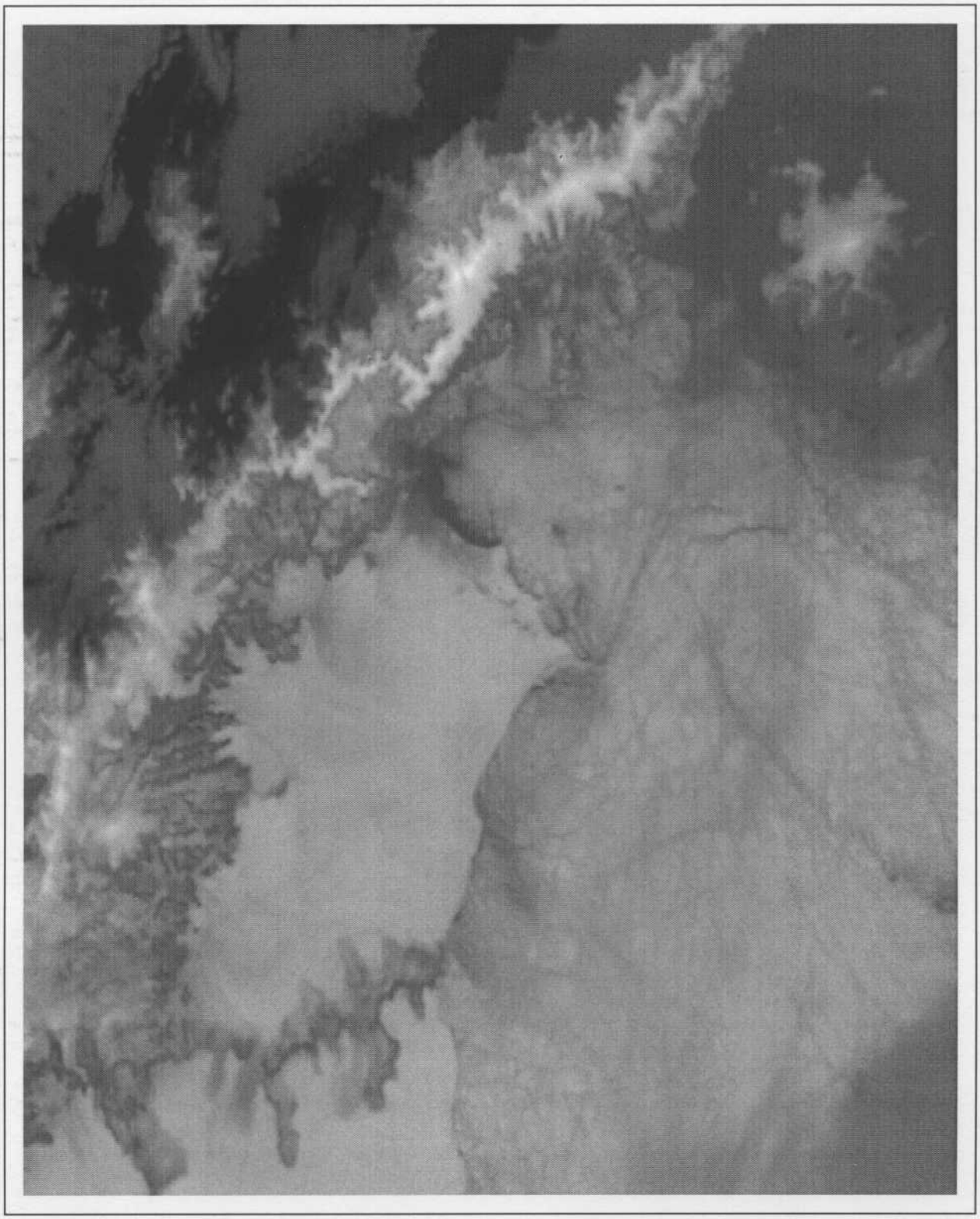
NATIONAL SNOW AND ICE DATA CENTER
WORLD DATA CENTER-A FOR GLACIOLOGY



Annual Report ——— 1998

Cover: "This image, dated March 23, 1998, shows the Larsen B Ice Shelf in West Antarctica in the early stages of an ongoing breakup. The notch in the northern half of the shelf front indicates a retreat past the point where it is stable."

National Snow and Ice Data Center
World Data Center-A for Glaciology (Snow and Ice)
CIRES, Box 449
University of Colorado
Boulder, Colorado 80309-0449
U.S.A.
Telephone: (303) 492-6199
FAX: (303) 492-2468
E-mail: nsidc@kryos.colorado.edu
URL: http://www-nsidc.coloardo.edu

Operated for:
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Satellite, Data, and Information Service
National Geophysical Data Center
Boulder, Colorado 80303
U.S.A.

Annual Report

1998

National Snow and Ice Data Center
World Data Center-A for Glaciology

TABLE OF CONTENTS

NATIONAL SNOW AND ICE DATA CENTER/ WORLD DATA CENTER-A FOR GLACIOLOGY

ANNUAL REPORT FY 1997-1998

INTRODUCTION

The National Snow and Ice Data Center (NSIDC)/World Data Center-A for Glaciology (WDC) is operated under a cooperative agreement between the University of Colorado, Cooperative Institute for Research in Environmental Sciences (CIRES), Environmental Research Laboratories (ERL) of National Ocean and Atmospheric Administration (NOAA). Within CIRES, NSIDC/WDC is a major part of the Cryospheric and Polar Processes division. NSIDC/WDC is completing its twenty-first year of service to the snow and ice research community from its Boulder location.

NSIDC/WDC is committed to make fundamental contributions to cryospheric science and to excel in managing data and disseminating information to advance understanding of the Earth system. The role of the NSIDC/WDC is to acquire, archive and disseminate data relating to all forms of snow and ice, within the context of the ICSU guidelines for international data exchange (ICSU, 1987) and NOAA's mission. Complementing these data management activities, NSIDC carries on an active research program. Scientists are involved in both data management and application of the data to research endeavors.

NSIDC/WDC-A is funded by grants and contracts from various federal agencies, including NOAA, the National Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF).

HIGHLIGHTS

Circumpolar Active Layer and Permafrost System (CAPS) CD-ROM

Permafrost is ground (soil, sediment or rock) that remains at or below 0°C for at least two years, occurs both on land and beneath offshore arctic continental shelves, ranges in thickness from less than 1 meter to more than 1000 meters, and underlies upwards of 25% of the Earth's surface.

The CAPS CD-ROM is the first-ever compilation of permafrost and related data and metadata with a truly global perspective. The CD was produced for the International Permafrost Association's Data and Information Working Group by the NSIDC with funding from NOAA/NESDIS, NSF, and IPA. It was presented at the 7th International Permafrost Conference in Yellowknife, Northwest Territories, 22-26 June 1998. CAPS is the culmination of five years of work identifying and organizing selected sets of permafrost data and making them available to the international science and engineering communities, together with educators and policy-makers.

The major contents of the CAPS CD are:

- 56 selected data sets and 7 information sets of representative active- layer and borehole temperature profiles from IPA members;
- digital ARCINFO version of the IPA map of northern hemisphere permafrost, and maps for Alaska and Switzerland in GIF and GIS format;
- 12-language permafrost glossary;
- cumulative bibliography with search tool;
- index of more than 700 Russian permafrost maps.

All the data sets are accessable through an HTML interface.

A description ("DIF") of the CAPS CD was delivered to the Global Change Master Directory (GCMD), with cross-listings in other arctic directories. (The CAPS CD is available at NSIDC: www_nsidc.colorado.edu. The IPA web site also provides online access to the GGD and selected data and information products (www.soton.ac.uk/ipa).

