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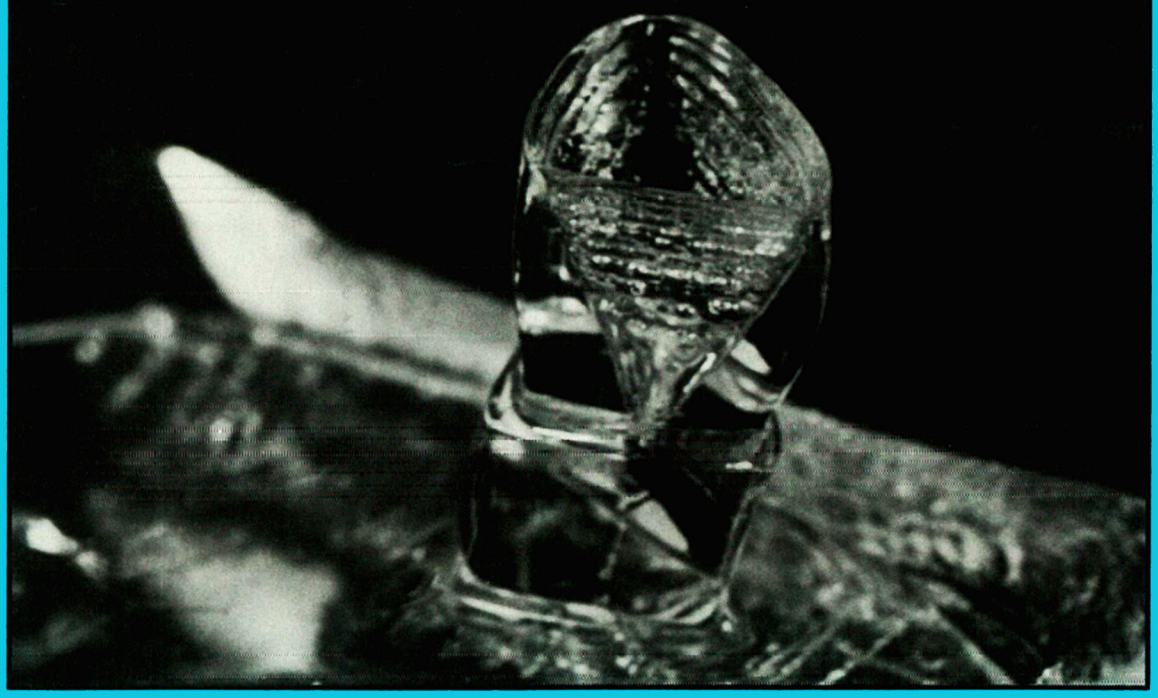

NEWS BULLETIN OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY

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ICE

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CONTENTS

COVER PICTURE: Hopper crystal grown from melt, University of Wyoming, 1998. Distilled and degassed water was being frozen in containers for the manufacture of larger blocks of polycrystalline ice to be used in deformation experiments conducted by N.F. Humphreys and J. Harper. During freezing, confined water broke through the thin skim of ice frozen on the surface and, by a fortuitous combination of freezing rate at the surface and expulsion of water from the interior of the container, formed columns approximately 2 cm across and 3 cm tall. The columns developed over approximately 24 hours. (Photograph by W.T. Pfeffer, January 1998).

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

EXCLUSION CLAUSE. *While care is taken to provide accurate accounts and information in this Newsletter, neither the editor not the International Glaciological Society undertakes any liability for omissions or errors.*

RECENT WORK

FINLAND

(For abbreviations used see page 8)

SEA ICE

Baltic Sea ice climatology

(J. Haapala, M. Granskog, A. Herlevi, M. Leppäranta, T. Saloranta, Zhang Zhanhai, GPHYS/UH)

Development work on the advanced coupled ice–ocean model for the Baltic Sea has continued in collaboration with scientists from the Institute of Marine Research, (University of Kiel) and the Swedish Meteorological and Hydrological Institute.

The work is a part of the "Baltic Sea System Study" (BASYS), supported by the European Commission MAST-III program. A comparison was made of the ice kinematics in the model and that derived from ERS-1 SAR data. The simulations gave representative values for the Hibler viscous–plastic rheology under Baltic conitions. The study suggested a reformulation of the rheology as well as the addition of a thin-ice category in the ice-thickness distribution. The theoretical framework of a new ice-thickness-distribution model has been formulated where the pack ice is decomposed to open water, two different types of undeformed ice, rafted ice and rubble ice. The benefit of such a classification is a better description of the minimum ice strength and thus more realistic ice velocities when thin ice is present. Also, the different thermodynamic growth/melting rates of the ice types can be introduced into the model, hence giving more detailed seasonal evolution of the pack ice. In addition, the five-level ice-thickness-distribution model gives more information about the surface properties (albedo, roughness) of pack ice. The main features under investigation are ice melting and wintertime convection. This modeling contributes to the BALTEX part of GEWEX.

Observations of sea-ice sediments in the Baltic have started with the purpose of basic mapping and later inclusion of sediment transport in the ice model.

A field experiment, Zooming of Ice Physics 1997 (ZIP-97), was performed in the Bay of Bothnia, Baltic Sea from 5–21 March 1997. It focused on the morphology and dynamics of sea ice over a large spatial range: basin-wide (100 km), intermediate (10 km) and local (10 m). The work is a part of the project "Local Ice Cover Deformation and Mesoscale Ice Dynamics", or Ice State, supported by the European Commission Marine Science and Technology program (MAST-III). Participants include: the Ship Laboratory (HUT); Nansen Environmental and Remote Sensing Center, Norway; Scott Polar Research Institute, Cambridge, U.K.; Department of Geophysics (UH); and the Engineering Research Institute, University of Iceland. Scientists from the Arctic Centre (UL), the Department of Geophysics (UO) and the Geological Survey of Finland also contributed to the ZIP–97 experiment.

Radar sounding of sea ice

(A. Sinisalo,UO; A. Blanco,UH; J. Moore, AC/UL)

The use of ground-penetrating radar on sea ice in the Arctic Ocean was investigated as part of Finnish participation in ARCTIC96. Similar work was carried out in the Gulf of Bothnia under the EU/MAST III Ice State program and some helicopter profiles were flown over both fast ice and drift-ice floes. Samples of ice were also drilled to determine dielectric conductivities.

Local ice-cover deformation and mesoscale ice dynamics

(K. Riska, J. Tuhkuri, M. Lensu, SL/HUT)

The objectives of this joint European project are to describe and model the processes involved in local ice-cover deformation and to incorporate these into the governing equations of mesoscale ice dynamics. Ridge-formation mechanics and ice-floe field deformation are studied experimentally in an ice-model basin and computationally by using the discrete-element model. The research also includes field experiments. The project is funded by the European Commission through the MAST-III programme. The participants in the project are Helsinki University of Technology, Nansen Environmental and Remote Sensing Center, Scott Polar Research Institute, University of Helsinki, and University of Iceland.

Compression of circular ice floes: experiments and simulations

(M. Hopkins, J. Tuhkuri, E. Hansen, M. Lensu, SL/HUT)

The three-dimensional deformation of ice fields made up of thin floes is central to the processes of ice-jam formation in northern rivers, pressure-ridge formation in northern seas, and the dynamics of ice fields in Antarctic marginal seas. Model experiments have been performed in which a floating layer of circular ice floes, confined in a rectangular domain, were uniaxially compressed. The forces exerted by the ice against the moving boundary were measured. Geometrically and dimensionally identical computer simulations have been performed and the calculated forces have been compared with the forces measured in the experiments.

Electromagnetic and laser profiling of sea-ice cover

(M. Lensu, SL/HUT)

A fixed-wing aircraft, with an electromagnetic ice-thickness sounder and laser surface profiler was used to map ice cover in different sea areas and the data were then analysed for thickness and ice-ridge distributions. Analysis packages for the data have been developed and the results used to construct theoretical models for thickness and ridging statistics. This work is done in cooperation with the UH, the Geological Survey of Finland and Kvaerner Masa Yards.

Morphological evolution of sea-ice

(M. Lensu, SL/HUT)

A unified theory for the evolution of sea-ice morphology is being developed. Evolution is described in terms of differential equations for distributions pertaining to the morphological variables (ice thickness, floe size, ridges, leads). These equations can then be coupled with dynamical equations to models capable of predicting morphological evolution.

ICE ENGINEERING

Ship in compressive ice

(K. Riska, M. Patey, SL/HUT)

Compressive ice considerably increases the ice loads and the ice resistance of a ship. This problem has been studied experimentally in a model basin and theoretically. A uniform level ice cover and a broken ice field have been used in the experiments. The research has clarified the additional ship resistance due to ice pressure and thus the susceptibility of ships to get stuck in ice, as well as the physical processes present when ice is pressing at ship sides, when a ship is stopped in compressive ice. This study has included cooperation with the Russian Academy of Sciences and with Kvaerner Masa Yards.

Harmonization of Polar class ship rules

(K. Riska, SL/HUT)

Seven different sets of structural rules have been issued for Polar vessels. In 1993, an initiative began to unify these rules and an international working group was set up by the International Association of Classification Societies (IACS). After five years, some proposals for the different parts of the unified structural rules have been made. The objective is to develop a Code for Polar Shipping for the International Maritime Organization (IMO). A set of unified structural regulations will also be issued by IACS. In this project, HUT/SL has developed the longitudinal strength requirements for the structural regulations.

Design ice forces in multi-year ice

(K. Riska, SL/HUT)

The maximum bow ice force in a head-on collision with a large ice feature has been analyzed. In the Canadian ice regulations, this force is part of the definition of all other ice-loading quantities, such as hull load-area factors and local pressures. The head-on collision has been treated both analytically and numerically. The analytical model employs Laplace transform methods and makes some linearizations of the problem. The analytical solution is valid for infinite and non-infinite ice, and takes the hull-girder response into account. The analytical solution is corroborated by a numerical model which solves essentially the same equations in a time-step manner. The solution will provide the time-history of vessel motions, ice forces, bending moments and shear forces in the hull girder. As such, the solution can be applied to direct design of ice-going ships. This is a joint project with C. Daley, Memorial University of Newfoundland.

