank of River Beas in Manali

BANQUET will be held on Thursday evening, 9 April at Ambassador Resorts.

SYMPOSIUM STUDY TOUR – BEAS KUND TREK Beas Kund trek is one of the most popular and beautiful treks in Kullu Valley. Beas Kund is a holy lake where Rishi Vyas took his daily bath. The River Beas originates from here. Solang Nalla base camp is 13 km from Manali and 1 hour drive, a popular place for skiing, paragliding, etc. Dhundhi camp gives a first glimpse of Mt Hanuman Tibba and Seven Sisters. The Beas Kund area may be full of snow at the time of this trek. This is an enjoyable and easy going trek for any age group, walking under the shadow of the high mountains of the Pir Panjal Range. This trek does not require acclimatization to high altitude. Further details will be available on the symposium website.
The pricing per person will depend upon the group size. The average cost per person may be INR7500 for 3 days and 2 nights (10 April afternoon to 12 April evening).

ACCOMPANYING PERSONS PROGRAMME

The accompanying person registration fee (£145 for 18 and over, £110 for under 18) includes the

icebreaker, traditional barbeque, the mid-week excursion and the banquet. Short excursions in and around the Manali area will be offered, at additional cost. These include trips to Naggar, Roerich Art Gallery and Tibetan Monasteries. All participants may also like to visit the Hadimba Temple, Manu Temple, Manali Town and the Hot Water Spring (at Vashisth village).

POST-CONFERENCE WORKSHOP (13-15 April 2009)

There will be a post-conference workshop on Snow Characterization following the IGS symposium. The workshop is jointly planned by SASE, SLF and Boise State University. Drs Martin Schneebeli from SLF Switzerland and HP Marshall from Boise State University, USA, will be the plenary speakers. The venue will be the same as the IGS symposium but in a different hall. Limited seats are available on a first-come basis. All interested can contact Martin Schneebeli at schneebeli@slf.ch

The workshop programme is available on the conference website. http://issa2009.in/

TRAVEL, ACCOMMODATION AND OTHER LOCAL INFORMATION

Location and weather

Manali is situated in the Pir Panjal Ranges of western Himalaya. Its climate changes throughout the year. The altitude (6500 ft) gives it a favourable climate, with cool summers and harsh winters. During winter the snow-line comes down, there is snowfall in the region and heavy woollen clothes are required. In the month of April the temperature varies between 5 and 30°C with occasional convective rainfall.

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People and society

The people of Kullu are primarily farmers, but now the population has also scattered into emerging occupations such as tourism, weaving and skilled fields like computer applications. More than 70% of the populations are literate. This includes an equal ratio of men and women. The public sector is a main source of employment. There is a rich tradition of folk arts in Kullu. The excellent temple carvings, vibrant handicrafts, spectacular folk dances and melodious songs show the sensitivity of the people.

Manali economy

Manali's economy is based almost wholly on two things: fruit and tourism. Fruits – pears and apples – were first introduced to Manali by British settlers who realised that the area was perfectly suited for growing fruit. Today, Manali's fruit is among the choicest in north India; there's plenty of it in local markets, and a huge portion finds its way to other parts of India too. Manali is a popular base for treks and excursions into the surrounding areas; and the starting point for a trip to Ladakh. Tourism, hospitality and allied activities, including the production of handicrafts, are among the main economic activities.

Manalsu Nala

To get a more authentic flavour of the area, take a half-hour walk from the Mall across the Manalsu Nala to reach the village of old Manali. Also known as Manaligarh, it has a ruined fort and a cluster of houses built in the Pahari style, with heavy stone roofs and wooden balconies projecting out of the first floor. According to popular belief it is here that Manu the lawmaker lived around the 2nd century BC. His treatise, the 'Manusmriti', is the foundation of Hindu law and of the rigid caste system based on Varna or profession. Considered one of the most orthodox Hindu texts, the Manusmriti continues to be followed by many devout Hindus even today. In the centre of the village is the Manu Maharishi temple, a relatively new shrine dedicated to Manu. The village itself is an idyllic break from the rush of main Manali, surrounded by terraced maize fields and apple orchards. There are several guesthouses and cafes lining the path to the village.

Hidimba Devi Temple

Hadimba or Dhungiri temple in Manali is one of the most important temples in the region. This four-story wooden temple is located in the middle of a forest called the Dhungiri Van Vihar. Maharaja Bahadur Singh built the present wooden pagoda-like temple in 1553 after earlier structures were burnt down by forest fires. Standing on a stone platform surrounded by old deodar trees, the three-tiered temple is crowned with pennants, brass bells and a trident. Carvings of animals, plants and folk deities adorn the temple, while hunting trophies hang over its entrance. Inside the shrine is the brass icon of the goddess, surprisingly tiny compared to the huge temple structure and the legendary prowess associated with her. The shrine is within a natural cave formation dominated by huge rock. A set of enlarged footprints on the rocks is believed to be of Hadimba herself. In mid-July the idol from old Manali is brought to this temple for a major festival. As part of the frenzied celebrations, several animals including a buffalo and a goat are

sacrificed to the goddess. The blood falling on the stones is channeled to the mouth of goddess Hadimba. Not for the faint-hearted, this ancient ritual draws large crowds.

