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CONTENTS

COVER PICTURE: Outlet glacier from the Greenland ice sheet. (Photograph by Konrad Steffen)

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

RECENT WORK

FINLAND

(For abbreviations used see page 8)

SNOW

Snow conditions in Finland and impacts of global climate change

(S. Rasmus, T. Oksanen, Geophys/UHel)
Snowpack structure has been studied in different parts of Finland, and the variation of different snow quantities (depth, density, etc.) inside and between different biotopes. Reliability of the Swiss (Davos) snowpack-structure model has been evaluated for Finnish conditions. Snow scenarios for different zones at year 2100 are produced using regional-climate-model data as an input to the snow model. 50 year time-series from snow-survey lines (depth and density) are under investigation to explain year-to-year variability in these snow-cover properties. An effort will be made to relate these properties to large-scale atmospheric circulation, sea-ice extent and sea-surface temperatures. The evolution of ice layers and their effect on snow metamorphism in sub-Arctic snowpack has been examined, mainly in a cold room. Early results reveal ice layers within the snowpack thin by about 1.5 mm mon ^{1} under a strong temperature gradient

Seasonal snow cover in Antarctica

(E. Kärkäs, Geophys/UHel)
Physical properties of the seasonal snow cover have been mapped in western Dronning Maud Land during austral summers 1999/2000 and 2000/01. The aim is to document spatial and temporal variations in snow-cover properties. Measurements were made in shallow snow pits along a 350 km transect from the coast inland, covering at least one annual cycle and an elevation range from sea level to about 2500 m.

GLACIERS

Palaeoclimate studies on blue ice areas, Dronning Maud Land, Antarctica

(J.C. Moore, AC/ULap; A. Sinisalo, AC/ULap, Geophys/UOulu; J. Vehviläinen, AC/ULap, FFRI, ACL/UHel)
Shallow cores from Antarctic blue-ice areas offer ancient ice for palaeoclimatic studies. Extensive snow and blue-ice sampling, plus radar and DGPS work, have been made in five different blue-ice areas. Measured ion concentrations of ice and snow samples offer a record of anthropogenic and biogenic emissions possibly back to the last ice age. The surface-age distribution will be evaluated by geophysical measurements, and modelling the ice flow, and calibrated by radiocarbon dating of ice. The ^{18}O and ^{2}H isotope ratios will be measured to obtain information about the temperatures and possible sources of past precipitation.

Polythermal glaciers in Svalbard

(A. Pälli, AC/ULap)
Several polythermal glaciers have been studied using ground-penetrating radar and GPS. Ground-penetrating radar was used to map bedrock, warm-ice–cold-ice distributions, hydrological features and snow thicknesses. The spatial snow distribution, accumulation rate and hydrological drainage system of a glacier can be studied with GPS and surface data; providing important information for a glacier mass-balance calculation and on a polythermal glacier's response to climate change.

Lomonosovfonna ice core, Svalbard

(T. Kekonen, AC/ULap)
The entire 122 m deep Lomonosovfonna ice core, drilled in 1997, has been analyzed using ion chromatography at the FFRI research station in Rovaniemi. The major ion and methanosulphonate records are being interpreted. The next goal is to analyze particles from different depths from the melted- and filtered-ice samples using SEM-EDS at the University of Oulu.

SEA ICE

Coastal ice in the Baltic Sea

(M. Leppäranta, A. Lindfors, J. Ehn, Geophys/UHel)
The Baltic Sea is a brackish water basin where sea ice occurs annually. The length of the ice season is 5–7 months and the maximum thickness of undeformed ice is 120 cm. The structure and properties of coastal ice, as well as the light climate inside and beneath the ice cover, have been examined in the Gulf of Finland since 1999. Ice samples have been collected weekly, and each winter a 1–2 week intensive campaign has been arranged. The studies have shown that brackish waters with decreasing salinities bear a sea-ice structure down to the water salinity of 1–2 ppt. The ice sheet consists of congelation ice and snow-ice and the latter counts up to 50% of the ice volume. The light data include spectral data above and beneath the ice from the intensive campaigns and continuous PAR (photosynthetically active radiation) records from several depths through the ice sheet. The final results will be available soon following completion of the last experiment season in winter 2002. There has been close collaboration with the Institute of Low Temperature Science, Hokkaido University, and the Estonian Marine Institute.

Sea-ice dynamics

(M. Leppäranta, Zhang Zhanhai*, K. Wang, Geophys/ UHel [*Presently in Chinese Arctic and Antarctic Administration, State Oceanographic Administration, Beijing, China])

Sea-ice dynamics theory and models have been worked on for seasonally ice-covered seas, in particular the Baltic and Bohai Seas. The main questions have been the ice–ocean dynamic coupling, comparison of different sea-ice rheologies and scaling laws for ice dynamics based on basin size, ice thickness, rheology, forcing, etc. The validity of continuum models with decreasing gridsize has been evaluated based on experimental data with satisfactory results for a 5 km grid in an ice field with 50 cm thickness.

PhD theses on sea-ice geophysics in 2000

(Geophys, UHel)

Jari Haapala: Modeling of the seasonal sea ice cover of the Baltic Sea

Juha Uotila: Ocean current and sea-ice motion studies based on drifter observations and meteorological forcing

Zhang Zhanhai: On modelling ice dynamics of semi-enclosed seasonally ice-covered sea

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JAPAN (Hokkaido)

JAPAN

Snow flux at a road snow bank

(M. Matsuzawa, CERIH; M. Takeuchi, T. Kobayashi, JWAH)

Snow-flux measurements were carried out at the Ishikari Snowstorm Test Field of CERIH in February 2001 to investigate the influence of snow banks on road visibility. Observation heights are 1.2 m and 2.4 m at 1.2 m and 3.5 m from the roadside snowbank. Even if the visibility at 1.2 m was ~200 m, the visibility at 3.5 m was ~400 m. We observed improvements and differences in visibility with the height away from the snowbank.

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Snow accretion on railway vehicles, Northern District, Japan

(T. Ozeki, HUE; K. Akiniwa, A. Kondou, H. Kitagawa, JRH)

Railway track switches often fail to function properly in the presence of snow and ice. In the northern districts of Japan, railway vehicles suffer from snow accretion, and masses of accreted snow sometimes fall onto the switches. The snow cover on railway tracks was investigated at Iwamizawa, Hokkaido, once or twice a month using a snow pit. Observations of snow accretion were made on railway vehicles, particularly when the railway tracks were covered with new snow. Snow accretion was observed around the underfloor area and the front and rear cars of the trains. The snow type was mainly dry accreted snow that had a similar structure to wind-packed snow. On the other hand, snow layers near underfloor equipment were made of well-coarsened wet grains or melt-frozen grains. Ice layers, ice blocks and cavities were observed beside the heat source.

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Hydrological cycle in cold and nival drainage basins, northern Japan

(Y. Ishii, Y. Kodama, N. Ishikawa, ILTS/HU)

The Moshiri experimental watershed is in one of the coldest regions of Japan (44°22′ N, 142°17′ E). In winter, it is covered with snow 2–3 m deep (700–900 mm w.e.) and the minimum air temperature is −35° to −40°C. Soil under the snow is unfrozen during winter because of the thick snowpack. Recent studies here include: (1) contributions of snow-water storage to the basin water balance and their interannual variability; (2) possible changes in basin water balance under climate-warming scenarios; (3) water and solute budgets in the snowmelt–runoff process; (4) hydrograph separation using a three-component mixing model during the whole snowmelt period; (5) breakup of the temperature inversion layer; and (6) atmospheric heat budget. These studies were mainly supported by the MEXT.

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Sea-ice conditions, Hokkaido coast, Okhotsk Sea

(H. Enomoto, K. Tateyama, S. Kojima, CE/KIT)

Sea-ice conditions were investigated to validate satellite remote sensing. A small icebreaker was available for ice sampling near Mombetsu, Hokkaido, and an aeroplane was used for taking photographs and video over the Mombetsu area.

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RUSSIA

Water and energy flux over an alas lake, central Yakutia, eastern Siberia

(Y. Ishii, ILTS/HU; H. Yabuki, FORSGC; M. Nomura, EF/HU; N. Kobayashi, IHAS/NU; Hr. Tanaka, AG/KU; Hs. Tanaka, TERC/UTsuk; R.V. Desyatkin, IBPC)

As a part of the GAME-Siberia project, water- and energy-flux observations were made over an alas lake during summer 2000 in central Yakutia. An alas is a steep-sided, flat-floored depression created by melting of the permafrost and a common landform in this region. The alas observed, Ulakhan Sykkhan, is 45 km northeast of Yakutsk (62°09′ N, 130°31′ E). The

objectives are to clarify the difference in the surface energy balance over the lake/grassland/forest, and to learn how water-balance components affect the seasonal and interannual variation in alas water levels. Lake evaporation was calculated using Penman's method. Latent-heat flux over the lake was largest among those in the forest canopy and grassland whereas net radiation was almost the same over each land surface. Surface/subsurface flow components made a relatively small contribution to the lake water balance. This activity was supported by the MEXT and FORSGC.