Ship trafficability in ice

(K. Riska, M. Patey, SL/HUT)

The passage of a vessel across an ice-covered route has been simulated in order to determine a ship's suitability for transiting a route of various ice conditions. Transit times and energy consumption on different routes or under different ice conditions are studied. The ice conditions included in the simulation are those of open water, channel ice, level ice, and pack ice. Ship's speed and energy-expenditure calculations are based on ice-resistance formulae, developed mainly for first-year ice. This work is part of the International Northern Sea Route Programme (INSROP).

Powering requirements for merchant vessels in Baltic ice

(K. Riska, M. Wilhelmsson, SL/HUT)

The requirements placed on merchant-vessel propulsive power in different ice conditions have been studied. The project concentrates on ship resistance in navigation channels and in formulating the power requirements for different ice classes. The accuracy of earlier calculation methods for estimating resistance is not satisfactory. Therefore, both full-scale and model-scale tests have been conducted and a more accurate method for calculating the resistance of a ship in a navigation channel is under development. A methodology for studying the resistance of ships in brash-ice channels in a model ice basin has also been developed.

Ice environment and ship-hull loading along the NSR

(M. Lensu, K. Riska, P. Kujala, SL/HUT)

The objective is to combine ice conditions to ship transit and ship hull-damage calculations. Ice conditions are described in terms of the distribution of relevant features: ice thickness, floe size, leads and ridging. The assumed or observed composition of the ice cover, together with ship parameters, are used as input in a ship-transit simulation model for distributions of transit times, speeds and power consumption. Ice-cover parameters are also used in a statistical model for ship hull-damage probability.

probability. These two tools are used for trafficability analyses along the Northern Sea Route and elsewhere. The first phase of the program was a part of the International Northern Sea Route Programme (INSROP).

Interaction between conical offshore structures and level ice cover

(K. Riska, S. Wang, SL/HUT)
The failure and breaking pattern of level ice against a conical offshore structure has been simulated. In the model it is assumed that a vertical force breaks the ice cover into successive circular segments. Formation of the segments changes the geometry of the contact area between the structure and the ice cover. The ice pile-up and ride-up phenomena have been of special interest.

GLACIER STUDIES

Hydrothermal structure of polythermal glaciers, Svalbard

(J. Moore, A. Pälli, AC/UL; P. Maijala, UO)
Ground-penetrating radar has been used to investigate the transition between cold and temperate ice on several glaciers in northern and southern Svalbard in co-operation with the NPI, EU Ny Ålesund LSF, the University of Silesia and the Polish Academy of Sciences.

Chemical analysis of Lomonosov-fonna ice core

(T. Jauhiainen, J. Moore, AC/UL; J. Derome, FFRI)
The core is being analyzed for major ions, MSA and some organic species, in cooperation with NPI, University of Utrecht (Netherlands), the Universities of Stockholm and Uppsala (Sweden), LGGE and the Estonian Academy of Science.

EDUCATION

Glaciology training courses

(J. Moore AC/UL; M. Leppäranta, GPHYS/UH)
Training courses for students are provided through the European Commission TMR programme in cooperation with the University of Stockholm and University of Helsinki. One course on snow was held in Lammi, Finland and a glacier course was held at Tarfala, Sweden. More will follow.

ATMOSPHERIC ICE

Wind turbine, power line and transmission tower icing

(L. Makkonen, M. Marjaniemi, H. Holttinen, VTT; E. Peltola, Kemijoki Co.)
Studies on atmospheric icing of structures have continued. A numerical model of wind-turbine blade icing has been used to design heating systems for wind generators operating in icing conditions. The first Arctic wind park, that utilizes this system, is now in commercial use in northern Finland. Modeling icing severity based on weather data has been developed and a new comprehensive model to simulate icing on power-line cables due to freezing precipitation. Comparisons between ice loads measured on a lattice TV tower and those simulated using weather data have been made.

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JAPAN

MOUNTAIN GLACIERS

HIMALAYA

Surveys of Yala Glacier in Langtang Valley, 1994 and 1996

(K. Fujita, K. Seko, IHAS; N. Takeuchi, FBBTIT)
Glaciological surveys were carried out in 1994 and 1996 to clarify the variation of Yala Glacier in Langtang Valley, Nepal Himalaya. It was found that the glacier terminus retreated drastically in the 1990s rather than the 1980s. The surface profile of the glacier also showed rapid lowering in recent two years (1994–96). Surface flow velocities of the glacier have decreased since 1982. These results mean that the shrinkage tendency of the glacier has been accelerated in the 1990s. Areal averages of mass balance, accumulation and ablation for a central drainage area during the monsoon season in 1996 were obtained as –357, 588 and –945 mm w.e., respectively. It was confirmed that an empirical relation between air temperature and ablation, which was derived from the observation at another glacier in east Nepal in a previous study, could not be applied directly to Yala Glacier.

Flow of Lirung Glacier, Langtang Valley

(N. Naito, M. Nakawo, K. Fujita, A. Sakai, K. Seko, IHAS; T. Aoki, DGUT; K. Asahi, GSEES; T. Kadota, MTSI; T. Shiraiwa, ILTS)
Surface flow velocities on the ablation area of Lirung Glacier were calculated from the results of six surveys from 1989 to 1996. The annual flow speed was about 6 m a^{-1} on the upper reach of the ablation area near the icefall and the summer speed was about 1.5 times faster

than that. About 2 km downstream from the upper reach, the annual speed decreased to about 2 m a^{-1} and the summer speed was a little faster. Ice thickness was estimated, using the laminar-flow theory, to be about 100 m or more in the upper reach and about 50 m in the lower reach of the ablation area. A rate of surface lowering was also preliminarily estimated, using the continuity equation, to be a little less than 20 cm a^{-1} on average in the ablation area.

Melt rate of ice cliffs, Lirung Glacier

(A. Sakai, M. Nakawo, K. Fujita, IHAS)

There are many ice cliffs exposed at the surface of debris-covered glaciers. Melt rates of ice cliffs on Lirung Glacier, in relation to their direction, were observed from May to October 1996. Heat budget at ice cliffs was examined with the meteorological data. Incoming shortwave radiation R_s to a slope was estimated, taking into account the intervening cloud, from observed R_s to a horizontal surface. The calculated incoming R_s was largest at surfaces with a southeastly direction and lowest to the northwest during the monsoon season. This is because the weather is fine in the morning and the sun shines on easterly slopes, and it is cloudy and rainy in the afternoon and westerly slopes receive relatively little solar radiation. Observed melt rate of ice cliffs coincided approximately with that calculated from heat balance considerations. It was on average 7.2 cm d^{-1} for cliffs with various orientations during the monsoon season. The ice-cliff melt amount reaches 69% of the total ablation in debris-covered areas, although the area of ice cliffs occupies less than 2% of the debris-covered area.

Snow-algae community on a Himalayan glacier, Shorong region

(N. Takeuchi, S. Kohshima, FBBTIT; K. Fujita, IHAS)

An altitudinal change of the snow-algae communities on a Himalayan glacier (AX010) at 4950–5380 m a.s.l. in Shorong region, East Nepal, was analyzed quantitatively to clarify the relationship between the glacier algal community and summer mass balance. The results were compared with those of another Himalayan clean-type glacier (Yala). On AX010 Glacier, 5 species of snow algae including 4 species reported from Yala Glacier were observed. On both glaciers, the algal biomass was at a similar level at the same altitude and decreased as the altitude increased at a similar rate. The structure of the algal community represented by the proportion of each species to the total algal biomass differed by altitude and summer mass balance estimated by stake measurement. The algal community on this glacier could be divided into the following two types: Type 1 community with 5 species highly dominated by *C. breissonii* observed in the negative mass-balance area from the terminus to 5180 m a.s.l.; and Type 2 community with 4 species dominated by the Oscillatoriacean alga observed in the positive mass-balance area above 5200 m a.s.l. In community structure, Type 1 and Type 2 communities corresponded to those observed in the lower part (5100–5200 m) and the middle part (5200–5300 m) of Yala Glacier, respectively. Relationships between the snow-algae community and summer mass balance were discussed. The results suggest that the snow-algae community could be useful as an indicator of summer mass balance and equilibrium line for this type of glacier.

KAMCHATKA

Firn-core drilling at summit ice cap of Ushkovsky volcano

(T. Shiraiwa, S. Yamaguchi, K. Matsuoka, S. Horikawa, ILTS; Y. Muravyev, A. Ovsyannikov, IVRAS; A. Salamatin, KSU)

A shallow firn-core drilling and surface snow sampling were carried out at the summit ice cap of the Ushkovsky volcano (3900 m a.s.l.), central Kamchatka, in July–August 1996 and May–June 1997. A 27 m long core obtained in 1996 contained approximately 27 years record of net balance. Annual-accumulation rates are calculated by reference to dated ash layers and amount to between 0.38 and 0.88 m a^{-1} during six fixed periods, with an average of 0.57 m a^{-1} water equivalent. The temperature of the firn is –16.5°C at 10 m depth. Melt-feature percentages in the firn core display a clear positive relationship with summer air temperature at 700 hPa over Kamchatka. Snow samples collected in 1997 were transported to Hokkaido University where the analyses are being carried out. Radio-echo sounding with an impulse radar was also made at the summit ice cap. The maximum thickness obtained was at about 240 m at the center of Gorshkov Crater.