Gadhan Thekchoking Gompa
This Gompa dominates the Tibetan area around the bottom of the Mall in Manali. Tibetan refugees built the Gompa in the late 1960s. The Gompa is covered with brightly coloured frescoes and a mid-size Buddhist statute and carries a list of the martyrs killed in the occupation of Tibet of 1987–9. Inside the brightly painted prayer hall is a statue of Shakyamuni (form of Buddha). The monastery is maintained through donations and the sale of carpets woven by the lamas within the temple workshop. A smaller Gompha near the market has a large gold-faced image of Buddha, which is best viewed from its first floor verandah. Monks can be seen printing prayer flags in the open terrace.

Mountaineering Institute
This Institute in Manali provides training facilities for basic and advanced climbing both for Indian nationals and foreigners. It offers other adventurous sports activities like high-altitude trekking, minor mountaineering, rock-climbing, skiing and has lodging and boarding arrangements. Equipment can be hired for trekking purposes.

Excursions from Manali
ROHTANG PASS (50 km) Rohtang Pass is the highest point, 4112 m, on the Manali-Keylong road, 51 km from Manali town. It provides a wide panoramic view of mountains rising far above clouds, which is a sight truly breathtaking.

ARJUN GUFA (5 km) On the left bank of the Beas, 5 km from Manali near the village of Prini, is the 'Arjun Gufa' or the cave of Arjuna one of the heroic brother of Pandhvas, who fought with Kaurav. In here Arjuna practised austerities to get Pashupata Ashtra or weapon from Lord Indra.

BEAS KUND (50 km) This is the source of the river Beas, at the Rohtang Pass. It is easily accessible. The great sage Vyas performed 'Tapa' here during the Mahabharat times. The place is still hallowed by celestial light. Because of this that the river got the present name of Beas.

JAGATSUKH TEMPLE (6 km) This is one of the biggest villages in Kullu district, famous for its Shiva temple built in 'shikhara' style. Nearby is the old and interesting Devi Sharvati temple.

KOTHI (12 km) A pretty little village on the Keylong road at the foot of Rohtang Pass. There are very fine views from Kothi, and the Beas River flows through a very deep and narrow gorge at this point. The well-situated Public Works Department (PWD) Resthouse is a popular place for overnight stays. Close to the rest house is an awe-inspiring gorge where Beas enters a chasm about 61 m deep and just few metres broad.

RAHALLA FALLS (16 km) At the start of the climb to the Rohtang Pass are the beautiful Rahalla Falls, at an altitude of 2501m.

SOLANG NULLAH (14 km) 14 km northwest of Manali in the Solang Valley, this is Himachal Pradesh's best ski slopes. The Mountaineering and Allied Sports Institute operates a 300m high ski lift and February is the best month to ski over here. State tourism runs a 7-day package for ski courses with accommodation in the Hotel Rohtang Manaslu in Manali. Courses are also offered by the Mountaineering and Allied Sports Institute and the North Face Ski School.

VASHISTH HOT SULPHUR SPRINGS (3 km) This small village near Manali is famous for its scenic beauty. The village has a temple dedicated to Lord Rama and Vashisth Muni. The village has some hot water springs, which are said to carry medicinal properties. It is a picturesque little place.

RAFTING The Beas River flowing through Kullu valley is suitable for not only white-water rafting but canoeing and kayaking too. Open between May to September.

SKIING Near Manali there are some slopes, which have been rated the best for skiing in the world. The Solang Nullah, Patalsu, Kothi, Marhi and Rohtang slopes are very good for skiing in the winter as well as summer.

HELI-SKIING For high mountain thrills perhaps nothing can surpass the magic of heli-skiing. The sport is available in the area abound by the Hanuman Tibba, Rohtang Pass, Deo Tibba and Chanderkhani Pass near Manali.

TREKKING The main trekking areas in Himachal are the Dhauladhar and Pir Panjal ranges, easily accesible from Kullu valley. Several treks lead over from Kullu valley to Lahaul and Spiti, Zanskar, Kinnaur and Kangra. Most treks pass through rugged and unspoiled terrain, deep forests and beautiful streams. Many old temples lie along the way.

Maps/Getting around
Manali town can be covered on foot, but for longer excursions and travel out of town, tourist buses and private taxis are available for hire. The Taxi Operators' Union (Ph: 01901–252205, 252450) has a counter near the tourist office. Charges in peak season are about Rs. 1000 for a full day trip around Manali. Motorcycles are available for hire at the Enfield Club (Ph: 01901–254090) on

Vashisht Road. Himachal Tourism (Ph: 01901–253531) runs regular bus tours to destinations around Manali.

Tourist Offices
The Himachal Pradesh Tourist Information Counter is located at The Mall, Ph: 01901–253531, Fax: 01901–52325).

What to bring
Days are pleasant in summer, but nights can get cold. It is advisable to bring light woollens. Winters are chilly with heavy snowfall during the peak winter months. If you are planning to go for hikes or take a shot at one of the adventure sports, keep extra pairs of shoes ready.