Over 300 copies of the CD have been distributed. It is available on request as long as supplies last. An update is planned when resources become available.

Retreat of an Antarctic Ice Shelf

Monitoring of the Larson B ice shelf with AVHRR images from the NOAA polar orbiting satellites revealed that a significant portion of the Larsen B shelf had disintegrated in late February 1998. Modeling studies indicate that the ice shelf is now probably unstable with respect to further breakup over the next one or two warm seasons. The total area of the Larsen B is about 11,000 square kilometers (a bit smaller than Connecticut), by far the largest ice shelf in the Peninsula to be threatened to date. The ice shelf is apparently responding to a distinct warming trend in the area, as recorded by several Antarctic bases in the region since the 1940's, and as indicated by reduced sea ice concentration to the west of the Peninsula. News organizations from around the world ran stories on this very visible response to a

warming trend. Annotated AVHRR images showing the changes in the shelf can be seen at: http://www-nsidc.colorado.edu/NSIDC/LARSEN/larsenb.html.

NSIDC SSM/I Data Makes Cover of Annals of Glaciology

A color image of sea ice motion created by Mr. T. Agnew, Atmospheric Environment Service, Canada and derived from 85 GHz SSM/I data produced by the National Snow and Ice Data Center made the cover of Volume 25 Annals of Glaciology. This copy of the Annals, a publication of the International Glaciological Society, includes the proceedings of the International Symposium on Representation of the Cryosphere in Climate and Hydrological Models, August 1996.

Greenland Summit Ice Cores

From 1989 to 1994, the U.S. and European scientific communities supported a bold undertaking to acquire an extensive paleoclimate record for the Northern Hemisphere. These efforts, termed the Greenland Ice Core Project (GRIP) and Greenland Ice Sheet Project Two (GISP2), acquired deep ice cores from on and near the Greenland summit. The GISP2 (US) site was located at 72° 36' N, 38° 30' W. The GRIP (European) site was located at 72° 35' N, 37° 38' W. A wide range of environmental and physical parameters were recorded from the cores. The data types are listed below:

- Air Mass Trajectories (GISP2)
- Chemistry (GISP2, GRIP)
- Climatological Data (GISP2)
- Cosmogenic Isotopes (GISP2)
- Dust (GISP2)
- Electrical Conductivity (GISP2, GRIP)
- Gas Concentrations in Air Bubbles (GISP2, GRIP)
- Physical Properties and Ice Core Stratigraphy (GISP2, GRIP)
- Stable Isotopes (GISP2, GRIP)
- Time scales (GISP2, GRIP)

A Special Issue of the Journal of Geophysical Research (Vol. 102, Number C12, November, 1997) on the Greenland Summit Ice Cores was published on the research carried out by both GISP2 and GRIP investigators. A CD-ROM was produced at NSIDC in conjunction with this Special Issue containing all of the GISP2 and GRIP data and information. The web interface, search engine, and analysis tools (PaleoVu) provided on the CD-ROM assist the investigator in acquiring the data and information needed. The CD-ROM was produced in cooperation with the GISP2 Science Management Office (SMO) at the University of New Hampshire, the World Data Center A (WDC-A) for Paleoclimatology at NOAA-NGDC (the US point of contact for the GRIP data), and the International Ice Core Data Cooperative at the University of Colorado.

Arctic Data from Submarines

The Arctic System Science Data Coordination Center (ARCSS) at NSIDC has been asked to archive data acquired from the Submarine Science Experiment (SCICEX). The U.S. Navy has granted the scientific community the use of Sturgeon class submarines to acquire information about the Arctic Ocean and Arctic sea ice. As the submarines track through the

Arctic, scientists are able to sample the salinity, oxygen content and temperature of the ocean quickly and with unprecedented sampling density. Recent studies suggesting the presence of a warm pool of arctic water give data collected by submarine increased importance.

NEW PRODUCTS

Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I Passive Microwave Data

These sea ice concentration data in the polar stereographic projection are derived from Nimbus-7 SMMR and DMSP SSM/I F8, F11, and F13 daily brightness temperatures at a cell grid size of 25 X 25 kilometers. The data set includes daily and monthly averaged sea ice concentrations beginning October 1978 and continuing through December 1996. The data, available on CD-ROM, include GIF browse files for both daily and monthly products, north and south polar grid pixel areas, latitude and longitude grids, IDL and Matlab software, and DOS and Mac .GIF viewers.

Efforts supporting the polar stereographic-grid SSM/I products included generation of new, value-added products that allow users to quickly observe key changes in ice conditions, and which reduce some of the limitations of the standard data sets. The new products include plots and tables of ice extent, statistics on frequency of ice coverage, movie loops of monthly mean ice concentrations, and ocean masks designed to help reduce spurious ice concentrations in open ocean areas. Work also continues to document sources of biases and error in the sea ice time series, including summarizing differences between satellites, and effects of atmospheric conditions, snowcover, and sensor viewing angle.

DMSP SSM/I Pathfinder Daily EASE-Grid Brightness Temperatures

The DMSP SSM/I Pathfinder Daily EASE-Grid Brightness Temperatures data set consists of three series, one each for the EASE-Grid Northern Hemisphere, Southern Hemisphere and Global projections. Processing is ongoing. Data from the F8 platform are available on CD-ROM and data from F11 and F13 will be available in early 1999.

SEASAT and GEOSAT Altimetry Data for the Antarctic and Greenland Ice Sheets

The Ice Altimetry System (IAS) CD-ROM contains surface elevations of the Antarctic and Greenland ice sheets derived from SEASAT and GEOSAT radar altimetry data. The SEASAT data were collected for a continuous 90 days in 1978, at latitudes between 72°S and 72°N. GEOSAT was launched in 1985 and placed in a nearly identical orbit to SEASAT, also at latitudes of between 72°S and 72°N. These data were acquired between April 1985 and September 1986.

The data are height profile Level 3 data and gridded height Level 4 data provided by the Oceans and Ice branch of the Laboratory for Hydrospheric Physics of Goddard Space Flight Center. Elevations from the full data rate (i.e., one measurement every 662.5 m) are provided in georeferenced databases. These elevations are relative to the WGS-84 ellipsoid. Gridded elevations at 10-km and 20-km spacing are provided in the gridded data sets created from the GEOSAT and Seasat data, respectively. IAS software to extract and browse subsets of these

data is included on the CD-ROM; it also allows the user to view contours created from the gridded data and groundtracks of the full-rate data.

Historical Arctic Rawinsonde Archive

Historical Arctic Rawinsonde Archive (HARA) on five CD-ROMs contains millions of vertical soundings (temperature, pressure, humidity, and wind) taken from all available rawinsonde ascents from Arctic land stations poleward of 65°N. HARA includes soundings from the beginning of the record (1947) and has recently been updated through mid-1996. HARA documentation is available on CD-ROM and in hard copy (NSIDC Special Report 2, 1992). CD-ROMs contain software (Fortran and C) for retrieval of data subsets.

NCEP/NCAR Arctic Marine Rawinsonde Archive

NCEP/NCAR Arctic Marine Rawinsonde Archive, available via ftp from NSIDC, contains 17,659 marine rawinsonde reports for the region north of 65°N. Its record extends from 1976 to 1996. These soundings have been extracted from the National Center for Atmospheric Research (NCAR) rawinsonde archive of the National Meteorological Center (NMC) (now the National Center for Environmental Prediction, or NCEP). The NCEP/NCAR Arctic Marine Rawinsonde Archive data set complements the Historical Arctic Rawinsonde Archive (HARA) for land stations and the Russian "North Pole" drifting station archive.