Koryto Glacier, Kronotsky Peninsula

(T. Shiraiwa, S. Yamaguchi, Y. Kodama, T. Matsumoto, ILTS; Y. Muravyev, IVRAS; G. Glazirin, CARHI)

Glaciological and meteorological studies were made at Koryto Glacier in Kronotsky Peninsula, eastern Kamchatka, in the summers of 1996 and 1997. The glacier (temperate type) lies between 320 m and 1180 m a.s.l. Shallow snow coring at several altitudes in July 1996 indicates that the balance increases linearly with altitude in the accumulation area. More than 6 m of mass balance from summer 1995 to summer 1996 was found at the highest part of the glacier. The ablation rate depends less on altitude in the accumulation area, although there was a significant difference in ablation rates between bare ice near the terminus and clean snow above the transient snowline. Simple estimates of mass balance during the balance year 1995–96 suggest that the extremely high positive specific net balance in the year can be ascribed to heavy snowfall in the winter of 1995–96.

Flow of Koryto Glacier

(S. Yamaguchi, T. Shiraiwa, K. Nishimura, T. Matsumoto, R. Naruse, ILTS; S. Kohshima, FBBTIT; Y. Muravyev, IVRAS; G. Glazirin, CARHI)

Ice-flow velocities were measured at Koryto Glacier in July 1996 and September 1997. In the latter measure-

ment, the maximum velocity along a flow line was obtained as 0.16 m d^{-1} around 700 m a.s.l. near the equilibrium line (EL) in normal years, and the minimum was 0.06 m d^{-1} around 1000 m a.s.l. The velocity at the EL decreased by about 30 m a^{-1} from 1960–97. Hourly and daily variations in surface flow velocities measured near the glacier terminus showed that the glacier was sliding at the base and there was a good correlation between variations in flow velocity and water discharge from the glacier.

Hydrological research, Koryto Glacier, 1997

(T. Matsumoto, K. Nishimura, T. Shiraiwa, S. Yamaguchi, Y. Kodama, ILTS; Y. Muravyev, IVRAS)
Hydrological observations were carried out at Koryto Glacier in September 1997. In stream A, a minor one of two runoff streams from the glacier terminus, water levels were measured automatically for 7 days. The discharge of stream A varied from 0.1–1.3 $m^3 s^{-1}$, and the discharge of steam B was estimated as about 5 times larger. Stream water and suspended sediment were sampled intensively (30 minute or 1 hour intervals) over 34 hours for chemical runoff analysis and estimation of subglacial condition. An automatic weather station was installed on the ridge close to the glacier in summer 1996, and recorded air temperature, relative humidity, global radiation, air pressure, wind speed, wind direction and precipitation (only in the snow-free season) until September 1997. Maximum and minimum daily air temperatures in this period were +17.4°C and –22.6°C, respectively.

PATAGONIA

Firn-core drilling, Hielo Patagónico Norte (HPN)

(K. Matsuoka, R. Naruse, ILTS; Y. Kitamori, K. Ogawa, UGSHU)
A 14.5 m deep firn-core drilling was performed in December 1996 in the accumulation area of Glaciar Nef, an eastward outlet glacier from the HPN (Northern Patagonia Ice Field). In addition, measurements of air temperature and melting rate were made in order to interpret features of the core. The HPN is located on the Pacific coast of the Andes in the middle-latitude westerly zone, so that heavy winds with much precipitation throughout the year made it difficult to work there. From 9 November to 11 December, 1996, we (Matsuoka, Kitamori and Ogawa) carried out a field campaign at the HPN. However, bad weather forced us to reduce the plan, so, without any aerial support, we could only work 11 days out of 28 on/near the icefield. We approached HPN from the east along Río Soler, where the treeline lies around 420 m a.s.l. Up to Camp 1 (510 m a.s.l.), horses were used for transportation. Beyond Camp 1 to 640 m a.s.l., large rocks on steep slopes, sandy plains, and bushes on flat slopes appear alternatively. After these, a steep slope with rocks appears and the valley reaches the left bank of Glaciar Nef. Around 1160 m a.s.l., the source of Río Soler, Camp 2 was set up on seasonal snow. At 1500 m a.s.l., Camp 3 was set up for drilling. The site (46°56 S, 73°19 W) is in the lower part of the accumulation area of Glaciar Nef. From 1–3 December, we drilled to 14.5 m. Except for a thin surface layer, the core was composed of granular snow with abundant ice layers. The mean density of the core was 670 kg m^3. In the lowest 1.2 m, water-soaked firn was found during the drilling. The borehole temperature showed that the part shallower than 6–7 m deep was melting and the part deeper than that was freezing (at –0.1°C). A distribution of oxygen-isotope ratios ($\delta^{18}O$) of 1–2 cm thick samples exhibits two contrasting regimes: a wide fluctuation from –10 to –14‰ in the upper 6 m and an almost constant value around –11‰ in the depths lower than 6 m. This contrast is considered to be due to a difference in the amount of percolation of meltwater, namely the snow in the layer shallower than 6 m was deposited in the latest winter and that in the deeper layer was deposited in previous years. Mass-balance features on the HPN are now being analyzed.

Glacier variations, Hielo Patagónico Norte, since 1944–45

(M. Aniya, IGUT; Y. Wakao, CNSUT)
In general, accelerated recessions observed until the end of the 1980s have been checked and the retreating rates have slowed down in the 1990s at many outlet glaciers of Hielo Patagónico Norte. This may have been caused by the precipitation increase during the early 1970s recorded at the nearest meteorological station (although located 200 km west to the icefield).

Recent glacier variations in Patagonia and contribution to sea-level change

(M. Aniya, IGUT)
Variations of more than 70 outlet glaciers of the Hielos Patagónicos since 1944–45 were summarized. We have considered possible causes for variations and estimated contribution to sea-level changes due to ice-volume loss over the last 50 years. If we take the ice loss to be 825 ± 320 km^3 with a density of 850 kg m^{-3}, the water equivalent is 700 ± 270 km^3. Then, we obtain 1.93 mm ± 0.75 mm in 51 years, or 0.038 ± 0.015 mm a^{-1} as the contribution to sea-level rise.

Dynamic characteristics of Glaciar Upsala

(R. Naruse, ILTS; P. Skvarca, IAA)
Glaciar Upsala, which calves into a lake (Brazo Upsala) on the eastern side of Hielo Patagónico Sur, has retreated more than 4 km during the last 20 years since 1978. Ice near the glacier front also thinned significantly, by about 33 m from 1990–93. Water depths of Brazo Upsala near the glacier fronts in 1978–97 were measured in 1994 and 1997 by H. Svetaz from Calafate. The maximum depth is more than 900 m and a large bump, about 250 m high,

existed on the bed near the glacier fronts in the 1980s. Assuming the height of the glacier surface above the lake level, we can estimate ice thickness near the fronts of former glaciers in 1978–97. Based on a preliminary analysis of the continuity condition, it is suggested that backstress from the bump and islands in the frontal part of the glacier played an important role in the dynamics of the glacier.

SNOW AND AVALANCHES

Fluctuation of $\delta^{18}O$ of surface snow with surface hoar formation

(A. Hachikubo, E. Akitaya, ILTS; H. Motoyama, NIPR; K. Suzuki, FSSU)

$\delta^{18}O$ and major ions of the surface snow layer were measured during hoarfrost formation in Hokkaido, Japan. In the nighttime, $\delta^{18}O$ decreased when surface hoar and depth-hoar crystals formed above and beneath the snow surface, respectively, while $\delta^{18}O$ increased due to evaporation in the daytime. These results suggested that $H_2{}^{16}O$ was enriched by condensation of the hoar crystals, whereas $H_2{}^{18}O$ was concentrated on the snow surface by the evaporation of light H_2O to the atmosphere. Concentrations of major ions were observed to change as well, according to condensation and evaporation of water vapor. $\delta^{18}O$ of hoar crystals condensed on 5–6 March 1996 was estimated to be approximately 5‰ lower than that of the original surface layer.

Velocity distribution in snow avalanches

(K. Nishimura, ILTS)

In order to investigate the detailed structure of snow avalanches, we have made snow-flow experiments at the Miyanomori ski jump in Sapporo and systematic observations in the Shiai-dani, Kurobe Canyon. In the winter of 1995–96, a new device to measure static pressures was used to estimate velocities in the snow cloud that develops above the flowing layer of avalanches. Measurements during a large avalanche in the Shiai-dani, which damaged and destroyed some instruments, indicate velocities increased rapidly to more than 50 m s^{-1} soon after the front. Velocities decreased gradually in the following 10 seconds. Velocities of the lower flowing layer were also calculated by differencing measurement of impact pressure. Recordings in the snow cloud and in the flowing layer changed with a similar trend and suggest a close interaction between the two layers. In addition, the velocity showed a periodic change. Power-spectrum analysis of the impact pressure and the static pressure depression showed a strong peak at a frequency between 4 and 6 Hz, which might imply the existence of either ordered structure or a series of surges in the flow.

Seismic signals induced by snow avalanche flow

(K. Nishimura, ILTS; K. Izumi, RIHSA)

Some observations and their analyses have dealt with the link between seismic signals and avalanche flow. The measurements during the passage of avalanches showed a specific spindle pattern which was quite different from that of natural earthquakes. The general trend strongly depended on the topographic features of the avalanche path, and as a result we could estimate avalanche velocity. The running power spectrum showed a meaningful shift of the dominant peak from the front to the rear part of the flow.