Shopping
The Mall is the main shopping area, selling local shawls, rugs, caps and footwear, besides a range of Tibetan handicraft items. The Himachal Handicrafts Emporium and Bhuttico weavers' co-operative are good for local handicrafts. The Tibetan Bazaar and Tibetan Carpet Centre, run by the refugee community, sells Thangkas, rugs, jewellery and prayer wheels, among other things.

Banks and money changers
Banking in Himachal Pradesh is not easy. Banking hours usually are 10 am–2 pm Monday–Friday and 10 am–12 noon on Saturdays. In Manali you will be able to change your money but it may be a tedious process to change substantial amounts at a time. Banks here accept travellers' cheques or currency only in either dollars or pounds sterling. Changing money anywhere but at accredited bureaus is illegal. Save up all exchange receipts (encashment certificates); these are required for visa extensions and other formalities and when you want to convert from rupees at the end of your trip.

Business guide
The fruit bowl of India, Himachal Pradesh is the place of canned fruits, bottled fruit juice and other products like jams, jellies and pickles. Timber trade and forestry are other lucrative business ventures. People are very cordial and observe an almost village community level protocol while transacting business.

Tipping
It is customary to tip 10% of the bill at restaurants, but you may tip less if service charges have been included in the bill. At hotels tip 10 bucks to the bellhop, the same to the doorman 'Durban'; if the service is particularly good, substantially more to the concierge and housekeeping.

Cab drivers do not expect to be tipped but the opposite is true if you have a hired a cab for a long period. You'll find some of the most friendly and colourful service at tiny nondescript roadside stalls called 'dhabas'. A small tip, even if it is only loose change, will be appreciated tremendously. Coolies (porters) at railway platforms have to be paid; negotiate the payment before you hire one.

Wildlife
The woodlands of Kullu preserve a variety of wildlife. The district has five wildlife sanctuaries of which Manali, Kais, Kanawar, Khokhan are in Kullu Valley and the Great Himalayan National Park is in Sainj valley. These sanctuaries preserve Musk Deer, Common Fox, Leopard, Ibex, Himalayan Tahr, Porcupine, Bear (black and brown), Goral (Nemorhaedus goral), Himalayan Yellow Throated Marten, Langur and Flying Squirrel, and also pheasants like Cheer Pheasant, Monal and Western Tragopan. The Great Himalayan National Park is situated in the Sainj valley of Kullu district. It harbours more than 300 species of birds and over 30 species of mammals, providing habitat for some of the highly endangered species like western tragopan, snow leopard and musk deer.

Manali sanctuary is located 1 km away from the international hill resort Manali. The main species of animals found in the sanctuary are leopard, musk deer, black bear, brown bear, Himalayn ibex. The birds found in the sanctuary are monal, koklas, chakor, tree creepers, snow pigeon, kingfisher etc. Snakes and lizards are also found.

These sanctuaries are rich in trees like oak (quercus incana), fir (abies pindrow), kail, spruce (pices smithiana), deodar (cedrus deodara), bras (rhododendron arborium), maple (acer pictum), walnut (juglans regia), fig (ficus spp), poplar (populus ciliata), pine (pinus roxburghii), aesculus (aesculus indica) etc.

The best time to visit these sanctuaries is April–June and September–October. During this period the weather and visibility is suitable for spotting animals and the high reaches are easily accessible.

VENUE
The conference venue is Siachen Auditorium inside the SASE campus.

Getting to Manali
Most foreign delegates will be flying into Mumbai or New Delhi.

1. From Mumbai it is possible to fly to Chandigarh, flight time 2:15 hours. It is then possible to drive from Chandigarh to Manali, a journey that may take 8 hours.
2. From New Delhi it is possible to travel (a) by road to Manali, a journey that may take 16 hours or (b) by train to Chandigarh (3:15 hours) and then by road to Manali (8 hours).

3. It is also possible either to fly to Chandigarh (0:35 hours) from New Delhi and travel by road to Manali (8hours), or to fly to Bhunter (Kullu) (1:15hours) from New Delhi and onwards by road to Manali (2 hours). The Delhi–Bhunter (Kullu) flight, although regular, depends on the weather conditions.

ACCOMMODATION INFORMATION

A number of luxury and budget hotels are available around the conference venue. Please see the conference web page for detailed information and web-links of hotels in the Manali region. Participants may directly approach the hotels of their choice for necessary accommodation booking. We recommend Ambassador Resorts, Holiday Inn, Hotel Piccadilly and Sterling Holiday Resorts for a comfortable stay. However, for any assistance from organizers please write to us at info@issa2009.in