Central Asian Snow Cover from Hydrometeorological Surveys

The Central Asian Snow Cover from Hydrometeorological Surveys data are based upon field observations made throughout three river basins: the Amu Darya, Sir Darya, and Naryn. These observations include end of month snow depth, snow density and snow water equivalent for snow points from the ground. Only snow depth is included for additional snow points measured at stakes from the air. Temporal coverage varies for each snow point, with the longest station record extending from 1932 through 1990. Data were provided to NSIDC by the former Central Asian Hydrometeorological Research Institute (Russian acronym SANIGMI) in Tashkent, Uzbekistan.

U.S.-Russian Arctic Atlases on CD-ROM

In 1997, Vice President Gore announced a new Arctic atlas in a press conference at the National Geographic Society. This atlas on CD-ROM contains fields of winter ocean temperature and salinity compiled from data including over a million classified observations by the Russian and U.S. Navies. The atlas is the result of the work of the Joint Commission's Environmental Working Group (EWG) Subgroup on Arctic Climatology. NOAA Director Dr. James Baker co-chairs the EWG with a Russian counterpart. Since the release of the first, precedent-setting atlas, an additional atlas on summertime Arctic oceanography has been produced, and Arctic sea ice and meteorology atlases are being planned by Russian and U.S. scientists. The National Snow and Ice Data Center is distributing the atlases. The first oceanography atlas can be viewed on-line at http://ns.noaa.gov/atlas/

Former Soviet Union Monthly Precipitation Archive, 1891-1993

This archive, compiled by P. Groisman of the University of Massachusetts, consists of monthly totals of precipitation measurements from 622 stations in the Former Soviet Union. The data collection environment and frequency of daily data collection varied from station to station. Two types of rain gauges were used to collect precipitation: Tretiyakov and Nipher-shielded. Corrections have been made to account for resulting variations. Corrections have also been made for winds and wetting losses. The data, in ASCII format, are divided into three files. The first file contains the precipitation data. The second file contains the station positions, elevation, and names. The third file contains the correction factors used to adjust the precipitation data. All three files are available via ftp.

ARCSS New Products:

Ecosystem Carbon Fluxes, Toolik Lake, Alaska, 1995

Carbon Dioxide information was collected at the Toolik Lake Field Station during the summer of 1995. Included are the following parameters: Julian day, treatment, set, plot, PAR, air temperature and CO_2 exchange. Each random 1.5m x 1.5m plot was analyzed every four hours or less frequently, depending on rainfall delays. Snow was removed from the plots on 3 May and 12 May with subsequent soil heating occurring on 12 May. A Li-Cor 6200 portable gas exchange system was used to measure CO_2 flux.

Methane Flux Data, Alaska North Slope 1994-1995

Methane fluxes were collected at Happy Valley and Toolik Lake ARCSS/LAII study sites during summers in 1994 and 1995. Air and soil temperatures were also collected in conjunction with the methane measurements. The data were collected at varied times during the field season, from every other day to weekly. Water table manipulations were also done to determine the sensitivity of the wet tundra methane and carbon dioxide fluxes to changes in the water table.

Output Data from LAII-BATS ARCSyM Model Run

Gridded output information from the ARCSyM limited area climate model run are available. Most of the grids are 15x15 grid points centered at 69° N, 149°8' W, with 20 km grid resolution, with some as 70x40 grids centered on 68° N and 152° W, with 20 km grid resolution. Model variables include all standard climatological parameters at 23 tropospheric levels (e.g. temperature, u and v wind components, pressure, available moisture, etc.).

Active Layer Depth & Snow Depth, Kuparuk Basin, 1995

Active layer and snow depths were measured on 1 km x 1 km grids within the Kuparuk Basin, Alaska, at various times throughout the summer of 1995. The parameters were measured at 121 surveyed grid nodes spaced at 100 meters at the following locations: Atqasuk, Barrow, Betty Pingo, Happy Valley, Imnavait Creek, Toolik Lake and West Dock.

Thaw Depth and Thawing Degree-Day Data, North Slope, Alaska, 1995

Temperatures and thaw depth were collected from the North Slope, Alaska during the summer of 1995. Air temperatures were recorded every 15 minutes from 10 study plots on a

transect from Prudhoe Bay to Toolik Lake and at site adjacent to the airport runway at Deadhorse. Daily means were calculated and degree days were derived as the sum of temperature deviations above and below 0°C.

Thaw depth data were collected on several dates for each of the 1 km x 1 km ARCSS/LAII study grids on the North Slope. Field procedures involved making two measurements at each of the 121 stakes using a rigid steel rod calibrated in 1 cm increments: data values are the average of these two measurements. The following locations were probed at the following times: Atqasuk (18 July; 04 August; 30 August), Barrow (01 July, 17 July, 02 August, 27August), Betty Pingo (13 July, 30 July, 23 August), Happy Valley (08 July, 26 July, 19 August), Imnavait Creek (05 July, 25 July, 20 August), Toolik Lake (07 July 22 July, 13 August) and West Dock (14 July, 29 July, 24 August).

Soil Temperatures, Toolik Lake, Alaska, 1995

Soil temperatures were collected at the Toolik Lake Field Station during the summer of 1995. Included are the following parameters: Julian day, hour of day, control temperature (°C), extended season temperature (°C) and extended season plus heating temperature (°C). Each random 1.5m x 1.5m plot was analyzed once per minute with one thermocouple per plot located intertussock at 5 cm soil depth. The data are stored as hourly averages from Julian day 126 to 247. Two Campbell 21X microloggers were used to maintain a level of measurement precision at 0.1°C.

Canopy Foliage Area Index, Toolik Lake, Alaska, 1995

Leaf Area Index (LAI) information was collected at the Toolik Lake Field Station during the summer of 1995 using a Li-Cor LAI-2000. Included are the following parameters: Julian day, treatment, plot number, sample size, mean LAI (m^2/m^2) and standard deviation. Each random 1.5m x 1.5m plot was analyzed 5 times over the growing season. Snow was removed from the plots on 03 May and 12 May with subsequent soil heating occurring on 12 May.

ARCSS Educational CD-ROM

In cooperation with the Greenland Ice Sheet Project 2 (GISP2) Science Management Office (SMO) at the University of New Hampshire, a CD-ROM for classroom use was created at NSIDC. The CD-ROM (Into the Arctic: Information and Educational Activities for Studying Climate) was inspired by the compilation and research results from GISP2 and contains information, data, graphics, activities, and a glossary designed for use by teachers and students. Many other sources of data and information are included on this CD-ROM in addition to the data and information from the GISP2 project.

WEB DEVELOPMENT

In addition to announcing 16 new or substantially updated products in our on-line data catalog, NSIDC released two new products on the World Wide Web: each is designed to meet the information needs of lay audiences. Our new Avalanche Awareness web pages (January 1998) answer basic science and safety questions about avalanches and direct users to additional resources. The new Snow on the Web pages (March 1998) refer users to a variety of web sites offering general information about snow, including links to sites addressing El

Niño and snowfall, sites presenting winter storm safety information, and sites offering winter recreation information. The Data Center also used the World Wide Web to announce the detection in February 1998 of an apparent breakup occurring on Antarctica's Larsen B ice shelf.