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Decadal and interdecadal climate change from Kamchatka ice-cores, circum-Okhotsk region

(T. Shiraiwa, ILTS/HU; Ya.D. Murav'yev, IVRAS)

Analyses of oxygen/hydrogen stable isotopes and major ionic species were made for the upper 106.03 m of a 211.70 m ice core from the glacier in Gorshkov crater, Ushkovsky volcano, central Kamchatka peninsula. Seasonal fluctuations were found in the profiles of $\delta^{18}O$, δD, d excess, NH_4 and NO_3, while those of H^+, Na^+, K^+, Mg^{2+}, Ca^{2+}, Cl^- and SO_4^{2-} were composed of both background atmospheric and volcanic signals. Delineation of annual increments from seasonal $\delta^{18}O$ cycles were used to convert the depth series of the signals to a time series, after careful corrections for density and flow thinning. As a result, a 170-year time series of net accumulation rate, the annual averages of $\delta^{18}O$ and NO_3, were reconstructed. The net-accumulation rate changed with frequencies of 32, 12–13, and 5 years, while the $\delta^{18}O$ changed with centennial and 11 year cycles. A gradual increase of NO_3 since 1860 is attributed to a possible increase in anthropogenic activities. Comparisons of the net accumulation rate and $\delta^{18}O$ time series from Ushkovsky volcano with those from Mount Logan, Canada's highest mountain, suggest the Pacific Decadal Oscillations are recorded in the net accumulation and $\delta^{18}O$ time series. To confirm this, we are planning additional ice-core drillings in Canada, Kamchatka and Siberia from 2002 to 2004.

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Permafrost on Mount Ichinsky, Kamchatka, Russia

(T. Sone, ILTS/HU; Y. Sawada, GSEES/HU; K. Yamagata, JUE)

Permafrost distribution and development has been investigated on the west slope of Mount Ichinsky Volcano (54.65° N, 157.75° E; 3607 m a.s.l.). The stagnant terminus of West Ichinsky glacier lies at 1200 m a.s.l. Periglacial landforms, such as frost-crack polygons, solifluction lobes, turf-banked steps, patterned ground and earth hummocks, are observed above the treeline of 900 m a.s.l. On-the-spot measurements of ground temperature in autumn 2000 revealed the altitudinal development of frozen ground and the active layer. Continuous meteorological observations of air temperature, wind direction and speed, and ground temperature were conducted at 1000 m a.s.l. from September 2000–August 2001. In addition, ground temperatures were measured at 1700 m a.s.l. Mean air temperature in this period was –4.4°C.

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ALASKA

Yukon Water and Energy Experiment (YuWEX)

(N. Ishikawa, Y. Kodama, Y. Ishii, ILTS/HU; S. Urano, T. Hirano, AG/HU; K. Chikita, FS/HU; K. Kawauchi, MurIT; K. Yabe, SSA; T. Sato, A. Sato, NIED/STA)

An integrated and comprehensive examination of hydrological processes in permafrost areas of interior Alaska is being undertaken. The following were observed in 2001: (1) intensive measurements of snow distribution, evapotranspiration, CO_2 efflux, depth of active layer, ground-water level, runoff, dependency of soil moisture on topography and vegetation; (2) annual water/heat balance in the CPCRW; (3) runoff along the Yukon River. The total hydrological balance and interactions with other environmental phenomena are examined across a valley profile and then analyzed with complementary data such as soil type, vegetation distribution, snow and water conditions, ground temperature, and soil thermal and hydraulic conductivity. Counterparts of this study are WERC/UAK-F and USGS-AK. This project is supported by the JAMSTEC and MEXT.

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ANTARCTICA

Periglacial environment and geomorphology, James Ross and Seymour Islands, Antarctic Peninsula

(J. Mori, ILTS/HU; K. Fukui, TMU; J. Strelin, CADIC/IAA; C. Trielli, UNC)

Periglacial environment and geomorphology research were carried out on James Ross and Seymour Islands (64° S, 57° W) from January–March 2001, in a joint Argentine–Japan project. On James Ross Island, air temperature, temperature of the active layer, soil-surface movement and other factors are monitored to reveal the developmental processes of stone-banked terraces and patterned ground on Riscos Rink Plateau. The active layer in summer 2000/01 was shallow, about 40 cm. In the Lachman area, a ground survey for detecting protalus-rampart movement was made after a 3 year interval. Air and permafrost temperatures are monitored here. Permafrost temperature is also measured on Seymour Island.

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JAPAN (Honshu)

APPLIED SNOW & ICE STUDIES

Climate conditions in areas with snow and ice houses

(K. Izumi, RIHSA)

Fifty years ago, snow- and ice houses were used to store snow and ice collected from snowfields and frozen lakes. The snow and ice was consumed by people and used for cooling food throughout the summer. Distribution of these houses was examined in the literature and the climatological conditions at the time investigated with the Mesh Climatic Data File (1955–84) of the Japan Meteorological Agency. Snow houses were found in heavy snow areas on the coast of the Sea of Japan, while ice houses were in the less snowy areas along the Pacific coast and in the interiors. They were located where minimum January and February temperatures were below freezing.

Snow-melting road design for road heating system considering snowfall hours

(S. Kamimura, NUT)

Various types of new pavements using natural or unused energy as heat sources for snowmelting have been developed in last decade. One system in particular, using geothermal energy from a shallow layer 10–200 m deep, is about to be implemented. Because geothermal heat is relatively low in both temperature and durability, road design for melting snow with such systems is rather difficult compared to conventional road-heating systems using fossil fuel. New design criteria for geothermal energy snowmelting have been proposed taking into account snowfall rate and duration.

Ballast-flying caused by accreted snow- and ice-fall from high-speed trains

(K. Kawashima, S. Iikura, T. Endo, T. Fujii, RTRI)

When trains run over a snow-covered track at high speed, dropped lumps of accreted snow and ice from the cars scatters ballast on the track damaging the car body and the environment along the track. The physical properties of snow and ice accreting to the bodies and underfloor equipment of trains were investigated in Hokkaido in January and February 2001. Accretions of snow and ice were found to reach a maximum mass of 15 kg, with densities of 150–900 kg m^{-3}. Tests of ballast-flying were also carried out using an air cannon. Ballast flying occurs mainly at train speeds of 80–140 km h^{-1} when the mass of snow and ice dropped was not less than 2 kg.

Snow transportation techniques

(T. Kobayashi, NIED)

Various snow-transportation systems for collecting significant amounts of snow at one site from widely distributed, naturally deposited snow, for air conditioning or food storage, etc., have been examined. Among many, the pneumatic conveyancing system has the advantage of using a rather flexible passage. An experimental system was operated to assess its ability to pile up a lot of wet snow in a cooling plant. A transportation rate of 10 t h^{-1} over a distance of 100 m with a 10 cm diameter tube was achieved. This is acceptable, but the system needs to be improved if it is to transport the wetter snow that is often encountered on the Japan Sea side.

Blowing-snow countermeasures evaluated by wind-tunnel and CCD-image analysis

(H. Nishimura, M. Matsuda, MTSI)

Highway visibility impaired by blowing snow may cause severe traffic accidents and road closures, etc., in northern Japan. Many different countermeasures, e.g. snow- and living fences, have been installed beside highways. However, the selection of appropriate countermeasures may be largely a matter of luck. How well blowing-snow countermeasures can improve visibility can now be evaluated quantitatively by analysis of CCD images of blowing snow in a cold wind tunnel. This enables selection of the most effective measure, depending on local conditions before it is installed.

Wind tunnel modelling and numerical simulation of snowdrift

(H. Mitsuhashi, N. Ohbayashi, CST; A. Sato, NIED; O. Nakamura, K. Miyashita, WEI Co.; H. Yamaguchi, Y.IAA)

A wind tunnel experiment successfully reproduced snowdrifting around a building in Antarctica. Similar experiments were also performed on a gymnastics hall to be built shortly by the Aomori Prefecture. The results were used for numerical simulation, and the snow-depth distribution around the hall, which is still in a design stage, was predicted.

Blowing-snow studies using a wind-tunnel

(A. Sato, T. Sato, O. Abe and K. Kosugi, NIED)

Several miniature-scale model experiments were carried out in the Cryospheric Environment Simulator (CES) wind tunnel. In addition to basic experiments, 1/100 to 1/20 scale models of highways, snow fences and buildings were tested. Artificial "real" snow crystals in the CES were used to create blowing snow. Drifting around the buildings, or visibility on the highway, were investigated to improve snow-fence design or arrangements for different air-temperature and wind-speed conditions.