COMPUTER AND INTERNET ACCESS

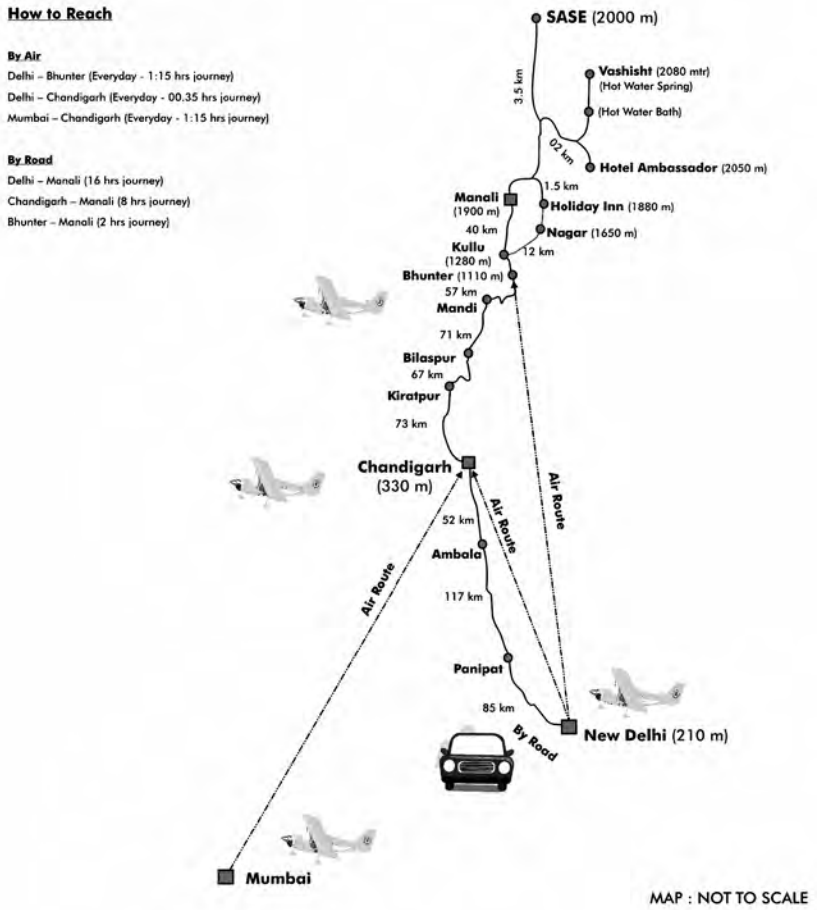
Internet access will be available in the SASE campus. Two terminals for viewing the presentation will also be available in a separate room.

REGISTRATION

Registration will be through the IGS main office. See form below.

IMPORTANT DATES

Abstracts due	15 January 2009
Notification of acceptance	1 February 2009
Pre-registration deadline	25 February 2009
Papers due	15 March 2009
Deadline for full refund	29 February 2009
Deadline for refund	20 March 2009
Registration	5 April 2009
Conference starts	6 April 2009
Final revised papers	8 June 2009



INTERNATIONAL GLACIOLOGICAL SOCIETY
SYMPOSIUM ON SNOW AND AVALANCHES
Manali, India, 6–10 April 2009
REGISTRATION FORM

Family Name: _____

First Name: _____

Address: _____

_____

Tel: _____ Fax: _____ E-mail: _____

Accompanied by: Name: _____ Age (if under 18) ____

Name: _____ Age (if under 18) ____

REGISTRATION FEES	**£**	**€**	**US$**
Participant (IGS member)	275	350	510
Participant (not IGS member)	325	410	600
Student or retired IGS member	140	177	260
Accompanying person	145/110	185/140	270/205
Late registration surcharge (after 25 February 2009)	50	65	95
TOTAL REGISTRATION FEES	____	____	____

ACCOMMODATION
Accommodation bookings should be done by individual attendees through the local links as indicated above.

Payment of registration fee may be made by cheque to: INTERNATIONAL GLACIOLOGICAL SOCIETY
or preferably 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 by a direct bank transfer to: Bank of Scotland, 38 St Andrew Square, Edinburgh, EH2 2YR, UK.

£ Sterling Account name: International Glaciological Society. Sort Code 80-11-00 Account no: 06065959
IBAN number: GB90 BOFS 8011 0006 0659 59 SWIFT/BIC code: BOFSGB21012

€ Euro Account name: International Glaciological Society. Sort Code 12-20-10 Account no: 40571001
IBAN number: GB90 GB85 BOFS 1220 1040 5710 01 SWIFT/BIC code: BOFSGB21EUL

$ US Account name: International Glaciological Society. Sort Code 80-20-13 Account no: 40571USD01
IBAN number: GB98 BOFS 8020 1340 5711 01 SWIFT/BIC code: BOFSGB2SXXX

Please note that we need the full amount.
ANY BANK OR TRANSFER CHARGES MUST BE BORNE BY THE PAYEE AND INCLUDED IN THE BANK TRANSFER.
It is usually possible to indicate this on the bank transfer form by ticking a box. Please inquire at your bank.
If payment made after 25 February 2009, 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

Annals of Glaciology editorial policy

The *Annals of Glaciology* is a peer-reviewed, thematic journal published 2 to 4 times a year by the International Glaciological Society (IGS). Publication frequency is determined and volume/issue numbers assigned by the IGS Council on a year-to-year basis and with a lead time of 3–4 years.

Themes can be on any aspect of the study of snow and ice. Individual members can make a suggestion for a theme for an *Annals* issue to the Secretary General, who will forward it to the IGS Publications Committee (which includes, as an *ex officio* member, the IGS Chief Editor; see new IGS Chief Editor job description). The IGS Publication Committee will make a recommendation for an individual themed *Annals* issue, together with a potential *Annals* Chief Editor for that issue, to IGS Council. The IGS Council will make the decision whether to proceed, taking into account the spread of topics and the overall capacity for publication of pages in *Annals*.