Experiments and numerical simulation of ping-pong ball avalanches

(K. Nishimura, J. McElwaine, S. Keller, Y. Ito, ILTS; Y. Nohguchi, NISIS; K. Izumi, RIHSA)

Snow-avalanche experiments at a ski jump have been carried out since 1995. Natural snow, maximum 300 kg in weight, was released in winter, whereas we used up to 500,000 ping-pong balls in summer to simulate three-dimensional granular flows along the inclined plane. Since the effect of the air drag acting on a ping-pong ball is fairly large, the flow arrived at a steady-state within a short distance. The terminal velocities attained showed a remarkable growth as the number of ping-pong balls increased. Similarity analysis shows that the experiment at the ski jump corresponds to a natural powder-snow avalanche that runs for several kilometers. Video cameras positioned above the flow allowed measurements of the location and the distance of a single ball, which finally lead to its velocity. Particle-velocity profiles in the flow, as well as other properties, are obtained. The static pressure-depression measurements in and above the flow led the air-velocity profiles and suggested the strong interaction between the balls and the surrounding air. Computer simulation of three-dimensional, inhomogeneous two-phase flows that uses the DEM (Discrete Element Method) for the particles and the Reynolds-averaged Navier–Stokes equations for the fluid are currently also in progress. The unique nature of the ping-pong ball experiment provides a wonderful opportunity for testing a theory and simulation of strongly coupled two-phase flows.

Submitted by Renji Naruse
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ABBREVIATIONS USED IN REPORTS

AC	Arctic Centre, UL
CARHI	Central Asian Research Hydrometeorological Inst., Tashkent, Uzbekistan
CNSUT	College of Natural Science, Univ. of Tsukuba, Ibaraki, Japan
DGUT	Dept. of Geography, Univ. of Tokyo, Tokyo, Japan
FBBTIT	Faculty of Bioscience and Biotechnology, Tokyo Inst. of Technology, O-okayama, Tokyo, Japan.
FFRI	Finnish Forest Research Inst., Rovaniemi
FSSU	Faculty of Science, Shinshu Univ., Matsumoto, Japan
GPHYS	Dept. of Geophysics
GSEES	Graduate School of Environmental Earth Science, Hokkaido Univ., Sapporo, Japan
HUT	Helsinki Univ. of Technology
IAA	Instituto Antártico Argentino, Cerrito 1248, Buenos Aires, Argentina
IGUT	Inst. of Geoscience, Univ. of Tsukuba, Ibaraki, Japan
IHAS	Inst. for Hydrospheric–Atmospheric Sciences, Nagoya Univ., Nagoya, Japan
ILTS	Inst. of Low Temperature Science, Hokkaido Univ., Sapporo, Japan
IVRAS	Inst. of Volcanology, Russian Academy of Sciences, Petropavlovsk–Kamchatsky, Russia
KSU	Kazan State Univ., Russia
LGGE	Laboratory of Environmental Glaciology and Geochemistry, Grenoble, France
MTSI	MTS Inst. Inc., Sudachokosaten Bldg., 1-5 Kanda Sudacho, Chiyoda-ku,Tokyo, Japan
NIPR	National Inst. of Polar Research, Itabashi, Tokyo, Japan
NISIS	Nagaoka Inst. of Snow and Ice Studies, Nagaoka, Japan
NPI	Norwegian Polar Inst.
RIHSA	Research Inst. for Hazards in Snowy Areas, Niigata Univ., Niigata, Japan
SL	Ship Laboratory, HUT
UGSHU	Undergraduate student, Hokkaido Univ., Sapporo, Japan
UH	Univ. of Helsinki, Finland
UL	Univ. of Lapland, Rovaniemi, Finland
UO	Univ. of Oulu, Finland

INTERNATIONAL GLACIOLOGICAL SOCIETY

IGS STAFF CHANGES IN CAMBRIDGE

Last year saw the departure of our production manager, David Rootes, as well as Brenda Varney, one of those who sets your manuscripts in our desk-top publishing system. In August, David J. Garbett will start work in our Cambridge office as a full-time editorial assistant. David comes to us from the University of Wales, where he has been taking an M.Phil. in glaciology at the centre in Aberystwyth. He is familiar with the Cambridge scene having worked with the Sea Ice Group at the Scott Polar Research Institute, with the Ice and Climate Division of the British Antarctic Survey and with the Cambridge Arctic Shelf Programme. He will be assisting the Secretary General in the handling of your manuscripts and the Society's publications.

IGS WEB PAGE

We would like to thank Dr Christina Hulbe very much indeed for maintaining a Web page for the International Glaciological Society. Following recommendations from her Ad Hoc Committee on the Internet, and her recent graduation, the Web page will move to Cambridge. The Scott Polar Research Institute has generously offered to host this. At the moment the new site is being revised and updated. Following some more testing, the site address will be distributed through the IGS Bulletin Board and published in the next issue of *ICE*.

IGS BULLETIN BOARD

Newer IGS members may not be aware that the Byrd Polar Research Center of The Ohio State University generously hosts an electronic bulletin board for the IGS. Instructions for subscribing or sending messages to subscribers are as follows:

To send a message to the list send mail to:
igs@geology.ohio-state.edu

To subscribe to this list send mail to:
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IGS BRITISH BRANCH ANNUAL MEETING, 10–11 SEPTEMBER 1998

School of Geographical Sciences, University of Bristol

This year's annual meeting of the British Branch of the IGS will be held in Bristol on Thursday 10th and Friday 11th September. Presentations are invited on all aspects of ice and snow research, in the form of talks or posters. Please submit your abstract by email to j.l.wadham@bristol.ac.uk by the end of July.

For further details and registration forms, see the School of Geography Webpages at:

http://www.ggy.bris.ac.uk/

or contact:

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IGS MEMBERSHIP LIST

Please note the following changes, errors and/or omissions for the *List of Members* distributed earlier this year. No further corrections will be issued but members can obtain help from the IGS office if they are unable to contact another member.

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DONORS

The International Glaciological Society wishes to thank all its Contributing members, from 1995 to 1997, who have helped further its objectives by generously paying a higher membership rate. The names of all those who have not requested anonymity are acknowledged below:

Sidar Anandrakrishnan
Carl S. Benson
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Jack Kohler
Douglas R. MacAyeal
Joe S. Walder
Johannes Weertman
H. Jay Zwally

IGS BRITISH BRANCH ANNUAL MEETING

Department of Earth Sciences, Keele University, September 10–11, 1997

The successful IGS Branch meeting held at Keele University included the following papers:

NEIL ARNOLD
Modelling the seasonal evolution of a subglacial conduit system

ANDREW P BARRETT AND DAVID N COLLINS
The relationship between borehole water level and water pressure in the subglacial drainage system beneath an Alpine glacier

DOUGLAS BENN
Reconstructing subglacial strain patterns from particle fabric and morphology

BEN BROCK AND MARTIN KIRKBRIDE
The influence of supraglacial tephra deposition on the ablation of Icelandic glaciers

DAVID N COLLINS
Rainfall-induced high-magnitude discharge events in warm summers in glacierised Alpine basins

FLEUR CUER
The basal ice layer of Skeiðararjökull

J A DOWDESWELL, A-M NUTTALL, B UNWIN AND D G WINGHAM
SAR interferometry of Svalbard glaciers and ice caps

STEPHEN ELLIS
Supraglacial dirt cones of the Öræfi region, south east Iceland

SAMANTHA J EVE
The geomorphic impact of the November 1996 jökullhlaup, Skeiðararsandur, Iceland: determined from aerial photographs

I J FAIRCHILD, J A KILLAWEE, B SPIRO, R LORRAIN, L JANSSENS AND J-L TISON
Freezing of carbonate-rich solutions: calcareous precipitates and carbon dioxide-rich gas bubbles in ice

MICHAEL J GARDINER, J CYNAN ELLIS EVANS, MALCOLM G ANDERSON AND MARTYN TRANTER
Snowmelt modelling on Signy Island, Antarctica

NEIL GLASSER
Subglacial meltwater erosion at Loch Treig, Scotland

MICHAEL HAMBREY
Structural glaciology and debris-entrainment in a surge-type glacier: Kongsvegen, Svalbard

EDWARD HANNA
Improved estimates of Antarctic sea ice extent and concentration derived from a new passive microwave algorithm

R J HARDY AND J L BAMBER
A reassessment of the balance of drainage basins on the Greenland ice sheet

RICHARD HODGKINS
A laboratory experiment into nutrient release from glacial sediments:implications for oceanic CO_2 release

DANIEL HOWELL
The last Eurasian ice sheet: matching geological evidence and computer modelling studies

BRYN HUBBARD
Ice coring at Glacier de Tsanfleuron, Switzerland: preliminary results

ANDREW KERR
Tectonic constraints on East Antarctic ice sheet evolution

PETER G KNIGHT AND DEBORAH A KNIGHT
Experimental observations of subglacial debris entrainment into the vein network of polycrystalline ice

BERND KULESSA AND BRYN HUBBARD
Subglacial measurement of electrical self-potential and implications for basal drainage at Haut Glacier d'Arolla, Valais, Switzerland

M A MORALES MAQUEDA, A J WILLMOTT, J L BAMBER AND M S DARBY
Study of the small ice cap instability with a coupled atmosphere–sea-ice–ocean–land-ice model

PHILIP M MARREN
The magnitude and frequency regimes of Scottish Late Devensian proglacial fluvial systems

ANNE MARIE NUTTALL AND JULIAN DOWDESWELL
Determining drainage basin areas and balance velocities of East Greenland tidewater glaciers using Landsat imagery

A PAYNE
A thermomechanical model of the West Antarctic ice sheet

MATTHEW J ROBERTS
Supraglacial stream dynamics on the glaciers of Öræfajökull, southeast Iceland

ANDREW J RUSSELL, OSKAR KNUDSEN, JUDITH K MAIZELS AND PHILIP M MARREN
Controls on the geomorphic impact of the November 1996 jökullhlaup, Skeiðararsandur, Iceland

MARTIN SHARP, MARK SKIDMORE AND PETER NIENOW
Chemistry of a High Arctic supraglacial snow cover

MARTIN SIEGERT
Correlating the Vostok ice core to the Dome C drilling site using radio-echo layering

D A SWIFT
Origin and significance of a Late Devensian meltwater channel system in northern Cumbria

JUSTIN TAYLOR
Large-scale sedimentation, ice sheet dynamics and tectonics on continental margins