SNOW AND AVALANCHES

Intercomparison of precipitation gauges

(K. Yokoyama, Y. Kominami, T. Kawakata, NARO; H. Ohno, NIAES)

Three types of precipitation gauges were compared over six winters in the Hokuriku region, with the reference to

the Double Fence Intercomparison Reference (DFIR). The gauges tested were RT-1, RT-3 and RT-4 of tipping-bucket type, which are often used in Japan. The precipitation measured by DFIR was converted to the "BUSH gauge value", which was regarded as "true". The catch ratio (measured : true), was in the order of RT-4>RT-1>RT-3, decreasing with the increase in wind speed. For example, the approximate catch ratio was 0.8 for RT-4, 0.7 for RT-1 and 0.6 for RT-3 for solid precipitation at a wind speed of 2 m s^{-1}. For most snowfall, the measured value should be corrected.

Relationship between snow avalanches and terrain characteristics

(Y. Yamada, NIED; H. Mizukoshi, GSI; M. Aniya, UTsuk)

Digital 10 m contour data were used to produce terrain characteristic slope maps of plan form (divergent, convergent, planar), profile form (concave, convex, straight), aspect (30° interval) and gradients (5° interval). A map of ridge lines and 30 m and 50 m buffers was also produced. Distribution maps of snow avalanches, cracks, cornices and other snow features were overlaid on these maps and their location characteristics were analyzed statistically.

Snow survey in eastern Siberia

(Y. Fujii, NIPR; F. Nishio, CEReS)

The physical and chemical properties of snow in a ~1500 x 3000 km area, centered on Yakutsk, eastern Siberia, have been surveyed. The survey was by repeated snow-pit observations, every 100 km, along four radial routes from Yakutsk. Well-developed depth hoar, with densities 200–220 kg m^{-3}, and anthropogenic chemical components are distributed widely in eastern Siberia.

Spatial variation of chemical species in snow, northwestern Greenland

(S. Matoba, H. Motoyama, O. Watanabe, NIPR; T. Yamasaki, Avagnaq; M. Miyahara, ATEC Inc.)

Snow was surveyed in the Thule area, northwestern Greenland, in 2000. The trip ran from Siorapaluk Village to Meehan Glacier (route I: S–N), and from the top of Meehan Glacier to the inland ice sheet along an ice ridge (route II: W–E). Dog sledges were used to eliminate exhaust pollution and provide high mobility on the glaciers. Snow samples were taken and snow-pit observations made along the traverses. Samples were analyzed for $\delta^{18}O$, major ions and heavy metals. $\delta^{18}O$ values decreased with increasing altitude on I, but increased with increasing altitude beyond 1500 m on II. Snow-pit observations revealed $\delta^{18}O$ had already increased from early spring at 1500 m, although $\delta^{18}O$ on Meehan Glacier (1000 m a.s.l.) had not. This suggests warm water vapor in this area was transported from inland to the coast in spring. Concentrations of heavy metals decreased with increasing distance from the coast. The ratio of Pb, Cu and Zn, close to the value obtained in Dye 3 but not those in Svalbard and the Swiss Alps, shows the dominant source area of heavy metal pollution could be North America.

Water channels in snow surfaces

(Y. Kominami, NARO)

Several kinds of crops (e.g. wheat and beans) are often damaged by strong water flushing during snowmelt, when the fields are covered with snow. Laboratory experiments and computer calculations were carried out on the formation of water channels on snow during spring melting on farmlands. It was inferred that water-channel formation depends on melt rate and snow-particle size.

Development of a snow model applicable for a wide area

(S. Suizu, Geosystems Inc.)

A model has been developed to estimate Japanese snow accumulation, snowmelt and the water equivalent of deposited snow using the Digital Elevation Model and Automatic Meteorological Data Acquisition System (AmeDAS) data of the Japan Meteorological Agency. The model predicts snowfall and snowmelt for a given site from AMeDAS precipitation, sunshine-duration and air-temperature data, and by calculating heat-balance components over the snow cover. Both results lead to a calculation of the water equivalent of deposited snow for the site. The model was successfully applied to 8000 km^2 of the Horuriku region.

Snowmelt from diurnal changes of the SSM/I brightness temperature gradient

(H. Ohno, NIAES)

A new satellite-derived index, Index of Snow Melt (ISM), has been defined and introduced: a subtraction of brightness temperature difference, from 19–37 GHz measured along ascending pass (19a–T37a) from that measured along descending pass (T19d–T37d) by SSM/I on DMSP Fright-13. It was found that large ISM values lay along the border of the snow-covered area throughout the melting season. The proposed ISM value may to some extent represent the snowmelt rate.

Winter variations of solid precipitation

(M. Shimizu, O. Abe, NIED)

The temporal variation of snowfall was examined for winters 1981/1982 to 1999/2000 for 10 regions in the Japanese Islands (western Hokkaido, eastern Hokkaido, western Tohoku, eastern Tohoku, Kanto-Koshin, Tokai, Hokuriku, Kinki, Sanin and Sanyo-Shikoku), using AMeDAS Japan Meteorological Agency data. Variations in solid precipitation amounts has been small in western Hokkaido, while extremely large in Hokuriku. In the mid-1980s, winters with heavy solid precipitation tended to decrease. It increased in the latter half of the 1990s, but decreased again to the normal value afterwards.

Bacterial flora in snow of the Tateyama Mountains by 16s rRNA analysis

(T. Segawa, N. Okada, S. Kohshima, TIT; K. Ushida, KPU)

Bacterial flora in snows of the Tateyama Mountains, Japan Alps, Toyama was analyzed by 16s rRNA gene analysis. Snow samples collected in March, June and August 2000 contained at least 20 species of bacteria

(5, 9 and 11 species of bacteria respectively), including those from cold environments, such as Antarctic soil; *Cryobacterium psychrophilum*, *Janthinobacterium lividum* and *Taxeobacter ocellatus*. Autotrophic bacteria seem to increase as snowmelting proceeds. Bacterial colonies cultured with an *in situ* meltwater medium at 4°C was revealed to be *Janthinobacterium lividum*.

ANTARCTICA

Shallow ice-core analysis

(F. Nishio, Y. Toyama, CEReS; T. Kameda, KIT; H. Motoyama, T. Furukawa, G. Hashida, M. Kohno, M. Igrashi, M. Takata, NIPR; K. Satow, NNCT; K. Suzuki, ShinU; K. Naoki, HUE)

Three ice cores, covering the last several hundred years, were recovered in East Dronning Maud Land from 1998–2001. Continuous analysis was made for stable isotope, major chemical ions, ECM, digital recording of stratigraphy and bulk density. At some depths, tritium concentration and impermeability were measured and laser tomographs were investigated.

Dynamic ice-sheet behaviour, Shirase drainage basin

(F. Nishio, CEReS; T. Furukawa, H. Motoyama, NIPR; K. Matsuoka, ILTS; S. Fujita, HU)

Markers have been installed along the principal flowline and the 2200 m contour line. Their positions were determined by differential GPS, to estimate flow velocity and future ice flux. Multi-frequency radar-echo sounding was used to examine the internal structure of the ice sheet and basal conditions. A large anisotropy was found near the bottom, where ice flow was convergent, which is compatible with a theoretical prediction.

SEA ICE

Frequent occurrence of sea-ice breakup in Lutzow–Holm Bay, Antarctica

(S. Ushio, NIPR)

Sea ice in Lutzow–Holm Bay (69°S, 38°E) has frequently broken up since 1980. In 1997/1998 in particular, the event was long-lasting, with a wide open sea. Breakup also occurred in 2000 and 2001 with almost the same situation. This study aims to reveal the physical processes and important factors behind the breakup. The breakup line nearly coincides with the bathymetric shelf-break region. Winds in the fall season are considered crucial for triggering the breakup. Satellite imagery, meteorological and tidal data, and offshore pack-ice movement will be analyzed in detail.

HIMALAYA

Recent shrinkage of glaciers in Bhutan

(Karma, Y. Ageta, N. Naito, A. Sakai, NU; S. Iwata, C. Narama, TMU)

The areal distribution of 66 debris-free glaciers and their changes have been examined for the Bhutan Himalaya, based upon a couple of inventories, several topographical maps and satellite images. No glaciers have advanced here for the last 30 years. Within the working area, glaciers with no debris cover occupied 146.87 km^2 in 1963, but 134.94 km^2 in 1993. The average rate of the shrinkage was greater than that in the Nepal Himalaya. The rate decreased with increasing altitude of the lowest elevation of glaciers. Three small glaciers have completely disappeared in the last 30 years.

Surface lowering of debris-covered glaciers in the Nepal Himalaya

(N. Naito, K. Fujita, A. Sakai, Y. Ageta, NU; T. Kadota, FORSGC; M. Nakawo, RIHN; H. Conway, UWA)

Based on repeated topographical surveys of ablation areas of debris-covered Lirung and Khumbu Glaciers, Nepal Himalaya, a lowering of the glacier surface was detected. The average rate of lowering was estimated to be 1–2 m a^{-1} from 1996–99 for Lirung Glacier and about 2 m a^{-1} from 1995–99 for the uppermost ablation area of Khumbu Glacier. The lowering on both glaciers accelerated in the 1990s. A theoretical consideration suggested a large surface depression could be produced where the surface slope decreased down-glacier, but mass balance was increasing downward, a condition often encountered in the ablation area of a debris-covered glacier. Such a large depression could initiate a large glacier lake.