Once the decision to proceed has been made, an *Annals* Chief Editor for the *Annals* issue will be appointed. The IGS Secretary General will then issue a call for papers and outline a schedule of deadlines for receipt of submissions by the *Annals* Chief Editor and final accepted papers by the IGS Production Manager.

The *Annals* Chief Editor will set up a team of 'topical' experts to act as Scientific Editors for the *Annals* issue. The Scientific Editors, in turn, will be responsible for soliciting reviewers for all papers assigned to them by the *Annals* Chief Editor. The *Annals* Chief Editor will, on the basis of recommendations from the Scientific Editors, make the decision whether to accept or reject papers, and will forward accepted papers to the IGS Production Manager.

The *Annals* Chief Editor will report to the IGS Chief Editor on a monthly basis throughout the editorial process and, upon its completion, will submit a final report within 2 weeks of the last paper in the issue being accepted.

The IGS Chief Editor shall then 'sign off' the issue and forward the final report to the chairperson of the Publications Committee and the IGS Production Manager.

ANNALS *NUMBERING SYSTEM*

With the new *Annals* editorial policy, the volume and issue numbering system for *Annals of Glaciology* has changed. Presently the *Annals* are given a single volume number, e.g. *Annals* Volume 40, etc. A new system is being introduced that is similar to the *Journal* numbering system.

The volume numbering will start with number 50. That is the volume number originally assigned to the Mass Balance *Annals*. That will avoid any conflict with older *Annals* volumes. The issue number will be the 'old' volume number. For example, *Annals* 51 from the Radioglaciology issue will be
Annals 50(51), i.e. volume 50 and issue 51, published in 2009 and an 'arbitrary' issue number, that 'happens' to be in sequence with the old *Annals* system. Hence we will have

Mass Balance Measurements and Modelling, *Annals* 50(50)

Radioglaciology, *Annals* 50(51)

Dynamics of Glaciology, *Annals* 50(52)

Glacier Inventory, *Annals* 50(53)

Snow and Snow Avalanches, *Annals* 51(54)

and so on.

This way we keep the old numbering system and bring in a new system similar to the *Annals*, reinforcing the concept that the *Annals* is a 'journal'.

Swansea University give the Royal Society Summer Science Exhibition a GLIMPSE of Greenland's future – http://www.greenlandice.org/

At the time of writing it's now been two months since the end of the Royal Society's Summer Science exhibition – just about enough time for us all to recover from what turned out to be a very intense week! The Summer Science Exhibition is an annual four day event this year held between 30 June and 3 July in London at the Royal Society – the National Academy for Science.

Twenty-three exhibits were booked to take part in the exhibition from a wide range of groups including CERN, individual university groups and inter-institutional projects such as the Mars Lander project – their robot was directly opposite our stand and certainly drew a lot of attention. When we applied to exhibit this year we had no idea of the scale of the event, and with 90 applications from around the UK to compete with we were certainly delighted when the Royal Society invited the *GLIMPSE* project to attend.

The *GLIMPSE* (Greenland Ice Margin Prediction, Stability and Evolution) project run by Swansea University's Glaciology Group under the lead of Professor Tavi Murray began in autumn 2007, and is funded for a five year period by a Leverhulme Trust Research Leadership Award. By October 2008, the *GLIMPSE* team will consist of

Figure 1. Scenes from *GLIMPS*E at the 2008 Summer Science Exhibition. Top left: Swansea PhD student Benedict Reinardy demonstrates recent glacial thinning in Svalbard with photogrammetry. Top right: the Mars Rover – an example of some of the other exhibits. Bottom left: PhD student Damien Mansell demonstrates data from the Optech laser scanner. Bottom right: Dr Kilian Scharrer, NERC funded PhD student Damien Mansell, Leverhulme funded PhD student Nick Selmes, and GLIMPSE project manager Tim James pose with the team mascot.

four post-doctoral and four postgraduate researchers working as a multi-disciplinary group in Swansea in order to understand the natural variability of the rapidly changing outlet glaciers in Greenland (are current changes a long-term trend or merely expected short-term variability?). The key outcome is expected to be better predictions of the future extent and behaviour of the Greenland ice sheet and therefore of future sea level rise.

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Once the initial preparations for the exhibition were under way it was clear that we had a large task on our hands, and so Prof. Tavi Murray and *GLIMPSE* project manager Dr Tim James swung into action to raise the support we'd need to capture the public's imagination on the day. Financial support was going to be crucial if our exhibit was to stand out at an event of this size, and we were fortunate to receive help from a wide range of sponsors, including a generous donation from the International Glaciology Society.

Our stand was laid out to both inform the public of the latest research into the Greenland Ice Sheet, and to raise awareness of the multidisciplinary aspects of glaciology in a hands- on fashion. One of my favourite tools for this were the 3D models of London landmarks that were produced before the exhibition using a terrestrial laser scanner borrowed from Optech Inc. This allowed us to show visitors what sort of technology can be used by glaciologists to measure calving front behaviour –- with reference to familiar landmarks. Our radar demonstration was popular too, where visitors could see how ice ice-sounding radar can be used to map the bed of a glacier or find englacial channels using a high high-frequency radar (much higher than we'd use in the field), lent to us by the University of Leeds, and bottles of water and tin foil to create different reflectors.