KATE TEASDALE
Glaciofluvial sediments associated with the 1991 surge of Skeiðararjökull, Iceland

MARTYN TRANTER
Evidence for a microbial role in subglacial chemical weathering

RICHARD WALLER
The role of tectonism in the formation, appearance and dynamic behaviour of debris-rich basal ice

JOURNAL OF GLACIOLOGY

The following papers have been accepted for publication in the *Journal of Glaciology*

W ABDALATI AND K STEFFEN
Accumulation and hoar effects on microwave emission on the Greenland ice sheet dry snow zones

L ARNAUD, M GAY, J.-M BARNOLA AND P DUVAL
Imaging of firn and bubbly ice in coaxial reflected light: a new technique for the characterization of these porous media

E M ARONS, S C COLBECK AND J M N T GRAY
Depth hoar growth rates near a rocky outcrop

H BLATTER, G K C CLARKE AND J COLINGE
Stress and velocity fields in glaciers: Part II. Sliding and basal stress distribution

M S CAO
Detection of abrupt changes in glacier mass balance in the Tian Shan mountains

J G COGLEY AND W P ADAMS
Mass balance of glaciers other than the ice sheets

J COLINGE AND H BLATTER
Stress and velocity fields in glaciers: Part I. Finite-difference schemes for higher-order glacier models

K M CUFFEY AND E J STEIG
Isotopic diffusion in polar firn: implications for interpretation of seasonal climate parameters in ice-core records, with emphasis on central Greenland

P M CUTLER
Modelling the evolution of subglacial tunnels due to varying water input

H ENGELHARDT AND B KAMB
Basal sliding of Ice Stream B, West Antarctica

D R FATLAND AND C S LINGLE
Analysis of the 1993–95 Bering Glacier surge using differential SAR interferometry

M P FISCHER AND R D POWELL
A simple model for the influence of push-morainal banks on the calving and stability of glacial tidewater termini

U H FISCHER, N R IVERSON, B HANSON, R LEB HOOKE AND P JANSSON
Estimation of hydraulic properties of subglacial till from ploughmeter measurements

A C FOWLER AND E SCHIAVI
A theory of ice-sheet surges

R M FROLICH AND C S M DOAKE
Synthetic aperture radar interferometry over Rutford Ice Stream and Carlson Inlet, Antarctica

K FUJITA, M NAKAWO, Y FUJII AND P PAUDYAL
Change in glaciers in Hidden Valley, Mukut Himal, Nepal Himalayas, from 1974 to 1994

R E GAGNON AND P H GAMMON
In situ thermal profiles and laboratory impact experiments on iceberg ice

N F GLASSER, M J HAMBREY, K R CRAWFORD, M R BENNETT AND D HUDDART
The structural glaciology of Kongsvegen, Svalbard, and its role in landform genesis

W GREUELL AND R BÖHM
2 m temperatures along melting mid-latitude glaciers, and implications for the sensitivity of the mass balance to variations in temperature

B HANSON, R LEB HOOKE AND E M GRACE, JR
Short-term velocity and water pressure variations downglacier from a riegel, Storglaciären, Sweden

W D HARRISON, K A ECHELMEYER AND C F LARSEN
Measurement of temperature in a margin of Ice Stream B: implications for margin migration and lateral drag

R C A HINDMARSH
Drumlinisation and drumlin-forming instabilities: viscous till mechanisms

R C A HINDMARSH
Ice stream surface texture, sticky spots, waves and breathers: the coupled flow of ice, till and water

R C A HINDMARSH
The stability of a viscous till sheet coupled with ice flow, considered at wavelengths less than the ice thickness

A HUBBARD, H BLATTER, P NIENOW, D MAIR AND B HUBBARD
Comparison of the first order approximation for glacier flow with field data: Haut Glacier d'Arolla, Switzerland

B HUBBARD, A BINLEY, L SLATER, R MIDDLETON AND B KULESSA
Inter-borehole electrical resistivity imaging of englacial drainage

D E LAWSON, J C STRASSER, E B EVENSON, R B ALLEY, G J LARSON AND S A ARCONE
Glaciohydraulic supercooling: a freeze-on mechanism to create stratified, debris-rich basal ice. 1. Field evidence

M LEPPÄRANTA, S YAN AND J HAAPALA
Comparisons of sea ice velocity fields from ERS-1 SAR and a dynamic model

G E LISTON AND M STURM
A snow-transport model for complex terrain

R MACAYEAL, E RIGNOT AND C L HULBE
Ice-shelf dynamics near the front of the Filchner–Ronne Ice Shelf, Antarctica, revealed by SAR interferometry: model/interferogram comparison

K MELVOLD AND J O HAGEN
Evolution of a surge-type glacier in its quiescent state: Kongsvegen, Spitsbergen, 1964–95

N A NERESON, C F RAYMOND, E D WADDINGTON AND R W JACOBEL
Recent migration of Siple Dome ice divide, West Antarctica

J OERLEMANS AND W H KNAP
A one-year record of global radiation and albedo from the ablation zone of the Morteratschgletscher, Switzerland

B T RABUS AND K A ECHELMEYER
The mass balance of McCall Glacier, Brooks Range, Alaska: its regional relevance and implications for the climate change in the Arctic

E RIGNOT
Hinge-line migration of Petermann Gletscher, North Greenland, detected using satellite radar interferometry

E RIGNOT AND D R MACAYEAL
Ice-shelf dynamics near the front of the Filchner–Ronne Ice Shelf, Antarctica, revealed by SAR interferometry

M TRUFFER AND A IKEN
The sliding velocity over a sinusoidal bed at high water pressure

J WALLINGA AND R S W VAN DE WAL
Sensitivity of Rhonegletscher, Switzerland, to climate change: experiments with a one-dimensional flow-line model

G S WILSON, D M HARWOOD, R A ASKIN AND R H LEVY
Late Neogene Sirius Group strata in Reedy Valley: a multiple resolution record of climate, ice sheet and sea level events

ANNALS OF GLACIOLOGY

The following papers from the International Symposium on Snow and Avalanches held in Chamonix Mont-Blanc, France, 26–30 May 1997, have been accepted for publication in *Annals of Glaciology* Vol. 26, edited by D.M. McClung:

V ADAM, V CHRITIN, M ROSSI AND E VAN LANCKER
Infrasonic monitoring of snow-avalanche activity: what do we know and where do we go from here?

L ARNAUD, V LIPENKOV, J M BARNOLA, M GAY AND P DUVAL
Modelling of the densification of polar firn: characterization of the snow–firn transition

R BINTANJA
The interaction between drifting snow and atmospheric turbulence

R BOLOGNESI
Inferential statistics to verify prediction models

A N BOZHINSKIY AND L A SUKHANOV
Physical modelling of avalanches using an aerosol cloud of powder materials

A CAGNATI, M VALT, G SORATROI, J GAVALDÀ AND C G SELLÉS
A field method for avalanche danger-level verification

P A CHERNOUSS AND YU V FEDORENKO
Probabilistic evaluation of snow-slab stability on mountain slopes

C COLÉOU AND B LESAFFRE
Irreducible water saturation in snow: experimental results in a cold laboratory

H CONWAY
The impact of surface perturbations on snow-slope stability

J D DENT, K J BURRELL, D S SCHMIDT, M Y LOUGE, E E ADAMS AND T G JAZBUTIS
Density, velocity and friction measurements in a dry-snow avalanche

Y DURAND, G GIRAUD AND L MÉRINDOL
Short-term numerical avalanche forecast used operationally at Météo-France over the Alps and Pyrenees

M E EGLIT
Mathematical and physical modelling of powder snow avalanches in Russia

Y ENDO, Y KOMINAMI AND S NIWANO
Dependence of new-snow density on slope angle

C FIERZ
Field observation and modelling of weak-layer evolution

M B FÖHN, C CAMPONOVO AND G KRÜSI
Mechanical and structural properties of weak snow layers measured in situ

D FONT, M MASES AND J M VILAPLANA
Experimental mass-flux measurements: a comparison of different gauges with estimated theoretical data

D FONT, F NAAIM-BOUVET AND M ROUSSEL
Drifting-snow acoustic detector: experimental tests in La Molina, Spanish Pyrenees

A D FROLOV AND I V FEDYUKIN
Elastic properties of snow–ice formations in their whole density range

G FURDADA AND J M VILAPLANA
Statistical prediction of maximum avalanche run-out distances from topographic data in the western Catalan Pyrenees (northeast Spain)

H GALLÉE
Simulation of blowing snow over the Antarctic ice sheet

M J GARDINER, J C ELLIS-EVANS, M G ANDERSON AND M TRANTER
Snowmelt modelling on Signy Island, South Orkney Islands

P GAUER
Blowing and drifting snow in Alpine terrain: numerical simulation and related field measurements

T G GLAZOVSKAYA
Global distribution of snow avalanches and changing activity in the Northern Hemisphere due to climate change

V N GOLUBEV AND A D FROLOV
Modelling the change in structure and mechanical properties in dry-snow densification to ice

J M N T GRAY AND Y C TAI
On the inclusion of a velocity-dependent basal drag in avalanche models

M GUDE AND D SCHERER
Snowmelt and slushflows: hydrological and hazard implications

INTERNATIONAL SYMPOSIUM ON THE VERIFICATION OF CRYOSPHERIC MODELS

Zürich, Switzerland, 16–20 August 1999

CO-SPONSORED BY
Swiss Federal Institute of Technology
University of Zürich

FIRST CIRCULAR

The International Glaciological Society will sponsor an international symposium on the Verification of Cryospheric Models in 1999. The symposium will be held at ETH, Zürich, Switzerland with registration on 15 August, and sessions from August 16–20, 1999.