Micro-organisms in Himalayan ice core

(F. Nakazawa, K. Fujita, NU; K. Ohta, HyARC; N. Takeuchi, FORSGC; S. Kohshima, TIT; M. Nakawo, RIHN)Himalayan ice cores contain many micro-organisms, such as snow algae and bacteria. Their growth rate is considered dependent on temperature, sunlight availability and amount of meltwater. Hence micro-organisms in ice cores can be considered good indicators of the past environment. Concentration of organic acids has been analyzed for an ice core from Rikha Samba Glacier, Nepal Himalaya. The peak depths of the organic acids concentration did not coincide with those for dust concentration. This seems to indicate that organic acid concentrations increased as the result of the high activity of micro-organisms in summer, so the peak depth would indicate the summer layer.

PHYSICS AND CHEMISTRY OF ICE

Effect of impurities on grain growth rate in ice-sheet ice

(N. Azuma, T. Takeda and M. Inoue, NUT)

To investigate the effect of impurities on grain growth rate in ice-sheet ice, experimental studies of grain growth were conducted using artificial polycrystalline ice containing various soluble and insoluble impurities such as SO_4^{2-}, Cl^-, NO_3^-, Ca^{2+}, $CaCO_3$ and SiO_2, etc. in the temperature range −5° to −20°C, and the impurity concentration range between 20 ppb and 200 ppm. Although the experiments are still underway, results show soluble impurities accelerate the growth rate at temperatures higher than about −10°C, and that below −10°C soluble impurities impede the growth rate.

Contributed by Masayoshi Nakawo

ABBREVIATIONS USED

AC/ULap	Arctic Centre, University of Lapland, FIN-96101 Rovaniemi, Finland
AG	Agriculture
CADIC	Centro Austral de Investigaciones Cientificas
CE	Civil Engineering
CEReS	Center for Environmental Remote Sensing, Chiba University
CERIH	Civil Engineering Research Institute of Hokkaido
CPCRW	Caribou Poker Creek Research Watershed
CST	College of Science and Technology, Nihon University, Tokyo 101, Japan
FFRI	Finnish Forest Research Inst., Rovaniemi
FORSGC	Frontier Observation Research System for Global Change, Tokyo 105-6791, Japan
FS	Faculty of Science
GAME	GEWEX Asian Monsoon Experiment
Geophys	Geophysics
GSEES	Graduate School of Environmental Earth Science
GSI	Geographical Survey Institute
HU	Hokkaido University, Sapporo 060-0819, Japan
HUE	Hokkaido University of Education, Hokkaido 085, Japan
HyARC	Hydrospheric Atmospheric Research Center, Nagoya University, Nagoya 464-8601, Japan
IAA	Instituto Antartico Argentino
IBPC	Institute for Biological Problems of the Cryolithozone, Russia
IHAS	Inst. for Hydrospheric–Atmospheric Sciences
ILTS	Inst. of Low Temperature Science, Hokkaido University, Sapporo 060-0198, Japan
IVRAS	Institute of Volcanology, Russian Academy of Sciences, Petropavlovsk–Kamchatsky, Russia
JAMSTEC	Japan Marine Science and Technology Center
JRH	Hokkaido Railway Co., Japan
JUE	Joetsu University of Education, Japan
JWAH	Japan Weather Association Hokkaido Regional Head Office
KIT	Kitami Institute of Technology, Kitami, Hokkaido 090-8507, Japan
KPU	Kyoto Prefectural University, Kyoto, Japan
KU	Kyoto University, Kyoto, Japan
MEXT	Ministry of Education, Culture, Sports, Science and Technology, Japan
MTSI	MTS Inst. Inc., Sudachokosaten Bldg., 1-5 Kanda Sudacho, Chiyoda-ku,Tokyo, Japan
MurIT	Muroran Institute of Technology, Japan
NARO	National Agricultural Research Organization
NIAES	National Institute for Agro-Environmental Sciences, Tsukuba, Ibaraki 305-8604, Japan
NIED	National Research Institute for Earth Science and Disaster Prevention, Shinjo, Yamagata 996-0091, Japan
NIPR	National Institute of Polar Research, Itabashi, Tokyo 173-8515, Japan
NNCT	Nagaoka National College of Technology, Nagaoka 940, Japan
NU	Nagoya University, Nagoya 464, Japan
NUT	Nagaoka University of Technology, Nagaoka 940-21, Japan
RIHN	Research Institute for Humanity and Nature, Kyoto 602-0878, Japan
RIHSA	Research Institute for Hazards in Snowy Areas, Niigata University, Ikarashi, Niigata 950-21, Japan
RTRI	Railway Technical Research Institute, Minami-Uonuma, Niigata 949-6408, Japan
ShinU	Shinshu University, Nagano 399, Japan
SSA	Sapporo School of the Arts, Hokkaido, Japan
STA	Science and Technology Agency, Japan
TERC	Terrestrial Environment Research Center, UTsuk
TIT	Tokyo Institute of Technology, Tokyo, Japan
TMU	Tokyo Metropolitan University, Japan
UAK-F	University of Alaska Fairbanks, Fairbanks, AK 99775-7320, U.S.A.
UHel	University of Helsinki, FIN-0014 Helsinki, Finland
UNC	Universidad Nacional de Cordoba, Spain
UOulu	University of Oulu, Finland
USGS-AK	U.S. Geological Survey, 800 Yukon Drive, Fairbanks, AK 99709, U.S.A.
UTsuk	University of Tsukuba
UWA	University of Washington, Seattle, WA 98195-1360, U.S.A.
WEI Co.	Wind Engineering Institute Co., Japan
WERC	Water and Environmental Research Center
Y.IAA	Y. Ikehara Architect & Associates

INTERNATIONAL GLACIOLOGICAL SOCIETY

ANNUAL GENERAL MEETING 2002

MINUTES OF THE ANNUAL GENERAL MEETING OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY

13 June 2002, Yakutat High School, Yakutat, Alaska, U.S.A.

The President, Dr Robert A. Bindschadler, was in the Chair.
46 members from 10 countries were present.

1. The Minutes of the last Annual General Meeting, published in *ICE*, 2001, Nos 126 and 127, p. 24–27, were approved on a motion by M.F. Meier, seconded by G.K.C. Clarke and signed by the President.

2. The President gave the following report for 2001–2002:

This is my last report to you as your President. I will close with some reflections on what this experience has taught me about the Society. But first, it is important to record what our accomplishments have been over the past year, the turnovers we have weathered and the bright outlook for our future. I will not discuss finances, leaving that to our most capable Treasurer, John Heap, who is able to attend today.

Calendar year 2001 was Volume 47 of the *Journal of Glaciology*. 696 pages were published, close to the 716 pages of the previous year. As has become our two symposia norm, two more volumes of *Annals of Glaciology* have been published this year: Volume 32, containing papers from the International Symposium on Snow, Avalanches and Impact of the Forest Cover held in Innsbruck in May 2000, at 364 pages; and Volume 33 with papers from the International Symposium on Sea Ice and its Interactions with the Ocean, Atmosphere and Biosphere, held in Fairbanks, Alaska, with a whopping 608 pages. They mark a considerable increase in published pages of almost 200 from the previous year (1668 versus 1474).

This year, the first *Annals of Glaciology* to be published will be Volume 34. This 464 page volume contains 67 papers from the Fourth International Symposium on Remote Sensing in Glaciology, held in Maryland last year, and should be printed next month

The second will be *Annals of Glaciology* 35, containing 89 papers from the Symposium on Ice Cores and Climate, in Kangerlussuaq, Greenland. It will be published later in the year and may be close to the 600 pages of *Annals* 33.

The first issue of *ICE* will be published later this summer. These periodic reports on glaciological work being undertaken by different countries are a good way to inform others of your own ongoing work. I have seen these reports lead to comments or offers of collaboration from colleagues with similar interests or projects. If your work has not been featured in a recent issue of *ICE*, please contact your National Correspondent to find out when the next submission will be prepared.

Another way the Society disseminates glaciological works is by co-publication ventures. We have now completed our second such venture with the University of Washington Press. *Secrets of the snow: visual clues to avalanche and ski conditions* by Ed LaChapelle was published last year and is selling well. The University of Washington Press is marketing it with his *Field guide to snow crystals* that was reprinted by the IGS.

All these publications are the result of hard work by many individuals. Nothing gets published without passing through our Cambridge office and the scrutiny of our Secretary General, Simon Ommanney. In the absence of a Production Manager and some additional staff turnover, Simon has had to shoulder many additional responsibilities this past year. He has not only survived, but he has maintained the high quality we have come to expect during his tenure as Secretary General. He is not adequately compensated, but help is on the way. Not only have we replaced the now-retired typesetter Joan Keating, with Ann Leeding, but I am also pleased to announce that we have hired Tim Labrum as our new Production Manager. Tim has excellent credentials and came highly recommended. He will begin in a few weeks on July 1. Linda Gorman has remained through this period as a very steadying influence in her post as Simon's capable assistant.