Backing up all of the high tech gadgetry was a host of displays with information relating to Greenland glaciology. Whilst While the key information was available in written form, we found that most visitors much preferred to talk to an exhibitor about the topics that interested them most. Fortunately, most of the Swansea University glaciologists were more than happy to come to London for the week, and we had a small army of lecturers, post-doctoral researchers, and postgraduate and undergraduate students answering questions over the four days. This proved an exhausting experience in the heat of the exhibition so we operated a shift system so any visitors were greeted by enthusiastic faces rather than tired and sweaty ones!

The most interesting part of the exhibit for me personally was the range of people who came to

Figure 2. A Twin Otter flies over the periphery of the Greenland Ice Sheet as part of the *GLIMPSE* 2008 field campaign. The ice sounding radar antennae visible on the wings is using a much lower frequency than our exibit's radar demonstration.

visit our stand throughout the week. Some had a very personal interest in our exhibit –- such as Derek Fordham, the chairman of one of our sponsors, the Gino Watkins Memorial Fund, and a veteran of a Greenland Ice Sheet crossing in the 1960s. Others – including the thousands of school children visiting – arrived knowing nothing about Greenland or glaciers, and hopefully left knowing a lot more (possibly more than they'd have liked!). Reaction from all was very positive, and now the GLIMPSE exhibit is due to exhibitedtouring around Wales, . the The first event will be at the Pembrokeshire Technium.

In conclusion, if you have a topic which you think the public might enjoy learning about, and you've got a spare week next summer and a lot of enthusiastic friends – get you application in for next year's Summer Science Exhibition. I can promise a lot of hard work and strange questions, but a lot of fun and satisfaction as well. Fancy it?

Nick Selmes
GLIMPSE Project Team, Glaciology Group,
Swansea University

The Glacier Trust

The Glacier Trust was set up in July 2008 by IGS member Robin Garton, who graduated from the Southampton Geography Department in 2007 aged 61. Garton, who had spent 40 years as an art dealer, became interested in glaciology as a result of mountaineering. His interests widened into glacier hazards and concerns about the effects of climate change on communities living at altitude.

Figure 1. The author on Chopiqualqui (>6000m), Peru in June 2008.

Rapid climate change in the Himalayas is already the stark reality for the mountain communities. Over 2000 m, temperatures are rising at two to three times the rate at sea level. One report (in press) will suggest that mean annual temperature in Nepal rose 1.7°C in the 30 years up to 2005. At the recent IGS symposium in Limerick, Lonnie Thompson suggested that this was the result of increases in atmospheric moisture and loss of albedo.

Glacier lake outburst floods are not the only problems faced by proglacial communities and subsistence hill farmers. The increasing variability of the snowline means that melt water sources are no longer reliable. Pre- and post-monsoon drizzle is increasingly being replaced by droughts, which are followed by more intense monsoons. In the drought periods, the soil loses cohesion and becomes prone to mass wasting and erosion from monsoon inundation.

The problem that The Glacier Trust seeks to address is that physically-based scientific organisations seem to have little capacity to share their information with the communities most at risk. Much effort goes into scientific reporting on climate change hazards. But the information seldom gets to where it is most needed. Garton commented, 'We are living in a post Palcacocha culture.' This refers to 2003, when NASA incorrectly predicted a catastrophic outburst flood from the Peruvian glacier lake Palcacocha in Northern Peru. This has severe economic consequences for the nearby town of Huaraz. Garton found that it seems to have closed a door between hazard assessment science and communities at risk.

With the help of Craig Hutton in the Southampton GeoData Institute, Garton began to identify the issues where a relatively small organisation could provide real benefit. Nepal's topography, topology and demography are complex. Perhaps for these reasons, it has not published a *National Adaptation Programme of Action* in response to climate change issues. Thus the work of helping communities to learn to cope with climate change falls increasingly to the voluntary sector (NGOs) whose work has the potential to affect millions of lives.

The Glacier Trust now exists as a funding organisation, whose purpose is to enable communities living at altitude to adapt to climate change. It seeks both to strengthen the relationship between science and the community through education and training and to develop the means by which experience and skills can be shared and translated between communities. It is intended to achieve this by strengthening the capacity within communities (called capacity building) to implement adaptation strategies that will enable them to cope with their rapidly changing circumstances.

Projects supported by The Glacier Trust must be demand led, *i.e.* they must answer the real needs of the community in consultation with that community rather than being project driven by a set of external objectives. After consultation with NGOs, the following development sectors have initially been identified for support:

– Agricultural diversity and ecology
– Forestry management and consideration of other forms of renewable energy
– Hazard awareness and mitigation
– Sustainable (eco) tourism
– Water resource management

The interdisciplinary and interconnected aspects of these sectors are important in developing deliverable programmes.

The Glacier Trust supports NGOs that already have strong local and regional networks and are well placed to listen to the needs of the communities. These NGOs are also able to work both with regional and local development committees to help them form adaptation strategies. However, among published reports on climate change and development in the Himalayas, there are calls for improvements in the quality of implementation of projects developed by NGOs and other stakeholders. Quality of implementation is not simply a matter of money. It depends on the capacity of the communities to respond. Therefore in this context capacity building will have two vital functions: (1) to develop the education and training by which the relationship between science and the community is strengthened and implemented; (2) to develop the means by which experience and skills can be translated and shared between communities.