CURRENT PROGRAMS

Antarctic Data Coordination Center

NSIDC is funded by the National Science Foundation's Office of Polar Programs to operate the U.S. Antarctic Data Coordination Center. The goal of this project is to improve access to U.S. funded Antarctic scientific data by creating data descriptions for these data and entering them into the Antarctic Master Directory (AMD) which is a node of the International Directory Network/Global Change Master Directory (IDN/GCMD). The AMD is a web-based, searchable electronic directory containing data descriptions (metadata in the form of DIF entries). NSIDC has been working with NSF/OPP to develop and implement a data policy which will support the activities of scientists regarding the development of metadata and planning for data management. We expect this policy to be in place beginning in 1999.

NSIDC has been a leader in the establishment of the international framework for this activity. The SCAR/COMNAP Joint Committee on Antarctic Data Management, consisting of representatives from participating countries, SCAR, COMNAP and the AMD host (the International Center for Antarctic Information and Research in New Zealand), now meets annually to respond to the call from SCAR/COMNAP to improve access to scientific data, and to provide newly participating countries with guidance and justification for establishing National Antarctic Data Centers. Of the participating countries, the U.S. has provided the largest number of data directory entries to the AMD thus far.

Greg Scharfen is the PI on this project. Rob Bauer, the Data-Coordinator, is responsible for contacting Antarctic Investigators and coordinating submission of Antarctic Data descriptions to the Antarctic Master Directory.

ARCSS Data Coordination Center

The ARCSS Data Coordination Center (ADCC) at NSIDC completed its first year of an extended grant to provide ARCSS data and information to the scientific community well into the 21st century. We continue to be a catalyst for ARCSS integration through data and information management. Several changes have been implemented which we feel will assist investigators in constructing consistent, user-friendly data sets for ease of archiving at the ADCC, not the least of which is the new ARCSS Home Page.

Matthew Cross is the PI on this project and Chris McNeave, the new ARCSS Data Coordinator, is responsible for user requests, data ingest, CD-ROM development, and design and maintenance of the ARCSS Home Page.

The work performed for each program within ARCSS has been extensive. This section describes both accomplishments and ongoing activities of the ADCC within the last year.

GISP2

All data for the GISP2 project are now available on the ARCSS Home Page and through a CD-ROM (see Highlights. p.3) developed jointly with the National Geophysical Data Center (NGDC) so as to provide both GISP2 and GRIP data on the same product (NGDC is the archive for all GRIP data). This CD-ROM is a milestone in providing the most extensive paleoclimate record to date for the Northern Hemisphere. It also exemplifies the level of successful cooperation that can be achieved between two different funding agencies to develop a better product for the user community.

LAII

The LAII Project continues to be a significant contributor to the ARCSS archive. We now have all updated data through 1996 in the archive and are continually working with each LAII investigator on archiving and disseminating the most recent data available from LAII. We are also working directly with LAII PI's in developing internal protocols for archiving model data from their field sites. An Arctic Hydrology CD-ROM is currently under construction. It will contain both the raw hydrological measurements of all arctic rivers and modeled stream flow developed by Charles Vorosmarty at the University of New Hampshire.

OAII

The OAII project is becoming a major part of current data management activity at NSIDC. We are developing the Western Oceanographic Data Set (WODS) CD-ROM (a series of cruises from the last 15 years in and around the Bering Strait) which will be out by the end of the fiscal year. AOS data continue to arrive at the ADCC and we are working with AOS investigators on their data ingest to the archive. We are preparing for the large volumes of SHEBA data by working closely with the OAII SMO to establish migration plans when Phase II data are ready to be submitted to the archive. We will also assume archiving responsibilities of all SCICEX data and information (see p.3). We have contacted each of the SCICEX PI's and are establishing data migration plans for these observations.

Outreach

Relationships have been fostered with ARCSS Principal Investigators and others through attendance at meetings. In addition we also submit articles relating to ADCC activities in the publications "NSIDC Notes" and "Witness the Arctic."

ARCSS Home Page and Data Development

An effort to redesign and upgrade the ARCSS web site was started this year. The redesigned site is based on the idea of increasing the support of ARCSS data on a long term basis while providing information on current ARCSS issues through the use of links to project level SMOs. The new site contains information specifically created for the ARCSS investigator who needs to send his or her data to the Data Coordination Center. This PI-specific area contains the NSF Data Protocol as well as a complete listing of relevant data submission issues and guidelines that the PI and the ADCC must review prior to data ingest and release to the public. Also included is a data submission form that the PI can fill out and submit to the ADCC to announce the availability of data ready for transmittal to the archive. All of these changes are looked upon as integral steps in assisting the expanding user base of ARCSS data

and information beyond the traditional and well-defined ARCSS internal user base. The projected release for the new site is mid-August.

In support of archive and web site services, the ADCC has upgraded it development machine to provide the center with a platform devoted to project and web site development. This has allowed us to improve the efficiency of our primary platform by devoting it exclusively to archive and server support.

Data Ingest

The data ingest procedures were extensively reviewed and revised this year. Created were the ADCC's new standards for systematically receiving, reviewing, documenting and ingesting ARCSS data. This will assist PI's in helping them to standardize data and information submitted to the ADCC and ensure a more timely release to the scientific community.

Polar Pathfinders

SMMR and SSM/I Pathfinder

The National Snow and Ice Data Center (NSIDC), University of Colorado, has produced a twenty year, global, passive microwave brightness temperature time series by combining data from the Scanning Multichannel Microwave Radiometer (SMMR) 1978-1987 and Special Sensor Microwave/Imager (SSM/I), 1987-present. These daily, Level 3 (earth gridded) data are available in a common format: the NSIDC Equal Area Scalable Earth Grid (EASE-Grid), (Armstrong and Brodzik, 1995 and 1997). This product was made possible through support provided by the NOAA/NASA Pathfinder Program which was designed to assure that certain key non-EOS data sets of particular significance to global change research are identified, scientifically validated and made readily available to the research community.

The NSIDC EASE-Grid, is an azimuthal equal area (25 km) projection (Armstrong and Brodzik, 1995). The EASE-Grid was initially developed for passive microwave data and is currently used at NSIDC for the processing of the NASA Pathfinder Level 3 SMMR and SSM/I data as well as numerous other remote sensing and surface data sets. It should be noted that while the NSIDC EASE-Grid SMMR and SSM/I Pathfinder project has been included in the category of "Polar Pathfinders", it is, in fact, global in coverage and the primary product, earth gridded brightness temperatures, is designed to support not only the study of snow and ice but all aspects of earth system science.

EASE-Grid is being used for other products being distributed by the NASA Polar Pathfinder Program such as AVHRR and TOVS. Within the NASA Polar Pathfinder project the EASE-Grid cell size for the passive microwave products is 25 x 25 km, 1.25 x 1.25, 5 X 5, and 25 x 25 for AVHRR and 100 X 100 km for TOVS. (Schweiger, 1999). In addition, various other environmental data sets are being distributed by NSIDC in EASE-Grid format, for example: Northern Hemisphere EASE-Grid Weekly Combined Snow Cover and Sea Ice Extent; Arctic and Antarctic Research Institute (AARI) 10-Day Arctic Ocean EASE-Grid Sea Ice Observations; Arctic Water Vapor Characteristics from Rawinsondes. The EASE-Grid will also be used for snow and ice products derived from EOS MODIS and AMSR data and the EASE-Grid is being evaluated for the TRMM products.

The EASE-Grid processing of SMMR for the period 1978-1987 and SSM/I through mid-1998 has been completed for all three earth projections. Our goal of processing current data by September of 1998, which was established at the beginning of the project, has been achieved. Processed data are routinely distributed to approximately 150 researchers through various media including CD-ROM, 8mm tape, and ftp. In addition, the EASE-Grid Pathfinder Level 3 data sets are available via the EOS Information Management System (IMS). NSIDC will continue processing and distributing these data for the duration of the SSM/I mission.