Again we are deeply indebted to our *Journal of Glaciology* Chief Editors, Will Harrison and Matthew Sturm, and their indispensable assistant, Monica Court, for their management and running of the editorial office in Alaska. Regrettably, they have decided to step down at the end of their term next year. The Publications Committee, chaired by Julian Dowdeswell, led a successful search for

a replacement and we are very fortunate that Jo Jacka has agreed to take on the job of Chief Editor of the *Journal* next year. We will be working on the transition in the coming year.

This year the terms of Tómas Jóhannesson, Helmut Rott and Michiel R. van den Broeke were up as Scientific Editors for the *Journal*, but I am delighted to say they have agreed to serve another term.

Each *Annals* volume has its own Editorial Board. The papers presented here for publication in *Annals of Glaciology* Volume 36 are being expertly handled by co-Chief Editors, Charles F. Raymond and Cornelis J. van der Veen and their team of Scientific Editors.

We are continuing to explore improvements to, and electronic options for, our publications. We have been very pleased with the printing services of Page Brothers in Norwich and intend to move our *Journal* printing to them from Lochemdruk in Holland in the immediate future.

During the past year, we carried out an experiment with the Royal Society in the use of PDF files and the web for submitting and editing papers for the *Journal*. Although we will not be using the Royal Society's service, we do now accept the submission of papers to the *Journal* as PDF files and instructions for this are posted on our web site. Due to the different processing procedures and time scale, we do not plan to extend this to the *Annals* papers at the moment.

We have also been exploring options for placing both the *Journal* and *Annals* papers on the web. This would apply to some or all past volumes as well as all future issues. Discussions have taken place with Ingenta, the principal provider of this service in the UK with 10 year's experience. Ingenta has more than 185 partnerships with global academic publishers, societies and non-governmental agencies. It provides online access to more than 5400 journals and represents 8 out of the top 10 international publishers. Look forward to more progress on this front during the coming year.

As many of you noted, our web site was out of date for much of the past year. Unfortunately, our arrangements to solve this kept coming up short until Oliver Merrington stepped up and did an admirable job. We believe we now have a reliable webmaster. If the site fails to serve your needs, please continue to let us know.

As to future meetings, let me remind you of the excellent slate of upcoming symposia. Later this summer we will be hosting a second IGS meeting, this time on Physical and Mechanical Processes in Ice in Relation to Glacier and Ice-Sheet Modelling, in Chamonix-Mont Blanc, France. The response for this meeting has been excellent with 146 abstracts submitted and most planning to contribute papers for *Annals of Glaciology* Volume 37.

In 2003, we will sponsor the International Symposium on Snow and Avalanches in Davos, Switzerland, and co-sponsor the Seventh International Symposium on Antarctic Glaciology in Milan, Italy. In 2004, we will sponsor a meeting on Arctic Glaciology, probably in Geilo, Norway. At the moment, this is our only 2004 meeting. If you would like to organize a meeting that year on a topic that has not been covered recently, please consider submitting a proposal to Council. Alternatively, if you know of a meeting being held that year that might be suitable for an *Annals* volume, have the organizers contact the Secretary General to explore this option.

Since my last report to you, we have accepted an invitation from Yao Tandong of the Cold and Arid Regions Environmental and Engineering Research Institute to host an International Symposium on High-elevation Glaciers and Climate Records, to be held in Lanzhou, China, in 2005.

This is also an opportunity for me to express our thanks to Keith A. Echelmeyer and his local organizing team for all they have done to make this symposium such a success. Organization goes hand in hand with finances and we are grateful for the financial support of the U.S. National Science Foundation, NASA, the Geophysical Institute and the International Arctic Research Center of the University of Alaska Fairbanks, and the Arctic Research Consortium of the United States.

The topic of our next Secretary General is probably one you have been waiting for me to address. We are in the middle of receiving applications so there is little I am at liberty to tell you that you don't already know. A committee of distinguished members helped me organize the search process. The advertisements for Simon's successor are now out. If you did not receive one and my letter, you are not on our membership role and I'd like to see you immediately after the meeting ends. The competition closes at the end of June and an Appointments Committee made up of the IGS Executive and the Secretary General expects to complete the interviews promptly so their decision can be made in the latter half of this year, allowing for an extended overlap to ensure continuity of service to the Society.

Now the few final remarks I promised at the beginning of this address. Three years ago, I thought I knew the Society pretty well, having served as a member on Council, on other committees and on a number of Editorial Boards. I have learned so much more as President. Our Society is extremely healthy. It is rich in brilliant scientific minds and in exciting young talent. Our membership has grown nearly 20% over the past decade, especially among junior members. We have a steady stream of symposia with increasing attendance numbers, the *Annals* has achieved full status with the Science Citation Index® and more authors than ever are submitting to it. We have taken the *Journal* from three issues per year to four issues per year to reduce the time to publication.

Glaciology, in its full definition of the study of ice in all its forms, has risen within the scientific landscape and our Society with it. This growth and expansion has not proceeded without some growing pains. I have heard complaints that the themes of our symposia take too long to return to certain topics leaving some members feeling disconnected from the Society. I will share my joy at attending all IGS symposia during the past three years, the majority of which were outside my expertise. It was a very uplifting and educational experience and I recommend

you try it if at all possible. Alternatively, I will suggest you consider attending the combined AGU/EGS meeting next spring in Nice, France where Jonathan Bamber deserves high praise for producing a large number of sessions on an extremely broad set of glaciological topics at a single meeting. Don't let yourself get stuck in a narrow rut. Glaciology is a very broad subject.

Ultimately, the Society is under your control. It can be whatever you want it to be and will be whatever you allow it to be. It relies principally on volunteers, so I urge you to answer the call of your Society when it requests your involvement. I thank all of you who have served the Society over the past three years when I asked you to. This includes the members of the Nominations, Publications and Awards Committees as well as the ad-hoc Search Committee and those who have served, or are now serving, on Council.

For me, it is now time to move on to my position as Immediate Past President. The Nominations Committee had a very difficult time deciding on a single recommendation for our next President. I am very pleased with the choice of Liz Morris. I am proud to step aside with the Society in its present healthy condition and have every confidence that Liz will serve our Society well as its next President. I thank you for your continuing support of the Society and am most grateful for the experience of having been your President the past three years.

Thank you for your attention.

C.F. Raymond proposed, and M.F. Meier seconded, that the President's report be accepted. This was carried unanimously.

3. The Treasurer, Dr J.A. Heap, presented the following reported with the audited Financial Statements for the year ended 31 December 2001.

"The state of the Society's finances is best summarised by considering the changes from 31 December 2000 to 31 December 2001 in the following funds, as shown on page 13 of the accounts:

Seligman Fund: increased from £2220 to £7283 as a consequence of interest accrual and a bequest of £5000 from the Founder's widow, Loris Seligman;

Contingencies Fund: maintained at the same level of £12,684;

Annals Fund: increased from £68,846 to £93,937; reflecting normal variations in the account and a surplus from the Fairbanks meeting;

Publications Fund: increased from £21,092 to £21,825, as a consequence of sales, royalties and interest accrual;

Future Volumes: decreased from £53,709 to £22,378 reflecting lower amounts of advanced income received with respect to Annals 34 and Annals 35;

Accumulated Fund: increased from £201,913 to £265,482 (page 6) consequent upon a profit in that account for the year of £63,569 which included a loss of £956 in the value of investments due to an adjustment to market value (page 12, note 7). This reflects a modest increase in income over budget from the Society's core activities, a substantial reduction in expenditure due to staff vacancies, and unexpectedly good support for the sea-ice meeting in Alaska.

In 2001, the Society published 696 pages in the *Journal of Glaciology* and 972 pages in the *Annals of Glaciology*. In 2000, the figures were 716 for the *Journal* and 738 for the *Annals*, a year with two issues of the *Annals*. As I always note, the Society's publications are still very much dependent on the provision of page charges; the revenue still exceeds that derived from the total of members' dues. I wish to register once again the Society's warm thanks to all those authors who have been both able and ready to support the Society in this way.

May I, again, make a plea to all members of the Society to do all in their power to increase the membership. Although there has been a slight increase in membership we would very much like to reach a base of at least 1000 and there is some way to go. If you know of colleagues or students who are not members, please encourage them to join. I believe they will find it is extremely good value for money. Also, please ensure that libraries in any institutions in which you have influence either maintain their subscriptions or take one out."

H. Röthlisberger proposed, and M.M. Miller seconded, that the Treasurer's report be accepted. This was carried unanimously.

4. Election of auditors for 2002 accounts.
G.K.C. Clarke proposed, and M.F. Meier seconded, that Messrs Peters Elworthy and Moore of Cambridge be elected auditors for the 2002 accounts. This was carried unanimously.

5. Elections to Council. After circulation to all members of the Society of the Council's suggested list of nominees for 2002–2005, no further nominations were received, and the following members were therefore elected unanimously.