Although in its infancy, the Trust has some ambitious objectives for the future.

1. To use its website to publish fully referenced and periodically updated reviews of scientific literature issued both by NGOs and by academic journals. Thus a much needed overview of information relating to specific areas of climate change and development can be made available free of cost.
2. While the Trust does not see itself as a vehicle for funding or publishing research, it will consider contributing to such costs as a donor of last resort where, for example, crucial or fundamental data in respect of climate change needs to be presented for wider use.
3. The Trust recognises that strengthening academic qualification plays a major role in capacity building. It will therefore want to embed post graduate Nepali (or other Himalayan) student research projects in the projects that it undertakes. Students will be selected by demonstrating strong motivation and commitment to the community. If this proves successful, it is intended to twin these students in a programme with UK university students.
4. In time, the remit of the Trust may also extend to the part funding of a Himalayan student's PhD programme in the UK (probably with Southampton University), where the student's record indicates that the value of an international PhD (within the remit of climate change) would be of additional benefit to their native region.

Having identified the needs, the problem now is to raise the money. 'It is relatively easy to raise money to dig a well or to build a school', Garton commented. 'I've raised money for such projects in the past. But it is much more difficult when a community asks for something like a water resource management programme in order to retain soil moisture and prevent slope failure. Big donors are very itchy about assessment. But how do you assess a disaster that didn't happen, especially when two thirds of the budget is spent on training rather than on hardware?'

If you would like to support, please visit www.theglaciertrust.org

Robin Garton

Future meetings of other organizations

ESF-FWF-LFUI Conference

Mechanisms of Quaternary Climate Change: Stability of Warm Phases in the Past and in the Future
6–11 June 2009, Obergurgl, Austria

Chair: Carlo Barbante, University of Venice, Italy

Scope: The conference will address the difference between past interglacials, their climatic stability and their interaction with polar ice sheets and with the biosphere. It will cover several complementary disciplines in the field of climate change and will also aim to involve scientists of other disciplines closely related to climate changes, such as socio-economics and politics.

Grants: available for young researchers

Programme and applications: accessible online at www.esf.org/conferences/09285

Deadline for applications: 2 March 2009

Further information: visit www.esf.org/conferences/09285 or contact Ms. Jean Kelly, Conference Officer (jkelly@esf.org)

Glaciological diary

** IGS sponsored * IGS co-sponsored

2008

1–2 September
William Smith Meeting of the Geological Society 2008
Observations and Causes of Sea-Level Change on Millennial to Decadal Timescales
Burlington House, London
See http://www.geolsoc.org.uk/gsl/events/listings/page3053.html

2–3 September
Observations and causes of sea-level changes over millennial to decadal timescales
The Geological Society, London, UK
See www.geolsoc.org.uk/gsl/events/listings/page3053.html

3–11 September
The XIV Glaciological Symposium on Glaciology from International Geophysical Year to International Polar Year
Irkutsk, Russia
Contact: Yuliya Rayskaya: gs2008@onlinereg.ru
See http://www.onlinereg.ru/site.php?go=61&lang=ENG

8–9 September
***IGS British Branch annual meeting**
School of the Environment & Society, Swansea University, UK
Contact: Timothy D. James; igsbb2008@swansea.ac.uk
See http://www.swansea.ac.uk/geography/Research/igsbb2008/

8–11 September
10th International Symposium on High Mountain Remote Sensing Cartography, (HMRSC-X)
ICIMOD, Kathmandu, Nepal
See http://menris.icimod.net/HMRSC-X/

9–20 September
Karthaus 2008 summer course on 'Glaciers and Ice Sheets in the Climate System'
Karthaus, northern Italy
See http://www.phys.uu.nl/~wwwimau/education/summer_school/

12 September
Sea Ice Group workshop
University of Bangor, Bangor, Wales
See http://www.pol.ac.uk/home/news/seaice/

18–20 September
International Forum for Research into Ice Shelf Processes (FRISP)
A joint meeting with the West Antarctic Ice Sheet (WAIS) Initiative
Losehill Hall, Hope Valley, Derbyshire
Contact: FRISP – Adrian Jenkins; a.jenkins@bas.ac.uk; WAIS – Bob Bindschadler; robert.a.bindschadler@nasa.gov

20–24 September 2008
****International Workshop on World Glacier Inventory**
Cold & Arid Regions Environmental & Engineering Research Institute
Lanzhou, China
Contact: Professor Shiyin Liu; liusy@lzb.ac.cn

23–25 September
Workshop on GAMIT/GLOBK/Track Boulder, Colorado, USA
See http://www.unavco.org/edu_outreach/uscs/2008/gps.html

21–27 September
International Snow Science Workshop, ISSW
Whistler, Canada
See http://www.issw2008.com/

17–18 October
Nortwest Glaciology Meeting
University of Washington, Seattle, Washington. USA
See http://www.ess.washington.edu/Surface/Glaciology/nwg_08.html