AVHRR-Based Polar Pathfinder Data Production and Product Validation

Production continues for the AVHRR-Based Polar Pathfinder data sets, consisting of polar subsets, navigated, calibrated, and composited AVHRR channel data, viewing angles, surface albedo, skin temperature, cloud detection, and ice motion. The process of copying AVHRR GAC data from optical platters supplied by JPL is complete, resulting in GAC coverage for 1983-1991. 5-km products and 1.25-km products have been prepared for an NSIDC-produced data sampler to be distributed on CD at the American Meteorological Society meeting in Dallas, January 1999. 1.25-km and 5-km processing is continuing for 1997-1998, with 5-km processing also completed for 1987-1989. Blended ice motion products, combining motions from SMMR, SSM/I, AVHRR, and drifting buoys are nearing completion. Evaluation and improvement of the pathfinder products continues under separate NASA funding. Data from the Greenland automatic weather station network have been acquired that will serve as a validation data set for the Pathfinder surface albedo and surface temperature products. The Pathfinder data are being compared to field observations at a number of other locations, including the SHEBA site, and Antarctic ice sheets, and the NOAA/DOE ARM site at Barrow, Alaska. CIRES investigators involved in this effort include J. Maslanik, T. Scambos, J. Stroeve, R. Stone, and T. Haran.

Environmental Services Data and Information Management (ESDIM)

ESDIM Data Set Development

The NOAA/NESDIS Environmental Services Data and Information Management (ESDIM) program has funded data rescue and data set development activities at NSIDC. Over the last year, the following data sets were acquired by NSIDC and officially added to NGDC's NOAA data set archive:

"Italian Alps Monthly Snowfall and Snow Cover Duration";
"Russian River Ice Thickness and Freezeup/Breakup dates";
"Historical Arctic Rawinsonde Archive";
"Dominion Range Snow Pit and Ice Core Data";
"Dronning Maud Land, Antarctica, Ice Core Data";
"South Pole Snow Pit Data"; and
"Newall Glacier Snow Pit and Ice Core Data".

In addition, data and documentation were updated for the following NOAA data sets at NSIDC:

"Great Lakes Ice Charts";
"Great Lakes Cooperative Ice Observers Ice Gage Reports";

"International Ice Patrol Iceberg Reports";
"U.S. Coast Guard Great Lakes Surface Ice Reports"; and
"International Arctic Buoy Program Archive".

In 1997 and 1998, the International Permafrost Association partnered with the ESDIM project at NSIDC to publish the Circumpolar Active layer Permafrost System (CAPS) CD-ROM, with additional funding from NSF (see p.2).

The year brought progress in NSIDC's ESDIM-funded effort to increase on-line access to glacier data through cooperation with the International Council on Scientific Union's World Glacier Monitoring Service (WGMS) in Zürich. An agreement was made between Roger Barry, NSIDC/WDC-A for Glaciology Director, and Wilfried Haeberli, WGMS Director, that NSIDC would make WGMS data available through a data center web site, and would archive the data according to NOAA standards. NSIDC plans to merge WGMS glacier data with Eurasian glacier data previously rescued through ESDIM program to create a unique on-line World Glacier Data Base. Requests for glacier data are increasing. The Intergovernmental Program for Climate Change has identified glaciers as second only to world temperature as an indicator of global change.

NSIDC Distributed Active Archive Center (DAAC)

The primary goal of NSIDC DAAC is to serve communities identified by the Mission to Planet Earth Strategic Enterprise Plan 1996-2002, March 1996

(http://www.hq.nasa.gov/office/mtpe/stratplan/stratplan.html)

by providing easy and reliable access to EOS satellite data, ancillary in situ measurements and any necessary baseline data, model results, and relevant algorithms relating to cryospheric and polar processes. These activities will evolve from the existing practices at NSIDC DAAC to permit a smooth implementation of the EOSDIS Version 0 and transition to Version 2 of the EOS Core System (ECS) and beyond.

Infrastructure and Management

- Successfully completed transition to new 5 year contract with the Goddard Space Flight Center (GSFC) for operation of the NSIDC DAAC; included completion of proposal (October 1997) and contract negotiation (January 1998).
- Prepared for and hosted the National Research Council (NRC) DAAC review of NSIDC DAAC. NASA requested the NRC Committee on Geophysical and Environmental Data (CGED) to review each of the DAACs. NSIDC was reviewed in early March 1998. The NRC report has not yet been released.

Systems Engineering and Systems Development

- Ordered and installed, (StorageTek Timberwolf 9710 Digital Library DLT automated tape library system and SGI Origin 200) to replace aging CYGNET WORM jukebox. Started migration of NSIDC DAAC Version 0 data to the new DLT library. The digital library system is replacing our aging optical WORM juke box, which is used for all our V0 data sets. It is expected that the DLT digital library will be on-line by late CY 1998.
- Completed installation of ECS Version 2 hardware. This major milestone in the

deployment of the EOS Core System to NSIDC was completed in April 1998. The ECS installation at NSIDC consists of a StorageTek Powderhorn Silo capable of storing and retrieving 300 TB on magnetic tape, over 30 networked workstations and servers. Also included are output devices capable of delivering data on 4mm, 8mm, CD-R, media, and over the network.

- Completed installation of ECS Drop 4 software. Although the NSIDC DAAC ECS software is not completely functional, we did complete installation of the "Drop 4" software. This software provides functionality beyond the earlier "Testbed" software. Additional drops will be installed as they become available, and we expect to have an operational system in place by March of 1999.

Mission Coordination

NSIDC DAAC staff participated in multiple mission coordination tasks. These efforts develop the essential collaborations with instrument teams, science groups, and other data providers through face-to-face meetings. Major activities involving R.L. Armstrong, J.A. Maslanik, A.W. Nolin, T.A. Scambos, and G.R. Scharfen included:

- Attended Advanced Microwave Scanning Radiometer (AMSR) Science Team Meetings.
- Completed negotiations with MODIS Land group over Polar Stereo Gridded data production; Polar Grids now included in MODIS sea ice and snow cover products. Very recent developments have moved the MODIS product generation from the NSIDC DAAC to the MODIS Team Facility at GSFC. Thus NSIDC DAAC will not produce these gridded data sets, but will archive and distribute them. NSIDC efforts, along with the strong support the NSIDC User Working Group, were critical to convincing the MODIS Team and the ESDIS Project that these polar projection gridded products were important to the success of the MODIS snow and ice products.
- Participated in a MODIS/Multi-Angle Imaging Spectroradiometer (MISR) field validation campaign.
- Participated in the development of the Global Land Ice Monitoring from Space (GLIMS) project, designed to monitor the world's glaciers primarily using data from the EOS ASTER (Advanced Spaceborne Thermal Emission and reflection Radiometer) to be flown on the AM-1 satellite. GLIMS is a collaborative effort between the USGS Flagstaff Center, EOS ASTER Instrument Science Team, EROS Data Center (EDC), NSIDC, and a group of internationally distributed glaciologists at regional centers of expertise. NSIDC will provide the information management system for GLIMS consisting of a global inventory of land ice, including measurements (over time) of glacier length, area, boundaries, topography, snowline elevation, and surface velocity vectors, derived primarily from remote sensing data. The regional centers will derive the inventory information from the remote sensing data (archived at EDC) and provide this to NSIDC for archive and distribution. In this past year, NSIDC has participated in the planning for this activity. A draft proposal for NSIDC's portion of the project has been submitted to the USGS Flagstaff group. They are seeking funding for the GLIMS project from a group of federal agencies.