President:	E.M. Morris
Immediate Past President:	R.A. Bindschadler
Vice-Presidents:	R.B. Alley
	E. Brun
Elective Members:	J.O. Hagen
	N.R. Iverson
	S.J. Marshall
	J. Meyssonnier
	J.A. Richter-Menge

The appointments for E. Brun and J.O. Hagen were approved for 20002–2006 to restore the stagger and balance in the Council terms.

The AGM was adjourned on a motion from M.F. Meier, seconded by D. Trabant.

ANNALS OF GLACIOLOGY, VOLUME 35

The following papers from the International Symposium on Ice Cores and Climate, held in Kangerlussuaq, Greenland, 19–23 August 2001 have been accepted for publication in *Annals of Glaciology* Vol. 35, edited by E.W. Wolff:

J E Miller, J D W Kahl, F Heller and J M Harris
A three-dimensional residence-time analysis of potential summertime atmospheric transport to Summit, Greenland

I A Mogensen, S J Johnsen, A Ganoploski and S Rahmstorf
An investigation of rapid warm transitions during MIS2 and MIS3 using Greenland ice-core data and the CLIMBER-2 model

G W K Moore, K Alverson and G Holdsworth
Variability in the climate of the Pacific Ocean and North America as expressed in the Mount Logan ice core

D L Morse, D D Blankenship, E D Waddington and T A Neumann
A site for deep ice coring in West Antarctica: results from aerogeophysical surveys and thermo-kinematic modeling

R Mulvaney, H Oerter, D A Peel, W Graf, C Arrowsmith, E C Pasteur, B Knight, G C Littot and W D Miners
1000-year ice-core records from Berkner Island, Antarctic

F Nishio, T Furukawa, G Hashida, M Igarashi, T Kameda, M Kohno, H Motoyama, K Naoki, K Satow, K Suzuki, M Takata, Y Toyama, T Yamada and O Watanabe
Annual layer determinations and 167-year records of past climate of H72 ice core in East Dronning Maud Land, Antarctica

A S Palmer, V Morgan, M A J Curran, T D van Ommen and P A Mayewski
Antarctic volcanic flux ratios from Law Dome ice cores

V A Pohjola, T A Martma, H A J Meijer, J C Moore, E Isaksson, R Vaikmäe and R S W van de Wal
Reconstruction of 300 years annual accumulation rates based on the record of stable isotopes of water from Lomonosovfonna, Svalbard

M Proposito, S Becagli, E Castellano, O Flora, R Gragnani, B Stenni, R Traversi, R Udisti and M Frezzotti
Chemical and isotopic snow variability along the 1998 ITASE traverse from Terra Nova Bay to Dome C, East Antarctica

Qin Dahe, Hou Shugui, Zhang Dongqi, Ren Jiawen, Kang Shichang, P A Mayewski and C P Wake
Preliminary results from the chemical records of an 80.4 m ice core recovered from the East Rongbuk Glacier, Qomolangma (Mount Everest), Himalaya

S O Rasmussen, K K Andersen, M-L Siggaard-Andersen and H B Clausen
Extracting the annual signal from Greenland ice-core chemistry and isotopic records

N Reeh, H Oerter and H H Thomsen
Comparison between Greenland ice-margin and ice-core oxygen-18 records

R Röthlisberger, M A Hutterli, E W Wolff, R Mulvaney, H Fischer, M Bigler, K Goto-Azuma, M E Hansson, U Ruth, M-L Siggaard-Andersen and J P Steffensen
Nitrate in Greenland and Antarctic ice cores: a detailed description of post-depositional processes

U Ruth, D Wagenbach, M Bigler, J P Steffensen, R Röthlisberger and H Miller
High-resolution microparticle profiles at NorthGRIP, Greenland: case studies of the calcium–dust relationship

E Schlosser and H Oerter
Seasonal variations of accumulation and the isotope record in ice cores: a study with surface snow samples and firn cores from Neumayer station, Antarctica

E Schlosser and H Oerter
Shallow firn cores from Neumayer, Ekströmisen, Antarctica: a comparison of accumulation rates and stable-isotope ratios

W Schöner, I Auer, R Böhm, L Keck and D Wagenbach
Spatial representativity of air-temperature information from instrumental and ice-core-based records in the European Alps

T Shiraiwa, S Kohshima, R Uemura, N Yoshida, S Matoba, J Uetake and M A Godoi
High net accumulation rates at Campo de Hielo Patagónico Sur, South America, revealed by analysis of a 45.97 m long ice core

M-L Siggaard-Andersen, J P Steffensen and H Fischer
Lithium in Greenland ice cores measured by ion chromatography

J C Simões, J R Petit, R Souchez, V Ya Lipenkov, M de Angelis, Liu Leibao, J Jouzel and P Duval
Evidence of glacial flour in the deepest 89 m of the Vostok ice core

B T Smith, T D van Ommen and V I Morgan
Distribution of oxygen isotope ratios and snow accumulation rates in Wilhelm II Land, East Antarctica

B Stauffer, J Flückiger, E Monnin, J Schwander, J-M Barnola and J Chappellaz
Atmospheric CO_2, CH_4 and N_2O records over the past 60 000 years based on the comparison of different polar ice cores

E J Steig and R B Alley
Phase relationships between Antarctic and Greenland climate records

Sun Junying, Ren Jiawen and Qin Dahe
60 year record of biogenic sulfur from Lambert Glacier basin firn core, East Antarctica

S Suter and M Hoelzle
Cold firn in the Mont Blanc and Monte Rosa areas, European Alps: spatial distribution and statistical models

T Thorsteinsson and E D Waddington
Folding in strongly anisotropic layers near ice-sheet centers

R Traversi, S Becagli, E Castellano, A Migliori, M Severi and R Udisti
High resolution fast ion chromatography measurements of chloride, nitrate and sulphate along the EPICA Dome C ice core

R S W van de Wal, R Mulvaney, E Isaksson, J C Moore, J F Pinglot, V A Pohjola and M P A Thomassen
Reconstruction of the historical temperature trend from measurements in a medium-length borehole on the Lomonosovfonna plateau, Svalbard

R van Trigt, H A J Meijer, A E Sveinbjörnsdóttir, S J Johnsen and E R Th Kerstel
Measuring stable isotopes of hydrogen and oxygen in ice by means of laser spectrometry: the Bölling transition in the Dye-3 (South Greenland) ice core

J Vehviläinen, E Isaksson and J Moore
A 20th-century record of naphthalene in an ice core from Svalbard

V Verbeke, R Lorrain, S Johnsen and J-L Tison
A multiple step deformation history of basal ice from the Dye 3 (Greenland) core: new insights from the CO_2 and CH_4 content

E D Waddington, E J Steig and T A Neumann
Using characteristic times to assess whether stable isotopes in polar snow can be reversibly deposited

C P Wake, K Yalcin and N Gundestrup
The climate signal recorded in the oxygen-isotope, accumulation and major-ion time series from the Eclipse ice core, Yukon Territory, Canada

W Wang, R C Warner and W F Budd
Ice flow properties at Dome Summit South, Law Dome, East Antarctica

Y Wang, T Thorsteinsson, J Kipfstuhl, H Miller, D Dahl-Jensen and H Shoji
A vertical girdle fabric in the NorthGRIP deep ice core, North Greenland

Wang Ninglian, Yao Tandong, L G Thompson and M E Davis
Indian monsoon and North Atlantic Oscillation signals reflected by Cl^- and Na^+ in a shallow ice core from Dasuopu Glacier, Xixabangma, Himalaya

J Weertman
The Comninou–Dundurs effect and position stability of subglacial lakes

J Weiss, J Vidot, M Gay, L Arnaud, P Duval and J R Petit
Dome Concordia ice microstructure: impurities effect on grain growth

Yao Tandong, Duan Keqin, Xu Baiqing, Wang Ninglian, Pu Jianchen, Kang Shichang, Qin Xiang and L Thompson
Temperature and methane changes over the past 1000 years recorded in Dasuopu glacier (central Himalaya) ice core

C Zdanowicz, D A Fisher, I Clark and D Lacelle
An ice-marginal $\delta^{18}O$ record from Barnes Ice Cap, Baffin Island, Canada

IGS BRITISH BRANCH ANNUAL MEETING 2002

Department of Geography and Topographic Science, University of Glasgow, Scotland, U.K.
4–5 September 2002

SECOND CIRCULAR

The 27th annual meeting of the British Branch of the International Glaciological Society will be held at the Department of Geography and Topographic Science, University of Glasgow on Wednesday 4th and Thursday 5th September 2002.

Presentations are invited on all aspects of ice and snow research, in the form of either a short talk or poster. Time allocated for individual talks will be 15 minutes, plus 5 minutes for discussion. There will also be a session for shorter talks of 8 minutes, plus 2 minutes for discussion, for less formal presentations (e.g. by recently started postgraduate students or hot-off-the-press field results). The total number of talks will be restricted to ensure sufficient time for informal discussion and viewing of posters. Pin-boards will be provided for posters, which will be on display throughout the meeting. Delegates presenting posters will be required to give a two-minute "advertisement" for their

poster prior to the poster session. Awards for the best student poster and oral presentation will be made at the end of the meeting.