SYMPOSIUM ORGANIZATION

Simon Ommanney (Secretary General, International Glaciological Society)

CHIEF SCIENTIFIC EDITOR

Koni Steffen

LOCAL ARRANGEMENTS COMMITTEE

Atsumu Ohmura (Chairman), Heinz Blatter, Martin Funk, Wilfried Haeberli

THEME

Significant achievements have been made in the modelling of cryospheric components in recent years. Many models, however, remain untested, so that their reliability is often uncertain. This symposium will bring modellers, theoreticians and field scientists together to identify the needs and possibilities for verifying various models of the cryosphere.

TOPICS

The suggested topics include:

- ice in the atmosphere
- ice sheets
- ice shelves
- mountain glaciers and ice caps
- englacial hydrology
- calving
- snow cover
- avalanches
- sea ice, lake ice and river ice
- ice streams
- surges
- frozen soil and permafrost
- ice in the laboratory

Sessions will be developed around these topics

SESSIONS

Oral presentations will be held over 4½ days. There will be ample opportunity for poster displays.

One session on mountain glaciers and ice caps will be dedicated to the late Fritz Müller of McGill University, Montréal and ETH, Zürich who made significant contributions to the glaciology of mountain glaciers and died on the Rhonegletscher on 26 July 1980.

PUBLICATION

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

ACCOMMODATION

Details will be given in the Second Circular. A full range of hotel accommodation will be available.

EXCURSIONS

A post-symposium tour through the Swiss Alps will be organized for registrants, depending on the number expressing an interest in participating. Details will be

given in the Second Circular. If you are interested in joining such a tour please mark the form at the end of this circular and return it.

FURTHER INFORMATION

If you wish to attend the symposium please return the attached form as soon as possible. The Second Circular will give information about accommodation, the general programme, and preparation of abstracts and final papers. Copies of the Second Circular will be sent to those who return the attached reply form. Members of the International Glaciological Society will automatically receive one.

PLEASE RETURN FORM IMMEDIATELY TO:

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INTERNATIONAL GLACIOLOGICAL SOCIETY
SYMPOSIUM ON THE VERIFICATION OF CRYOSPHERIC MODELS

Zürich, Switzerland
16–20 August 1999

Family Name: _____

First Name(s): _____

Office Address: _____

_____

Tel: _____ FAX: _____

E-mail: _____

I hope to participate ☐

I expect to submit an abstract ☐

My abstract will be on to the following topic(s):

_____

I hope to join the post-symposium tour ☐

I am interested in an accompanying persons programme ☐

NEWS

WORLD GLACIER MONITORING SERVICE (WGMS), 1997

Fluctuations of glaciers

Preparation of Vol. VII, the *Fluctuations of Glaciers, 1990–95*, is in its final stage. It will contain information on 633 glaciers from 27 countries (including Antarctica). Data on glacier variations for 1990–95 were received for 534 glaciers in 18 countries with addenda from earlier years for 59 glaciers in 8 countries. Mass-balance data were submitted for 66 glaciers in 16 countries with addenda from earlier years for 13 glaciers in 9 countries. Information on mass balance vs altitude was provided for 37 glaciers in 10 countries and data on changes in area, volume and thickness for 7 glaciers in 4 countries. Finally, index measurements and special events were reported from 36 glaciers in 8 countries. The following special maps will be included: Canada – Thompson Glacier; Colombia – Nevado del Tolima; northeast Greenland – Storstrømmen; Svalbard – Amundsenisen, Hansbreen; Norway – Ålfotbreen, Nigardsbreen, Mikkaglaciären; Austria – Glaciers near Alpinzentrum Rudolfshütte; Hohe Riffel, Stubacher Sonnblickkees, Stubacher Sonnblickkees (snowline retreat 1989–90); Italy – Ghiacciaio del Caresèr 1967– 90; Kenya – Mount Kenya's glaciers 1947 and 1993.

The observation period documented reflects continued glacier melting. The estimated global average glacier mass balance for 1960–90 is more negative, closely correlated with global air temperature anomalies, and constitutes a contribution to sea-level rise of some 0.25 mm a^{-1}. Glaciers in continental-type climatic regions appear to have decreased steadily whereas maritime-type glaciers in humid areas show important variability.

Glacier inventory

Work on glacier inventories is in progress, but at a slow rate. Activities for making glacier inventory information available via the Internet have continued, in close cooperation with the WDC at Boulder/Colorado. Plans are being developed to update inventory information from the ASTER/GLIMS project.

Glacier mass balances

Data collection for Glacier Mass Balance Bulletin No. 5, 1995–96 to 1996–97, started in February 1998. Long-term glacier mass-balance observation programmes still

face very serious problems: that on the best-investigated tropical glacier, Lewis Glacier on Mount Kenya, has been terminated and no solution for continuation has yet been found.

WGMS homepage: http://www.geo.unizh.ch/wgms

100 years of worldwide glacier monitoring
The UNESCO/IHPSRH report *Into the 2nd century of world glacier monitoring: prospects and strategies* was printed in January 1998 and is being distributed.

Wilfried Haeberli, Director (haeberli@geo.unizh.ch)

SNOW AVALANCHE MODELLING AND MAPPING (SAME)

SAME is a joint project between European laboratories belonging to 7 countries (Austria, France, Iceland, Italy, Norway, Spain and Switzerland). It is funded by the European Union and Switzerland.

The main topics are :

- avalanche modelling in relation to mapping, i.e. practical use of databases and modelling for mapping;
- contribution of avalanche experimental measurements to model improvement;
- avalanche detection.

These topics are divided into sub-topics, resulting in 2 elementary tasks associating the scientists belonging to the 14 partner laboratories. Comprehensive information about the SAME partnership and program is available at www.grenoble.cemagref.same.fr.

YUKIGATA

The shapes created by snow patches surrounded by bare ground, or by open ground surrounded by snow, are called *yukigata* in Japan. Some of the famous ones are described in literature. In Niigata Prefecture some 200 *yukigata* shapes of persons or animals have been observed. Until recently, *yukigatas* were used as a type of natural calendar indicating appropriate times to start plowing, sowing, to pick wild vegetables in the mountains or catch fish. Because their formation is governed by snow accumulation, topography and snowmelt, *yukigatas* contain information on snow distribution and climate change. Details are being compiled by Takatsugu Yamada (takatugu@pop.lowtem.hokudai.ac.jp) and have been posted on the *yukigata* home page:

http://tomato2.lowtem.hokudai.ac.jp/members/yamataka/yukigata.htm

GLOBAL LAND ICE MONITORING FROM SPACE (GLIMS)

GLIMS will use data from the ASTER (Advanced Spaceborne Thermal Emission and reflection Radiometer), aboard EOS-AM1, to monitor the world's glaciers as part of NASA's Earth Observing System (EOS) program. The following elements are now being put in place:
1) software tools to track glaciers' areal extent; end of the melt season snowline; velocity field; and terminus;
2) global network of centers monitoring glaciers in their regions;
3) database infrastructure capable of handling about 82 gigabytes of additional data per year.

Please see the web site for details:
http://wwwflag.wr.usgs.gov/GLIMS/glimshome.html
Hugh Kieffer (hkieffer@flagmail.wr.usgs.gov)

ARCICE – ARCTIC ICE AND ENVIRONMENTAL VARIABILITY

This three-year programme, funded with £3 million by the U.K. NERC, aims to enhance our understanding of, and capacity to predict, variations in the Arctic cryosphere relevant to climate and sea-level change in northwest Europe. Further information is available at:
http://www.cecs.ed.ac.uk/arcice
or from
Andrew Kerr (arcice@ed.ac.uk)

AWARDS

The following IGS members have been selected as 1998 AGU Fellows:

Anthony J. Gow for fundamental discoveries about the behaviour of natural ice and its role in the Earth system.

Paul A. Mayewski for pioneering contributions to the understanding of historic changes in atmospheric chemistry and climate change through the studies of ice cores.

Charles F. Raymond for the clarity, range, and authority of his contributions to the physics of glaciers and ice sheets.

Shawn Marshall has been awarded a silver medal for doctoral research by Canada's Natural Sciences and Engineering Research Council. He has linked Ice Age surges to ice-flow instabilities.

David McClung has been named NSERC–FRBC–CMH Chair in Snow and Avalanche Science at the University of British Columbia. The chair, funded by the Natural Sciences and Engineering Research Council, Forest Renewal BC and Canadian Mountain Holidays, will form the basis of a permanent

research group to solve avalanche problems faced by industries and provide training in avalanche science.

The Royal Geographical Society has recently announced the following awards.

Patron's Medal to **David Drewry** for contributions to polar science and public awareness of geography.

Busk Medal to **David Collins** for contributions to understanding field processes in mountain environments

Gill Memorial Award to **Julian Dowdeswell** for contributions to the study of glacier geophysics.

FUTURE MEETINGS (of other organizations)

INTERNATIONAL CONFERENCE ON THE DEFORMATION OF GLACIAL MATERIALS

The Geological Society, Burlington House, Piccadilly, England, 7–8 September 1999

The conference, co-sponsored by the International Glaciological Society, will be concerned with the actual or modelled deformation of glacial materials in the broadest sense; including ice, soft sediments and analogue materials. Sessions will be related to topics such as: fast ice flow; ice character and deformation; modelling ice and sediment rheology; glaciotectonic processes and structures; deforming bed glaciology and structural glaciology. Papers from the symposium will probably be published by the Geological Society.

Organising committee:

Alex Maltman (President of Tectonic Studies Group; Geological Society)

Michael Hambrey (Director, Centre for Glaciology, University of Wales)

Bryn Hubbard (UK National Correspondent, International Glaciological Society, Tel: [44](1970)622-783; Fax: [44](1970)622-780; byh@aber.ac.uk)

XXII General Assembly of the International Union of Geodesy and Geophysics

Birmingham, England, 19–30 July 1999

INTERACTIONS BETWEEN THE CRYOSPHERE, CLIMATE AND GREENHOUSE GASES

This IUGG symposium will examine the interactions between the cryosphere and climate by focusing on the exchange of energy and greenhouse gases between cryospheric environments and the atmosphere. The symposium first examines the feedback mechanisms between climate and the distribution and duration of snow and ice masses. Subsequently, it will address the processes that influence fluxes of greenhouse gases (e.g. CO_2, CH_4, N_2O) between the atmosphere and different cryospheric reservoirs. The general aim is to provide state-of-the-art information on the major processes involving seasonal/ permanent snow and terrestrial ice cover that impact on the global carbon cycle.