Data Sets and User Outreach

The following data sets were published.

- SSM/I F8 EASE-grid global brightness temperature data CD-ROM and SSM/I F13 Polar Stereo gridded brightness temperature data CD-ROM
- Sea Ice Concentration Time Series (October 1978 - September 1995) generated by GSFC Polar Investigators from NSIDC DAAC-generated passive microwave grids (Scanning Multispectral Microwave Radiometer (SMMR) and SSM/I) and associated documentation
- Arctic Ship Sounding measurements distributed
- Greenland and Antarctic Digital Elevation Maps (DEMs) from the GEOSAT/SEASAT data
- NISE data operationally to MISR and Tropical Rainfall Measuring Mission (TRMM) Instrument Teams distributed. Details of this are provided below.

Liaison to the Modeling Community

A. Frei is coordinating DAAC outreach to the modeling community, interacting with the modeling community to establish a DAAC "point of reference"; advising the DAAC on data-related needs of the modeling community; and identifying appropriate data sets resulting from modeling research to the DAAC. Discussions have begun with DAAC and NSIDC personnel, as well as selected members of the modeling community, regarding their views on the relationship between the DAAC and the modeling community. The second phase will involve obtaining information from a wide variety of users and potential users of DAAC data sets regarding their knowledge and use of our data. Subsequently, this information will be used to improve our service to the modeling community.

DAAC Yearbook

NSIDC also compiles and edits the *DAAC Yearbook*. The *DAAC Yearbook* consists of a collection of feature articles highlighting scientific applications of DAAC data, preferably interdisciplinary applications using data from multiple DAACs. Written to be understood by a lay person with some college education, each article addresses a broad ecological or earth science theme. The narrative approach is relaxed, avoiding detailed explanations of processes and bureaucracy, relying instead on examples, anecdotes and graphics to enliven the presentation.

The Yearbook is attaining a wide circulation. It is distributed at meetings and mailed to scientists with a focus on the EOS Investigators Working Group (IWG). Efforts are also underway to distribute the publication to Mission to Planet Earth (MtPE) Interdisciplinary Science teams (IDS), the Science Data Panel, Science Working Group for the AM Platform (SWAMP), Global Change Fellowship, NOAA data centers, and Congress through the MtPE and NASA outreach offices.

NISE Data Set

Anne Nolin headed up a team of ten people charged with development of the Near real time Ice and Snow Extent (NISE) product. This daily product, derived from satellite passive microwave data, was developed to support the needs of several NASA/EOS instrument teams. This product represents the first time that global daily maps of sea ice concentrations and snow cover (both wet snow and dry snow) have been made available.

The Near Real-Time SSM/I EASE-Grid Daily Global Ice Concentration and Snow Extent product (Near Real-Time Ice and Snow Extent, NISE) is generated using multifrequency, multipolarization passive microwave data from the Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave/Imager (SSM/I). Data from the DMSP F13 SSM/I are used to create a global map of sea ice concentrations and snow extent. Data for the NISE product are provided in two 25-km azimuthal, equal-area projections (the NSIDC Southern Hemisphere, low (25-km) resolution (SL) and Northern Hemisphere, low (25-km) resolution (NL) EASE-Grids and are updated on a daily basis.

The sea ice coverage currently includes all Arctic and Antarctic sea ice areas poleward of 35° latitude. The snow extent product is global. Wet snow and dry snow extents will be mapped separately, using two different algorithms. The NISE product is created in near real time, i.e., within approximately two to four days of the satellite overpass.

Funding for the production of this data set was provided by the National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center (DAAC). The data set is currently available via ftp to investigators and instrument team members associated with the NASA Earth Observing System (EOS).

Sea Ice Products

Intercomparison of the DMSP SSM/I F8/F11 and F13 brightness temperatures and derived sea ice products to help ensure consistent data sets from theses sensors. Of particular importance is the corrected interpretation of ice extent time series involving data from these different sensors. The results of this work by Jim Maslanik and Julienne Stroeve are available online as a NSIDC Special Report and a paper has been submitted to *Remote Sensing of the Environment*.

Production of value-added products for the current sea ice data products available from NSIDC. These include providing users with ocean masks, daily and monthly values of total sea ice extent and total ice-covered area, total ice extent and total ice-covered area anomalies and trends.

Sea ice sensitivity studies using passive microwave radiative transfer models to examine the dependence of sea ice fraction to small variations in the satellite viewing angle. To investigate the sensitivity of brightness temperatures over sea ice to small variations in the satellite incidence angle, a combined sea ice/atmospheric model is used. The brightness temperatures are simulated with the model for several different ice types (nilas, FYI, MYI), with and without snow cover as a function of satellite incidence angle. Next, ice fractions are derived from the modeled brightness temperatures using both the NASA Team and the Bootstrap sea ice algorithms. The significance of incidence angle variations on ice concentrations for the different ice types is also investigated as a function of the amount of

open water in the pixel. Results show that the NASA Team-derived ice fractions are more sensitive to small changes in the satellite incidence angle than those from the Bootstrap sea ice algorithm. Changes of between 2-4% (absolute) in total ice fraction are seen for a 1 degree change in satellite incidence angle. Differences between the SMMR and SSM/I viewing angles for example, can therefore result in differences as large as 6-10% (absolute) using the NASA Team algorithm.

Moderate Resolution Imaging Spectroradiometer

The cryospheric community has demonstrated a need for improvements in the content and format of the proposed standard Moderate Resolution Imaging Spectroradiometer (MODIS) snow and ice products through the DAAC user working group, MODIS Instrument Science Team meetings, MODIS snow and ice workshops and ad hoc working groups. During the past year, the MODIS Instrument Science Team has responded by endorsing the development of additional products and formats. This includes plans for production, archive and distribution of the MODIS snow and ice products in the EASE polar grid. Science software for this has been completed and the concept has been incorporated into Team production scenarios. MODIS Team and DAAC estimates indicate there are adequate network and computing resources for the additional polar-gridded products during the ramp-up of production during the first year, but this will need to be re-evaluated as full production commences in year two after launch of the AM-1 satellite. The MODIS Team has also begun the development of snow cover-, sea ice- and lake ice-albedo products for implementation in the post-launch time frame. Both of these changes will add to the scientific value of the MODIS data for the cryospheric community. NSIDC is continuing its preparations for the launch of MODIS on board the AM-1 satellite. Participating in Science Software Integration and Test activities related to the MODIS snow and ice production software has been particularly useful for testing software and hardware systems and bringing hands-on experience to DAAC staff.

Global Land Ice Monitoring from Space

NSIDC is participating in the development of the Global Land Ice Monitoring from Space (GLIMS) project, designed to monitor the world's glaciers primarily using data from the EOS ASTER (Advanced Spaceborne Thermal Emission and reflection Radiometer). ASTER will be flown on the AM-1 satellite. GLIMS is a collaborative effort between the USGS Flagstaff Center, EOS ASTER Instrument Science Team, EROS Data Center (EDC), NSIDC, and a group of internationally distributed glaciologists at regional centers of expertise.

NSIDC will provide the information management system for GLIMS. Ultimately this will consist of a global inventory of land ice, including measurements (over time) of glacier length, area, boundaries, topography, snowline elevation, and surface velocity vectors, derived primarily from remote sensing data. Regional centers will provide expert analyses of the remote sensing data archived at the EDC DAAC, and provide the resulting information to NSIDC for ingest, archive and distribution. The USGS Flagstaff Center provides the primary focal point for the GLIMS effort.