If you wish to give a talk or poster, an abstract should be submitted to igs2002@geog.gla.ac.uk as 1 side of A4 plain text or Microsoft Word or Rich Text Format attachment by 15th July 2002. Alternatively, abstracts can be submitted on a 3.5" disc with the registration form. A booklet of abstracts will be distributed at the meeting.

If you wish to attend the meeting, please check the web site, complete the registration form and return to the address given. Registration is £25 for waged and £15 for unwaged delegates, and includes morning and afternoon tea or coffee with biscuits, wine or beer and soft drinks during the poster session, and the booklet of abstracts. Please include your cheque covering registration, accommodation, the annual dinner and lunches as required. Cheques should be made payable to *University of Glasgow*.

Accommodation is available on Tuesday, Wednesday and Thursday nights in halls of residence a short walk from the Department. Cairncross House provides single rooms *without* breakfast for £14.00 per person; single *en suite* rooms, with coffee and pastry in the morning, are available at Queen Margaret Hall for £24.85 per person. Both halls of residence have self-catering facilities. We regret that there are no halls of residence providing a good, hearty fry up during the 'conference season'! A list of nearby hotels and B&Bs is available by emailing igs2002@geog.gla.ac.uk to assist those who prefer to arrange accommodation for themselves. A limited amount of floor space is available for postgraduates with sleeping bags who indicate this preference on the registration form.

Lunch is available on Wednesday and Thursday at a cost of £5.50 per day and includes sandwiches, fruit, cake, tea or coffee and juice. The annual dinner will be held at Mother India curry house, at a cost of £14.00 per person (drinks not included). Please indicate any dietary requirements on the registration form.

Updated details of the meeting will be posted at http://www.geog.gla.ac.uk/igs2002. Registration will take place at 10.00–10.45 am on Wednesday 4th September, with the first oral session provisionally starting at 11.00 am. The final session will be timed to finish no later than 4.30 pm on Thursday 5th.

Potential delegates are invited to attend the Glacial Landsystems Working Group (GLWG) meeting near Glasgow (looking at field sites in the vicinity of Loch Lomond) on Monday 2nd and Tuesday 3rd September 2002. See http://www.geog.gla.ac.uk/~swilson/glwg for further details.

Darrel Swift & Pete Nienow (British Branch Meeting)
Department of Geography and Topographic Science
University of Glasgow, Glasgow G12 8QQ
(igs2002@geog.gla.ac.uk)

IGS NORDIC BRANCH ANNUAL MEETING 2002

Studenterhytta, near Oslo, 7–9 November 2002

The next IGS Nordic Branch meeting will be held at Studenterhytta, a conference centre in the middle forest, north of Oslo, from 7–9 November 2002. The meeting will be hosted by the Norwegian Water and Energy Administration (NVE) and the Department of Physical Geography, University of Oslo.

The format of these Nordic meetings is strictly informal: no abstracts or publications. Presentations/ discussions are usually in English, but any Scandinavian language will be welcomed. The emphasis is on exchange of ideas and furthering cooperation within the glaciological community in the Nordic countries. Researchers from outside the Nordic countries are encouraged to attend.

For more detailed information check:
http://www.geografi.uio.no/forskning/igs/

Gaute Lappegard (gaute.lappegard@geografi.uio.no)

IGS STAFF CHANGES

The IGS has appointed Timothy Labrum as its new Production Manager. He started work in the Cambridge office at the beginning of July. He is a graduate of the University of Edinburgh (MA Geography). Previously, he spent three years with the Royal Geographical Society (with IBG) where he worked as an Administrative/Publications Assistant in the Expedition Advisory Centre before moving on to become their Grants Co-ordinator. Most recently, he took time off to work on a glacial-geomorphological project in East Antarctica under the auspices of the Australian Antarctic Division.

REFEREE RECOGNITION

The Editors of the *Journal of Glaciology* and the IGS wish to express their appreciation to the following referees who provided particularly insightful or helpful reviews during 2001: C.R. Bentley, P. Huybrechts, J. Kohler, S.F. Price, J.-L. Tison, D.G. Vaughan and E.D. Waddington.

YAKUTAT SYMPOSIUM ON FAST GLACIER FLOW

Opening address by Robert A. Bindschadler, President of the IGS

Yakutat, Alaska, U.S.A., 10 June 2002

As President of the International Glaciological Society, I have the honor of being the first to welcome you officially to the International Symposium on Fast Glacier Flow. My interest in this meeting's theme extends far beyond my present role with the IGS. For me, being here is a homecoming. I began my glaciological field training right here and in the nearby mountains, studying the quiescent phase of Variegated Glacier. My summers as a graduate student in the 1970s included many hours pacing the Yakutat runway waiting for the infamous coastal Alaskan weather to clear, avoiding torrential downpours in the airport hanger and dodging the local FAA authorities who told us we couldn't use the airport hanger to stay dry. Like most of you, I have chosen to continue in the field of investigating fast glacier flow and am absolutely delighted to be back here again in Yakutat.

I also expect that most of you are extremely familiar with Stan Paterson's book *The Physics of Glaciers*. The first edition of this landmark text in glaciology contains only one photographic plate. On one side is a black and white aerial photograph of Variegated Glacier in 1964. On the other side is a photograph taken one year later, after the glacier had surged. That single startling visual comparison is enough to present the reader with the compelling mysteries embodied in glaciology.

It is the pursuit of solving the mysteries of fast glacier flow that brings us together in this rustic corner of maritime Alaska. Whether it is surging glaciers, outlet glaciers or ice streams, the topic is equally fascinating and appears repeatedly in our conference history. In 1968, glaciologists met in Saint-Hilaire, Quebec for the "Seminar on the Causes and Mechanics of Glacier Surges". The following decade, it was the "International Workshop on the Dynamics of Glacier Variations and Surges" in 1976 at Alma Ata, in the U.S.S.R. Again, it was ten years later that many of us met at the Chapman Conference on Fast Glacier Flow at Whistler, British Columbia, in 1986. Each of these meetings is a milestone in the study of rapid ice movement and I fully expect that volume 36 of the *Annals of Glaciology*, filled with your papers presented this week, will prove equally valuable to our research.

Looking at this week's program, we will collectively take a wide-ranging look at the topic of fast glacier flow. We begin by addressing surging glaciers, then move to outlet glaciers and close with ice streams. There will also be talks on more "normal" glaciers and on areas where ice once was but is no longer, because both topics afford us additional insight into mechanisms of fast ice flow.

All this would surely be enough to make this conference successful, but there will be more. Twice during this week we have the pleasure of honoring fellow scientists who have been leaders in our discipline. By happy coincidence, their continuing contributions have been central to the study of fast glacier flow. On Tuesday evening, the Seligman Crystal will be presented to Garry Clarke, who, among many topics, addressed the surging behavior of Trapridge Glacier, located just over the mountains to the north. Then, on Thursday evening at our banquet, we will present another Seligman Crystal to Geoffrey Boulton whose compelling research forced us to recognize that the character of subglacial till had much to do with the dynamics of rapidly moving ice. Knowing the entertaining speaking styles of these two distinguished scientists, both ceremonies are well worth attending and I'm sure their lectures will be very germane to this week's theme.

Finally, we cannot take for granted the organization required to put on scientific meetings such as these. As with every IGS symposium, the idea is brought to Council years in advance. This meeting was Keith Echelmeyer's vision. To hold the meeting in a remote location like Yakutat only added to the organizational challenge, but I have never known Keith shirk a challenge just because others see it as too hard. Once again, Keith and the supporting members of the organizing committee, most especially Mary Farrell, have proven that the difficult can be accomplished. I feel confident that we will find the facilities more than adequate and that being surrounded by beautiful scenery and many examples of sustained and episodic fast glaciers will enhance our discussions this week.

Our papers are being handled by an excellent Editorial Board led by the Chief Editors Charlie Raymond and Kees van der Veen. Charlie will speak to us soon and introduce the other Scientific Editors.

All the previous persons are volunteers. The IGS pays Simon Ommanney to oversee the organization and papers, but he is not paid nearly enough for the amount of work required to make these meetings, and the timely publication of the *Annals*, run so smoothly.

Having thanked all these people for their efforts on behalf of the Society. I must also thank you for being here. I think you will find that your attendance will be its own reward. We are about to have one fantastic week discussing the mysteries of fast glacier flow.

Thank you for your attention.