Papers are invited on the following and related topics:

A. Cryosphere–Climate Interactions

- Interannual variability of snow cover – connection between snow-cover anomalies and atmospheric circulation patterns.
- Cryospheric aspects of the hydrological cycle as represented in GCM and operational weather-prediction systems.
- Modelling the energy and mass balance of snow cover at various scales.
- Snow cover and climate interactions – coupled models and feedback studies
- Mass and energy exchanges on contemporary ice masses – measurement and modelling.
- Modelling interactions between palaeo-ice sheets and climate.
- Palaeoclimatic inferences from ice cores and air–snow transfer functions.

B. Cryosphere–Greenhouse Gas Interactions

- CO_2 and greenhouse gas fluxes from glaciers and ice masses – past and present.
- Processes involving terrestrial ice masses that perturb atmospheric greenhouse-gas concentrations.
- Methods for the quantification of greenhouse-gas release from soil under snow.
- Processes leading to greenhouse-gas production and release from soils under snow.
- Processes leading to greenhouse-gas production and release from permafrost.

Martyn Tranter, Department of Geography, University of Bristol, Bristol BS8 1SS, U.K. (Tel: [44](117)928-8307; Fax: [44](117)928-7878; tranter@bris.ac.uk; http://www.wlu.ca/~wwwiahs/index.html)

HYDROLOGY OF ICE-COVERED RIVERS

This IUGG workshop will focus on the effects of ice on physical, chemical and ecological processes on rivers and their riparian ecosystems. A special emphasis will be placed on the role of river ice and related catchment processes in producing hydrologic extremes, such as floods and low flows, and the role of climate variability in altering these extremes. Two other areas of specific interest are the role of ice in controlling sediment transport and morphological change, and new techniques for evaluating ice-affected flow, such as isotopic analysis.

The workshop will include a number of invited theme papers on the above subjects and open-forum discussions designed to quantify their international significance in various cold regions. A special publication based on the theme papers and rapporteurs' summaries of the discussions is planned.

Michael G. Ferrick, CRREL, 72 Lyme Road, Hanover, NH 03755-1290, U.S.A. (Tel: [1](603)646-4287; Fax: [1](603)646-4785: mferrick@crrel.usace.army.mil)

AGU CHAPMAN CONFERENCE ON THE WEST ANTARCTIC ICE SHEET

Orono, Maine, U.S.A., 13–18 September 1998

Background

The West Antarctic Ice Sheet (WAIS) has figured prominently in reports related to global climate change and its evolution. Glaciologists have identified it as the most likely source of a rapid increase in sea level due to a dramatic increase in ice discharge.

The WAIS initiative is a multidisciplinary American program begun in the early 1990s. Its primary goals are to predict future contributions to sea level from the West Antarctic ice sheet and contribute to interpretation of climate history from ice cores.

Somewhat earlier than WAIS, the European Antarctic research community formulated a multi-national and interdisciplinary effort called the Filchner-Ronne Ice Shelf Programme (FRISP) to investigate the dynamic interaction of the West Antarctic ice sheet and the surrounding ocean. This program has focused on the eastern portion of West Antarctica feeding the Filchner and Ronne Ice Shelves.

Despite a large overlap in scientific purpose, the two research communities have never held a joint meeting. This will be the first for these vibrant research groups.

Conference Objectives

The following is expected to be achieved:

- the oceanic and modeling strengths of FRISP will significantly bolster weaknesses in WAIS;
- the marine geophysical and ice dynamic strengths of WAIS will bolster weaknesses in FRISP;
- it is likely that new field studies will be drawn up to investigate the northern regions of West Antarctica as a joint WAIS/FRISP effort;
- first results from West Antarctic ice cores at Siple Dome will be presented;
- a "landmark" publication on West Antarctic research will result.

For further information contact:

R.A. Bindschadler, NASA/Goddard Space Flight Center, Code 971, Greenbelt, MD 20771, USA (Tel: [1](301)286-7611; Fax: [1](301)286-0240; bob@igloo.gsfc.nasa.gov; http://www.agu.org/meetings/cc98ecall.html

FIRST INTERNATIONAL CONFERENCE ON MARS POLAR SCIENCE AND EXPLORATION

Houston, Texas, U.S.A., 19–22 October 1998

Investigations by orbiting spacecraft have revealed that the Martian polar regions are as complex and dynamic as those of the Earth, containing a record of climate change that could well date back more than a billion years. Yet, our understanding of the nature and evolution of these regions is exceedingly poor. The following are just a few of the questions that will be addressed during this four-day meeting.

- How did the Martian polar caps originate?
- How old are they? And what is the chronology of events recorded in their strata?
- How do the compositional, physical, thermal, and radiative properties of the deposits vary, both geographically and with depth?
- What does their stratigraphy tell us about the annual cycles of carbon dioxide, water, and dust? And how have these cycles changed with time?
- Is there evidence of past or present glacial flow?
- Is the base of either cap currently at the melting point?
- Do basal lakes or other environments exist that are suitable for the survival and growth of indigenous life?

The purpose of this Conference, co-sponsored by the International Glaciological Society, is to assess the current state of Mars polar research; discuss what is likely to be learned from upcoming missions; and identify potential science objectives, spacecraft platform options, and instrument suites for a Surveyor- or Discovery-class mission to the north polar cap within the next decade. This meeting is intended to advance such a mission and serve as an important resource for those scientists wishing to develop instruments, propose

spacecraft, or participate as a member of a science team, in response to any future RFP.

Contributed abstracts will be published as part of an LPI technical report that will be distributed to the Conference participants at the meeting. They will also be available in electronic format, accessible via the Conference Web. They should address any relevant aspect of terrestrial or Martian polar research, including, but not limited to:

- polar geology, glaciology & hydrology;
- compositional, thermophysical & spectral properties;
- climate & meteorology;
- exobiology;
- geophysical & remote sensing investigations;
- instrument design & exploration strategies.

For further information regarding the format and scientific objectives of the workshop, please contact: Stephen Clifford (Tel: [1](281)486-2146; clifford@lpi.jsc.nasa.gov) or David Fisher (Tel: [1](613)996-7623; fisher@nrcan.gc.ca)
Questions concerning meeting logistics should be addressed to: LeBecca Simmons, Program Services Dept., Lunar and Planetary Institute, P.O. Box 58407, Houston, TX 77058 (Tel: [1](281)486-2158).

http://cass/jsc.nasa.gov/meetings/polar98/

BOOKS RECEIVED

Barry, R.G. and R.J. Chorley. 1998. *Atmosphere, weather and climate. Seventh edition.* London and New York, Routledge.

Bloom, A.L. 1998. *Geomorphology: a systematic analysis of late Cenozoic landforms. Third edition.* Upper Saddle River, NJ, Prentice Hall.

Bryant, E. 1997. *Climate process & change.* Cambridge, Cambridge University Press.

Colbeck, S.C. 1996. *Glaciers, ice sheets and volcanoes: a tribute to Mark F. Meier.* Hanover, NH, U.S. Army Corps of Engineers. Cold Regions Research and Engineering Laboratory. (CRREL Spec. Rep. 96-27.)

Hättestrand, C. 1997. *Ribbed moraines and Fennoscandian palaeoglaciology.* Stockholm, Stockholm University. Department of Physical Geography. (Avhandling/Dissertation 9.)

Hart, J. and K. Martinez. 1997. *Glacial analysis: an interactive introduction.* London, etc., Routledge, CD-ROM.

Hooke, R. LeB. 1998. *Principles of glacier mechanics.* Upper Saddle River, NJ, Prentice Hall.

Kennedy, B.W., L.R. Mayo, D.C. Trabant and R.S. March. 1997. Air temperature and precipitation data, Gulkana Glacier, Alaska, 1968--96. *U.S. Geol. Surv. Open File Rep.* 97-358.

Krimmel, R.M. 1998. Water, ice, and meteorological measurements at South Cascade Glacier, Washington, 1997 balance year. *U.S. Geol. Surv. Water-Resour. Invest. Rep.* 98-4090.

Martínez de Pisón, E. 1996. *El Valle de Tena: un paisaje modelado por el hielo.* Madrid, Diputación General de Aragón. Departamento de Agricultura y Medio Ambiente.

Nakawo, M., N. Hayakawa and L.E. Goodrich, *eds.* 1998. *Snow and ice science in hydrology: the IHP training course on snow hydrology.* Nagoya, Nagoya University. Institute for Hydrospheric–Atmospheric Sciences. Unesco, International Hydrological Programme.

National Institute of Polar Research (NIPR). 1997. *Antarctica: East Queen Maud Land/Enderby Land glaciological folio.* Tokyo, National Institute of Polar Research.

Ribstein, P., B. Francou, A. Coudrain-Ribstein and P. Mourguiart, *eds.* 1995. Eaux, glaciers & changements climatiques dans les Andes tropicales. *Bull. Inst. Fr. Étud. Andines (Lima),* 24(3).

Smith, R.F. 1997. *Final report of the Joint Services Expedition to the Blue Mountains, Ellesmere Island, High Arctic Canada, 1994.* Elmwood Avenue, Feltham, Middlesex TW13 7AH, U.K., Miltary Survey.

Spain: Ministerio de Medio Ambiente. 1997. *La nieve en las cordilleras españolas. Programa ERHIN, Año 1993/94 [Snow in the Spanish cordilleras. ERHIN Program, 19932/943].* Madrid, Ministerio de Medio Ambiente. Dirección General de Obras Hidráulicas y Calidad de las Aguas.