To date, NSIDC has provided input on data base design and content, international linkages, operational processing scenarios and more recently on the development of a proposal for funding the GLIMS activity.

Global Digital Sea Ice Data Bank (GDSIDB)

The WMO Global Digital Sea Ice Data Bank

The 7th Session of the WMO Commission on Marine Meteorology (CMM) Global Digital Sea Ice Data Bank (GDSIDB) Scientific Steering Group met at the NSIDC August 10-12 in conjunction with the CMM Sub Group on Sea Ice. Dr. I. Frolov, Director of the Arctic and Antarctic Research Institute (AARI), St. Petersburg, Russia and Dr. R.G. Barry, NSIDC Director served as co-Chairs.

There were 12 participants representing the national ice services of Canada,the Baltic countries, China, Japan, France, Iceland, Sweden, Russia and the USA, and also the WMO CMM. The group discussed changes in ice operations and product distribution, in the light of new technologies, especially RadarSat data, as well as ice nomenclature and reporting codes. The status of data deliveries to the GDSIDB centers at AARI and WDC-A for Glaciology/NSIDC were reviewed. A schedule for future activities was developed for the period September 1998-May 2000 which will for the first time include submissions of data by the Baltic countries, China and Iceland. A summary report of the meeting has been published by the WMO-CMM.

USER SERVICES

The User Services Staff is responsible for providing responses to user inquiries for NSIDC, WDC-A, NSIDC DAAC, and the ARCSS Data Coordination Center. User types and inquiries span a diverse range and include users from the commercial, government and educational sectors. Examples of inquiries received this year include students requesting information for school projects and reports, media and text book publishers requesting photographs and interviews, and science researchers requiring information about data holdings, processing, formats, and science algorithms.

Other activities of User Services Staff include work relating to product design and enhancement, representation on NSIDC Product Teams, and Data Center outreach activities. Product Teams to which User Services contributed this year include SSM/I Brightness Temperature and Sea Ice Concentrations, SSM/I Near-Real Time Sea Ice and Snow Extent, AVHRR Polar 1km Data Set, Greenland and Antarctic Altimetry, Antarctic Ice Velocity, COADS Polar Data Set, Joint U.S.-Russian Arctic Ocean Atlas, and Submarine Draft data.

NSIDC User Services provided staffing support for the EOSDIS USWG exhibit booth at the AGU Oceans Meeting, February 10-12, 1998 in San Diego, CA; Special Libraries Conference June 7-10, 1998 in Indianapolis, IN. User Services also assisted in staffing the NSIDC exhibit booth at the AGU Fall Meeting, December 9-11, 1997 in San Francisco, CA, and presented posters in two sessions.

User and Request Statistics

Requests in Fiscal Year 1998 reached an all time high of 2092, exceeding the next highest reporting year by 11%. This is largely due to the release of new products including the Circum-Arctic Permafrost System, the Greenland Ice Core data, and the Volume 5 update to the Historical Arctic Rawinsonde Archive CD-ROM series.

By far the largest community of users served was the educational/research community, with 1070 requests from U.S. and Foreign Universities. Two hundred and twenty-six requests were from U.S. Federal Agencies including NOAA and NASA, 70 from U.S. K-12, and 97 requests fell into the category of "General Public".

RESEARCH

NSIDC/WDC-A for Glaciology contributes actively to the basic and applied research of the Cryospheric and Polar Processes Division in CIRES. Much of this research also underpins the data management activities of the Center since the scientific staff carry out specific tasks for the NASA and NOAA or NSF related data management contracts and grants.

A summary of current projects, listed by principal investigator, follows.

Richard L. Armstrong

Validation of Passive Microwave Snow Cover Algorithms

When snow covers the ground, some of the microwave energy emitted by the underlying soil is scattered by the snow grains. Therefore, when moving from snow-free to snow-covered land surfaces, a sharp decrease in emissivity provides a nearly unambiguous indicator of the presence of dry snow. In addition, theoretical and empirical studies have demonstrated that the amount of scattering can be correlated with snow amount (number of grains) and specific wavelength. Based on these relationships, algorithms have been developed which indicate the presence of snow and compute either depth or snow water equivalent.

It is now possible to monitor the global fluctuation of snow cover over a 20 year period using passive microwave data (Scanning Multichannel Microwave Radiometer (SMMR) 1978-1987 and Special Sensor Microwave/Imager (SSM/I), 1987-present). The National Snow and Ice Data Center (NSIDC), University of Colorado, has produced an earth-gridded, daily, global, brightness temperature time series by combining SMMR and SSM/I data in a common format: the NSIDC Equal Area Scalable Earth Grid (EASE-Grid), (Armstrong and Brodzik, 1995 and 1997). This product was made possible through support provided by the NOAA/NASA Pathfinder Program which was designed to assure that certain key non-EOS data sets of particular significance to global change research are identified, scientifically validated and made readily available to the research community. The snow product data set which is currently being developed includes individual files of 5-day maximum snow extent and water equivalent as well as monthly climatologies describing average snow extent, snow water equivalent, probability of occurrence, and variance.

A key element in the development of accurate passive microwave algorithms is the availability of alternate data sets for comparison and validation. For example, as described in the next paragraph, we have evaluated the capability of passive microwave algorithms to reproduce the monthly Northern Hemisphere snow extent climatology resulting from the NOAA/NESDIS data for the period 1978 to 1997 (Armstrong and Brodzik, 1998). The NOAA data were regridded to the NSIDC EASE-Grid, an azimuthal equal area (25 km) projection (Armstrong and Brodzik, 1995). The EASE-Grid was initially developed for passive microwave data and is currently used at NSIDC for the processing of the NASA EOS Pathfinder Level 3 SMMR and SSM/I data as well as numerous other remote sensing and surface data sets.

In our comparisons with the NOAA snow extent data we applied the Chang et al. (1987) algorithm to determine snow extent for the SMMR period and a modified version of the same algorithm for the SSM/I period. Both visible and passive microwave data sets show similar inter-annual variability and both indicate maximum extent consistently exceeding 40 million square kilometers for the Northern Hemisphere (Armstrong and Brodzik, 1998). The visible data show higher magnitude departures from the monthly means while the long-term trends based on the departures are similar. The twenty year trend in mean annual snow extent derived from visible and passive microwave satellite data show a decrease of approximately 64,000 and 46,000 square kilometers per year respectively.

In order to evaluate regional differences between the two data sets, we compared average monthly extent where "average" is defined as conditions where 50% or more of the weeks making up the particular calendar month over the total period were snow covered. We have also analyzed the differences between the complete (0 to 100%) frequency maps. Results clearly indicate those time periods and geographic regions where the two techniques agree and where they tend to consistently disagree. For example, during the months of October, November and December the passive microwave data underestimate the southern-most snow extent in certain regions. The difference is greatest at the lower elevations across both North America and Eurasia where the snow cover is more likely to be shallow (less than about 3.0 cm) and may often exist at the melting temperature. In both of these situations (shallow and/or wet snow) the microwave algorithms tested thus far are unable to consistently detect the presence of snow. This same pattern was also observed within a shorter duration study by Basist et al. (1996). In order to better characterize the microwave brightness temperatures associated with shallow snow overlying both frozen and unfrozen ground we will apply the microwave emission model for a layered snowpack (MEMLS) currently under development by our European Union (EU) colleagues working within the project SNOWTOOLS (Solberg et al. 1997).