4–6 November
First International Symposium on the Arctic Research (ISAR-1): Drastic Change under the Global Warming
Tokyo, Japan
See http://www.jamstec.go.jp/iorgc/sympo/isar1/index.html

6–8 November
***IGS Nordic Branch annual meeting**
Finnish Institute of Marine Research, Helsinki, Finland
Contact: Olli-Pekka Mattila; olli-pekka.mattila@helsinki.fi
See http://www.geo.physics.helsinki.fi/NIGS-08/

10–13 November
Quaternary Climate: from Pole to Pole EPICA Open Science Conference
Venice, Italy
See http://www.epica2008.eu/

19–22 November,
IMPETUS 2008: Techniques in Polar and Ocean Observation and Monitoring
St. Petersburg, Russia
See http://www.otto-schmidt-laboratory.de/?Events:IMPETUS_2008 or contact Carolyn Wegner; e-mail: impetus2008@ifm-geomar.de

24–28 November
Fourth EGU Alexander von Humboldt International Conference
The Andes: Challenge for Geosciences
Santiago de Chile
Contact: Peter Fabian (EGU); peter.fabian@wzw.tum.de
René Garreaud (Universidad de Chile); rgarreau@dgf.uchile.cl

27–30 November
Workshop on Progress in Polar Research : 'Nature of response of Arctic glaciers to climate warming'
Warszawa, Poland
Contact: Jacek A. Jania; jjania@us.edu.pl

1–12 December
The United Nations Climate Change Conference
Poznan, Poland
See http://unfccc.int/meetings/cop_14/items/4481.php

15–19 December
AGU Fall meeting
San Francisco, California, USA
See http://www.agu.org/meetings/fm08/

2009

16–19 February
IASC – network on arctic glaciology
Biogeoscience Institute, University of Calgary Barrier Lake Station, Kananaskis Country, Alberta, Canada
See http://bgs.ucalgary.ca/

26–27 February
The 13th Alpine Glaciology Meeting
Innsbruck, Austria
See http://imgi.uibk.ac.at/IceClim/IceClim/CRYO/cryo_a.html
Contact: Irmgard Juen (Irmgard.Juen@uibk.ac.at), Andrea Fischer (andrea.fischer@uibk.ac.at), Georg Kaser (Georg.Kaser@uibk.ac.at)

22–27 March
Association of American Geographers, AAG, 2009 Annual Meeting
Las Vegas, USA
Includes: Glacier session, Changing Geographies of Arctic and more that may be of interest to glaciologists.
See: http://aag.org/annualmeetings/2009/index.htm

25–26 March
Workshop on subglacial processes and related topics
Svartisen subglacial laboratory, Engabreen glacier, Norway
Contact: Miriam Jackson; mja@nve.no
See http://www.nve.no/modules/module_109/publisher_view_product.asp?ientityID=23491

6–10 April 2009
****International Symposium on Snow and Avalanches**
Manali, India
Contact: Secretary General, International Glaciological Society
See http://www.igsoc.org/symposia/2009/manali/index.html

29 April–1 May
Atmosphere and Modelling Skills Workshop
British Antarctic Survey, Cambridge, UK
Organized by The UK Polar Network
See http://www.polarnetwork.org/new/

6–11 June
Mechanisms of Quaternary Climate Change: Stability of Warm Phases in the Past and in the Future
A ESF-FWF-LFUI Conference
Obergurgl, Austria
Contact Ms Jean Kelly, Conference Officer: jkelly@esf.org
See http://www.esf.org/index.php?id=5310

7–12 July
7th International Conference on Geomorphology (ANZIAG)
Melbourne, Australia
See http://www.geomorphology2009.com/
Contact: geomorphology2009@tourhosts.com.au

19–29 July 2009
Cryospheric sessions 20–24 July)
'Our Warming Planet' IAMAS, IAPSO, IACS joint assembly
Montréal, Canada
See http://www.moca-09.org/index.asp
Contact: montreal2009@nrc-cnrc.gc.ca

27–31 July
****International Symposium on Glaciology in the International Polar Year**
Newcastle, UK
Contact: John Woodward; john.woodward@unn.ac.uk
Secretary General, International Glaciological Society

8–19 September
Karthaus 2009 summer course on 'Ice sheets and glaciers in the climate system'
Karthaus, Italy
See http://www.phys.uu.nl/~wwwimau/education/summer_school/

27 September–2 October
International Snow Science Workshop, ISSW
Davos, Switzerland
See http://www.issw.ch

2010

31 May–4 June
****International Symposium on Sea Ice**
Symposium theme: The role of sea ice in the physical and biogeochemical system
Tromsø, Norway
Contact: Secretary General, International Glaciological Society

21–25 June
****International Symposium on Snow, Ice and Humanity in a Changing Climate**
Sapporo, Japan
Contact: Secretary General, International Glaciological Society

13–17 September
****International Symposium on Disappearing Ice**
A celebration of the 50th Anniversary of Byrd Polar Research Center
Byrd Center, Ohio State University, USA
Contact: Secretary General, International Glaciological Society

2011

5–10 June
****International Symposium on Interactions of Ice Sheets and Glaciers with the Ocean**
Scripps Institution of Oceanography, La Jolla, USA
Contact: Secretary General, International Glaciological Society

New members

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