Troelstra, S.R., J.E. van Hinte and G.M. Ganssen. 1995. *The Younger Dryas: proceedings of a workshop at the Royal Netherlands Academy of Arts and Sciences on 11–13 April 1994.* Amsterdam, etc., North Holland.

Tsatsoulis, C. and R. Kwok, *eds.* 1998. *Analysis of SAR data of the polar oceans: recent advances.* Berlin, etc., Springer-Verlag.

Wadhams, P., J.A. Dowdeswell and A.N. Schofield, *eds.* 1996. *The Arctic and environmental change.* Amsterdam, etc., Gordon and Breach Publishers.

GLACIOLOGICAL DIARY

** IGS sponsored * IGS co-sponsored

1998

3–4 August 1998
The Arctic Buoy Program: Scientific Achievements from the First 20 Years, Seattle, WA, USA
T. Villinger, ACSYS, P.O. Box 5072, Majorstua, N-0301 Oslo, Norway (Tel: [47]22-95-96-05; Fax: [47]22-95-96-01; tvilling@npolar.no)

5–7 August 1998
Sea Ice Charts of the Arctic: Scientific Achievements from the First 400 Years, Seattle, WA, USA
T. Villinger, ACSYS, P.O. Box 5072, Majorstua, N-0301 Oslo, Norway (Tel: [47]22-95-96-05; Fax: [47]22-95-96-01; tvilling@npolar.no)

10–12 August 1998
Workshop on Methods of Mass Balance Measurements and Modelling, Tarfala, Sweden,
A.G. Fountain, Department of Geology, Portland State University, Portland, OR 97207-0752, USA (Tel: [1](503)725-3386; Fax: [1](503)725-3025; fountain@pdx.edu)

17–21 August 1998
** International Symposium on Glaciers and the Glaciated Landscape, Kiruna, Sweden
Secretary General, International Glaciological Society, Lensfield Road, Cambridge, CB2 1ER, UK

26–29 August 1998
Symposium and Field Trip, IGU Commission on Climate Change and Periglacial Environments, Portugal.
G. Vieira, Centro de Estudos Geograficos, University of Lisbon, Alameda da Universidade, 1699 Lisboa codex, Portugal (Tel: [351](1)794-0218; Fax: [351](1)793-8690; goncalo.vieira@ceg.ul.pt; http://www.ceg.ul.pt/periglacial.htm)

24–28 August 1998
* Symposium on Global Changes in the Polar Regions, Tromsø, Norway
IASC Secretariat, Postboks 5072, Majorstua, N-0301 Oslo, Norway (Tel: [47]22-95-96-00; Fax: [47]22-95-96-01; iasc@npolar.no)

27–30 August 1998
** IGS Western Alpine Branch 1998 Excursion to Val Formazza, Italy
F. Valla, CEMAGREF-Etna, 2 rue de la Papeterie, B.P. 76, F-38402 Saint-Martin-d'Hères, France (Tel: [33]476-76-27-21; Fax: [33]476-51-38-03; francois.valla@cemagref.fr)

5–9 September, 1998
* Sixth International Symposium on Antarctic Glaciology (ISAG-6), Lanzhou, China
Secretary General of ISAG-6, Lanzhou Institute of Glaciology and Geocryology, CAS, Lanzhou 730000, PR China (Fax: [86](931)8885241; icecore@ns.lzb.ac.cn)

10–11 September 1998
** IGS British Branch Annual Meeting, School of Geographical Sciences, University of Bristol, UK
A.-M. Nuttall, Centre for Glaciology, University of Wales, Aberystwyth SY23 3DB (Tel: [44](1970) 622781; Fax: [44](1970)622659; A.M.Nuttall@ber.ac.uk; tp://www.ggy.bris.ac.uk/)

13–18 September 1998
* AGU Chapman Conference on the West Antarctic Ice Sheet, Orono, Maine, USA
R.A. Bindschadler, NASA/Goddard Space Flight Center, Code 971, Greenbelt, MD 20771, USA (Tel: [1](301)286-7611; Fax: [1](301)286-0240; bob@igloo.gsfc.nasa.gov; http://www.agu.org/meetings/cc98ecall.html)

14–19 September 1998
25th International Conference on Alpine Meteorology, Turin, Italy
Scientific Secretary of ICAM 98, Regiuone Piemonte–Servizio Meteoidrografico, C.so Unione Sovietica 216, I-10134, Italy (fax: 39-11-31.81.709; meteoidro@regione.piemonte.it

27 September – 1 October 1998
International Snow Science Workshop 1998, Sunriver, Oregon, USA
ISSW '98, Stevens Pass Inc., P.O. Box 98, Skykomish, WA 98288, USA (http://www.issw.noaa.gov)

6–9 October 1998
* Snow Hydrology: The Integration of Physical, Chemical and Biological Systems, Ascutney Mountain Resort, Vermont, NH, USA
Janet P. Hardy, Cold Regions Res. & Engineering Lab., U.S. Army Corps of Engineers, 72 Lyme Road, Hanover, NH 03755-1290, USA (Tel: [1](603)646-4306; Fax:[1](603)646-4785; jhardy@crrel.usace.army.mil

19–22 October 1998
* First International Conference on Mars Polar Science and Exploration, Houston, Texas, USA
S. Clifford, Lunar and Planetary Institute, P.O. Box 58407, Houston, TX 77058, USA (Tel: [1](281)486-2146; Fax: [1](281)486-2162; clifford@lpi.jsc.nasa.gov; http://cass/jsc.nasa.gov/meetings/polar98/)

1–4 November 1998
5th International Symposium on Glacier Caves and Karst in Polar Regions, Chiusa Pesio, Italy
Giovanni Badino, Via Cignaroli 8, I-10152 Torino, Italy (Tel: [39](11)436-1266; Fax: [39](11)521-4500; badino@to.infn.it)

6–10 December 1998
AGU Fall Meeting, San Francisco, CA
http://www.agu.org

1999

20–22 April 1999
* EISMINT/EPICA Symposium on Ice Sheet Modelling and Deep Ice Drilling, European Geophysical Society General Assembly, Den Haag, The Netherlands
C.S.M. Doake, British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 OET, U.K.(Off: [44](1223)251-488; Fax: [44](1223)362-616; csmd@bas.ac.uk

30 May – 4 June 1999
ISOPE-99, 9th International Offshore and Polar Engineering Conference, Brest, France
ISOPE-99, P.O. Box 1107, Golden, CO 80402-1107, USA (Tel: [1](303)420-8114; Fax: 303-420-3760)

11–16 July 1999
OMAE '99, 18th International Conference on Offshore Mechanics and Arctic Engineering, St. John's, Newfoundland, Canada
J. Myrick-Harris, Conference Office, Hatcher House, Memorial University of Newfoundland, St. John's, Newfoundland, Canada (Tel: [1](709)737-7922; Fax: [1](709)737-3520; jharris@morgan.ucs.mun.ca; http://www.mun.ca/ccore/omae99/)

19–30 July 1999
XXII General Assembly of the International Union of Geodesy and Geophysics, Birmingham, UK

Interactions Between the Cryosphere, Climate and Greenhouse Gases (M. Tranter, Department of Geography, University of Bristol, Bristol BS8 1SS, U.K. (Tel: [44](117)928-8307; Fax: [44](117)928-7878; tranter@bris.ac.uk; http://www.wlu.ca/~wwwiahs/index.html)

Hydrology of Ice-covered Rivers (M.G. Ferrick, CRREL, 72 Lyme Road, Hanover, NH 03755-1290, U.S.A. (Tel: [1](603)646-4287; Fax: [1](603)646-4785: mferrick@crrel.usace.army.mil)

16–20 August 1999
** International Symposium on the Verification of Cryospheric Models, Zürich, Switzerland
Secretary General, International Glaciological Society, Lensfield Road, Cambridge, CB2 1ER, UK

27–30 July 1999
IUTAM Symposium on Scaling Laws in Sea Ice Mechanics and Sea Ice Dynamics
John P. Dempsey, Dept. of Civil and Environmental Engineering, Clarkson University, Potsdam, NY 13699-5710, USA (Tel: [1](315)268-6517; Fax: [1](315)268-7985; john@jpdnz.cee.clarkson.edu)

7–8 September 1999
* International Conference on the Deformation of Glacial Materials, London, England
(Bryn P. Hubbard, Centre for Glaciology, Inst. of Geography & Earth Sciences, University of Wales, Aberystwyth SY23 3DB, Ceredigion, Wales, UK Tel [44](1970)622-783; Fax [44](1970)622-780; byh@aber.ac.uk)

27–30 September 1999
Fifth International Ice Drilling Technology Workshop (streves@unlinfo.unl.edu)

2000

May 2000
** International Symposium on Snow and Avalanches, Innsbruck, Austria
Secretary General, International Glaciological Society, Lensfield Road, Cambridge, CB2 1ER, UK

19–23 June 2000
** International Symposium on Sea Ice and its Interactions with the Ocean, Atmosphere and Biosphere, Fairbanks, Alaska
Secretary General, International Glaciological Society, Lensfield Road, Cambridge, CB2 1ER, UK

2001

23–27 July 2001
Physics and Chemistry of Ice, University of Kent, Canterbury, UK
John Dore and Vicky Nield (Fax [44](1227)827558; pcice@ukc.ac.uk; http://kiwi.ukc.ac.uk/physics/events.html)

to be announced
** Remote Sensing in Glaciology, Washington, District of Columbia, USA
Secretary General, International Glaciological Society, Lensfield Road, Cambridge, CB2 1ER, UK

August 2001
** Ice Cores and Climate, Kangerlussuag, Greenland
Secretary General, International Glaciological Society, Lensfield Road, Cambridge, CB2 1ER, UK

NEW MEMBERS

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