Robert A. Bindschadler

JOURNAL OF GLACIOLOGY

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

S A Arcone
Airborne-radar stratigraphy and electrical structure of temperate firn: Bagley Ice Field, Alaska, U.S.A

J Bamber and E Rignot
Unsteady flow inferred for Thwaites Glacier, and comparison with Pine Island Glacier, West Antarctica

B Cheng
On the numerical resolution in a thermodynamic sea ice model

B Cheng and T Vihma
Modelling of sea ice thermodynamics and air–ice coupling during warm-air advection

M S de Ruyter de Wildt and J Oerlemans
A method for monitoring glacier mass balance using satellite albedo measurements: application to Vatnajökull (Iceland)

D R Fatland and C S Lingle
InSAR observations of the 1993–95 Bering Glacier surge (Alaska) and a surge hypothesis

B Goodsell, M J Hambrey and N F Glasser
Formation of band ogives and associated structures at Bas Glacier d'Arolla, Valais, Switzerland

R L Hawley, E D Waddington, D L Morse, N W Dunbar and G A Zielinski
Dating firn cores by vertical strain measurements

Kang Shichang, Qin Dahe, P A Mayewski, S B Sneed and Yao Tandong
Correspondence. Chemical composition of fresh snow on Xixabangma peak, central Himalaya, during the summer monsoon season

P G Knight, R I Waller, C J Patterson, A P Jones and Z P Robinson
Discharge of debris from ice at the margin of the Greenland ice sheet

M Lüthi, M Funk, A Iken, S Gogineni and M Truffer
Mechanisms of fast flow in Jakobshavn Isbræ, Greenland. Part III. Measurements of ice deformation, temperature and cross-borehole conductivity in boreholes to the bedrock

C C Lundy, M Q Edens and R L Brown
Measurement of snow density and microstructure using computed tomography

D Mair, M Sharp and I Willis
Evidence for basal cavity opening from analysis of surface uplift during a high-velocity event: Haut Glacier d'Arolla, Switzerland

J S Munroe and D M Mickelson
Reconstruction of latest Pleistocene alpine glacier equilibrium line altitudes and paleoclimate, northern Uinta Mountains, northeastern Utah, U.S.A

F Ng and B Hallet
Patterning mechanisms in subglacial carbonate dissolution and deposition

G A Oldenborger, G K C Clarke and D H D Hildes
Hydrochemical coupling of a glacial borehole–aquifer system

A Pälli, J Kohler, E Isaksson, J Moore, J Pinglot, V Pohjola and H Samuelsson
Spatial and temporal variability of snow accumulation using ground-penetrating radar and ice cores on a Svalbard glacier

B T Rabus and K A Echelmeyer
Increase of 10 m ice temperature — climate warming or glacier thinning?

B T Rabus and O Lang
On the representation of ice shelf grounding zones in SAR-interferograms

E Rignot
Ice-shelf changes in Pine Island Bay, Antarctica, 1947–2000

C Schoof
Basal perturbations under ice streams: form drag and surface expression

J-L Tison, C Haas, M M Gowing, S Sleewaegen and A Bernard
Tank study of physico-chemical controls on gas content and composition during growth of young sea ice

J M Whitehead and B C McKelvey
Cenozoic glacigene sedimentation and erosion at the Menzies Range, southern Prince Charles Mountains, Antarctica

M A Zumberge, D H Elsberg, W D Harrison, E Husmann, J L Morack, E C Pettit and E D Waddington
Measurement of vertical strain and velocity at Siple Dome, Antarctica, with optical sensors

H J Zwally and Li Jun
Seasonal and interannual variations of firn densification and ice sheet surface elevation at the Summit of Greenland

NEWS

CRYOLIST

The old list server, run through the Geology Department of The Ohio State University for the benefit of our community, and called IGS, has now been superceded by CRYOLIST. This e-mail discussion list, sponsored by the U.S. National Snow and Ice Data Center, is open to anyone with an interest in glaciology. To subscribe, e-mail from the address from which you wish to post to <listproc@lists.colorado.edu> with "subscribe cryolist <full name>" (e.g. subscribe cryolist A.N. Other) in the body of your message. You will receive a confirmation message to which you must reply. You will then receive a message containing all the information you need to use the list.

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There are far more options, settings, and niceties about ListProcessor™ and we encourage you to explore all of them: HELP should be your starting point.

Todd Albert

MASS BALANCE OF MOUNTAIN AND SUBPOLAR GLACIERS

Mark Dyurgerov, the author, and editors, Mark Meier and Richard Armstrong (NSIDC), have recently released the most complete glacier regime dataset for worldwide mountain and subpolar glaciers as INSTAAR Occasional Paper No. 55 (Dyurgerov, M., 2002, Glacier mass balance and regime: data of measurements and analysis, 268 pp. http://instaar.colorado.edu/other/pdf_documents.html).

This is the most complete dataset of parameters on the glacier regime yet compiled and published. Data presented in appendixes include annual mass balances and related variables of mountain and subpolar glaciers outside the two major ice sheets. All available sources of information, such as publications, archived data and personal communications have been collected and include time-series of about 280 glaciers. Only observational data have been used for the period since the start of measurements in 1945/46 up to 1998. Data have been digitized, quality checked and all errors found were eliminated. The analyses of data, errors, comparison of methods, and application of the results to different fields are also included.

Mark Dyurgerov (dyurg@tintin.colorado.edu)

BOOKS RECEIVED

R B Alley and R A Bindschadler, *eds.* 2001. *The West Antarctic ice sheet: behavior and environment.* Washington, DC, American Geophysical Union. (Antarctic Research Series 77.)

J Bischof. 2000. *Ice drift, ocean circulation and climate change.* Berlin, etc., Springer-Verlag; Praxis Publishing. (ISBN 1-85233-648-X, DM210/GBP70/US$105)

N Davis. 2001. *Permafrost: a guide to frozen ground in transition.* Fairbanks, AK, University of Alaska Press. (ISBN 1-889963-19-4 (cloth), US$35.95)

E R Herren, M Hoelzle and M Maisch. 1999. *The Swiss glaciers, 1997/98 and 1998/99.* Zürich, Swiss Academy of Sciences. Glaciological Commission; Federal Institute of Technology. Laboratory of Hydraulics, Hydrology and Glaciology. (Glaciological Report No. 119/120.)

M P Lüthi. 2000. Rheology of cold firn and dynamics of a polythermal ice stream Studies on Colle Gnifetti and Jakobshavns Isbræ. *Eidg. Tech. Hochschule, Zürich. Versuchsanst. Wasserbau, Hydrol. Glaziol. Mitt.* 165, 212 pp.

N D Mulherin, W B Tucker, III, O P Smith and W J Lee. 2001. Marine ice atlas for Cook Inlet, Alaska. *EDRC/CRREL Tech. Rep.* 01-10, 145 pp.

K Okamoto, *ed.* 2001. *Global environment remote sensing.* Tokyo, Ohmsha Ltd. and IOS Press. (Wave Summit Course.)

M J Siegert. 2001. *Ice sheets and late Quaternary environmental change.* Chichester, etc., John Wiley and Sons Ltd. (ISBN 0471-98569-4 Hardback £60; ISBN 0471-98570-8 Paperback £19.99)

FUTURE MEETINGS (of other organizations)

7TH INTERNATIONAL SYMPOSIUM ON ANTARCTIC GLACIOLOGY

Milan, Italy, 25–29 August 2003

SPONSORED BY
Scientific Committee on Antarctic Research (SCAR)

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International Glaciological Society
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Italian Antarctic Programme
Italian Glaciological Committee

FIRST CIRCULAR

The Seventh International Symposium on Antarctic Glaciology will take place from 25 to 29 August 2003 at the University of Milano–Bicocca, Italy. The symposium is organised by the SCAR Working Group on Glaciology, with local arrangements undertaken by a committee from the Italian Antarctic Research Program.

THEME AND PLACE
Topics will cover all major areas of scientific and technical study related to Antarctic ice. There will be special emphases on studies that require intensified and co-ordinated research, such as ice–ocean–atmosphere interactions, ice-sheet mass balance, ice-sheet dynamics, subglacial lakes, and palaeoclimate studies from ice cores. Other topics, e.g. related to Antarctic glaciers, permafrost and sea ice will also be included. A program of oral and poster presentations, working-group meetings, public presentations and evening events is foreseen. SCAR-GLOCHANT programs such as ISMASS, ITASE, PICE and ASPECT will receive particular attention. The conference centre at the University of Milano–Bicocca is half-an-hour from the city centre and Milano is well served by international traffic.

SUBMISSION AND PUBLICATION OF PAPERS
The proceedings of the symposium will be published by the International Glaciological Society as a volume of the Annals of Glaciology. Details and deadlines for submission of abstracts, selection of papers and publication of papers will be given in the second circular. All submitted papers (from any oral or poster session) 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, and possibly other accommodation, will be available.

SYMPOSIUM ORGANIZATION
Giuseppe Orombelli (SCAR Glaciology Working Group) in association with Simon L. Ommanney (IGS)

EDITORIAL BOARD
Jo Jacka (Chief Editor)

LOCAL COMMITTEE
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FURTHER INFORMATION
If you wish to attend the symposium, please return the form below as soon as possible: by Fax ([39](02)64-48-28-95) or email (isag7@unimib.it).

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.

7th SYMPOSIUM ON ANTARCTIC GLACIOLOGY

Milan, Italy, 25–29 August 2003

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I hope to participate in the Symposium ☐

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My abstract will be most closely related to the following topic(s): _____

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Editor: C.S.L. Ommanney (Secretary General)
Assisted by T. Labrum

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