As the winter progresses, during the months of January through March, the two data sources agree quite well with one notable exception being at the lower elevations of eastern Europe where the passive microwave data often indicate an absence of snow. The general, large-scale agreement between the two data sources continues on through the spring months. The only region where the passive microwave data consistently indicate snow and the NOAA data do not is over the Tibetan Plateau and surrounding mountain areas. Again, similar results were obtain in the earlier study by Basist et al.(1996). However, in this case it is not entirely clear which remote sensing data set is correct due to the fact that there is only a very limited amount of surface station data available to support objective validation. NSIDC is currently acquiring surface snow observations which will be used for validating the remote sensing data over this region. These data are being made available through a collaborative snow hydrology study with colleagues at the Lanzhou Institute of Glaciology and Geocryology (LIGG) Lanzhou, China. In addition, once adequate land cover information has been obtained we will also apply the MEMLS model to better understand land surface microwave signatures within this specific region.

This work is supported by NASA Research Grants NAG5-6636 and NAG5-4506. Specific aspects of this study are being undertaken in direct collaboration with Drs. Christian Mätzler and Daniel Hiltbrunner, Applied Physics Institute, University of Bern, Switzerland and with A.T.C. Chang, NASA-Goddard Space Flight Center, Greenbelt, MD.

Roger G. Barry

Pilot Project for a Global Geocryological Database

This NSF-Project will be completed in Fall 1998. The Global Geocryological Database (GGD) project was designed to facilitate the identification, acquisition and dissemination of permafrost and frozen ground data for research and practical applications. The GGD was planned to be an internationally distributed system of linked nodes and data centers, with data sets being assembled in National Geocryological Databases. A primary task of the project, concerned the digitization of borehole and soil temperature data for sites in Russia and preparation of related metadata. These data records were transferred to WDC-A for Glaciology. 187 data set descriptions were obtained by contacting investigators These are incorporated in the CAPS Version 1.0 CD-ROM (see p.2).

The tasks of assembling critical data sets on soil and borehole temperature in Russia, as well as information on Russian permafrost maps was made possible by the collaboration of several Russian scientists (particularly Professor Nikolai Romanovsky, Dr. Evgeniy Melnikov, Dr. Marina Leibman and Professor David Gilichinsky).

Russian collaborators, under a subcontract, provided data digitization and checking for: selected deep well and borehole records from western Siberia; soil temperature records for northwest Russia (through 1965) related metadata (DIFs) and documentation, an inventory of selected Russian permafrost maps.

It was decided in 1996 that the GGD should be assembled and distributed via a CD-ROM. To finalize this activity a Supplement to the grant was proposed. Drs. J. Branson, Southampton and M. Leibman, Moscow worked at NSIDC in February 1998 to complete and check the ROM. The CAPS Version 1.0 CD was completed in June 1998; to date 350 copies have been distributed. The CAPS CD is described in Highlights (p.2).

Circumpolar Frozen Ground Conditions and Modeling Scenarios of Future Conditions

R.G. Barry and T. Zhang are collaborating with David Gilichinsky, of the Soil Science Institute, Pushchino, RAS, on this NSF project, which is part of a modeling study undertaken by Fritz Nelson (University of Delaware) and Oleg Anisimov (State Hydrologic Institute, St. Petersburg).

Soil temperature conditions in frozen ground are of considerable interest for global change research but long-term measurements are generally lacking. Such observations were made throughout the former Soviet Union at with some records beginning in the last century and many in the 1930s or 1950s. Some preliminary results show that changes in soil temperature were greater than changes in air temperature over the period of record. For example, at Irkutsk (1898-1994), mean annual air temperature increased by 1.47°C/100 yr. while mean annual 40 cm soil temperature increased by 2.3°C/100 yr. Mean monthly air temperature from

November through March increased by 2.6 to 3.2°C/100 yr., while changes during summer months were relatively small with slight decrease in June and July. Mean monthly 40 cm soil temperature increased by 3.5 to 9.2°C/100 yr. from November to March and decreased by 1.4 to 2.9°C/100 yr. from May through August. Changes in seasonal snow cover modify the impact of winter air temperature on soil climate. Changes in summer soil temperature may involve the changes in soil moisture conditions since changes in the thawing index of air temperature were relatively small. Changes in freeze depth at Irkutsk and Kargopol show a close relationship with freezing index and seasonal snow cover, while changes in thaw depth at Zyryanka were mainly controlled by thawing index values. A paper was presented at the 7th International Permafrost Conference in Yellowknife, NWT, and is published in the conference proceedings.

Florence M. Fetterer

Radarsat Multiyear Sea Ice Mapping

This project developed software that automatically classifies multiyear sea ice in 500 km square Radarsat ScanSAR imagery. The MIMS (Multiyear Ice Mapping System) Character User Interface allows the user to select from several processing options, including choosing to reduce the resolution of the image and choosing to apply a land mask. MIMS runs a dynamic, or local, threshold algorithm that uses local rather than global backscatter characteristics to decide what is multiyear ice in an image. The great advantage of this algorithm is that it performs well on uncalibrated imagery. Output products are image "maps" showing the location of multiyear ice, and contours of multiyear ice concentration. MIMS was developed with funding from the Naval Research Laboratory (NRL). It is intended for operational use at the Navy/NOAA/Coast Guard National Ice Center (NIC) in Suitland, MD. Multiyear ice poses a hazard to navigation; thus NIC's interest in quickly mapping its location. MIMS was delivered to NRL and to NIC in September, 1998. It will undergo evaluation at both organizations. Jing Ping Ye is the programmer for the MIMS project.

Allan H. Frei

Estimation of Regional Water Resources in Mountainous Regions under Changing Climatic Conditions

Investigating downscaling methods and evaluating climate models for use in estimating regional water resources in mountainous regions under changing climatic conditions. This study is supported under the NASA Land Surface Hydrology Program (NRA 97-MTPE-12) Proposal No. LSHP-1-0133 for three years beginning August 1998, Frei (Principal Investigator), Nolin and Serreze (Co-Investigators). In this project we examine the potential effects of climate change on snow and water resources in two case study regions: the Upper Colorado River Basin and the Catskill Mountains in southeastern New York State. We investigate several potential statistical downscaling techniques in order to characterize the relationship between synoptic scale circulation and snow fluctuations. In addition, models are used to estimate potential changes in circulation as well as the effects of such changes on regional hydrology. Such studies are important because projections of climate change, and

subsequent impacts, at local to regional levels are relatively uncertain. In this project we attempt to reduce the uncertainties in such projections. At the time of writing, basic hydrological and meteorological data for the two case study regions are being gathered and analyzed to characterize observed historical fluctuations.

The evaluation of snow water equivalent across grassland regions. NASA Land Surface Hydrology Program (NRA 97-MTPE-12) Proposal No. LSHP- 1-0077. Three years beginning July 1998, Frei, Robinson (Rutgers University), Leathers (University of Delaware), and Mote (University of South Dakota). In this project historical observations of snow water equivalent (SWE) over grassland areas are used in conjunction with snow pack models to estimate historical fluctuations in SWE over grassland areas of the Northern Hemisphere. Such studies are important because snow is a major water source in many grassland areas, and is often an important factor in flooding events. On regional to continental scales, this information can be important for evaluating the ability of climate models to simulate SWE, which is the focus of the CU portion of this project.

Jim A. Maslanik

SHEBA Activities

CIRES personnel participated in two elements of the Surface Heat Budget of the Arctic (SHEBA) during April, May, and July 1998. J. Maslanik (CIRES/CCAR) and R. Stone (CIRES) used a suite of sled-mounted instruments to collect spatially distributed observations of skin temperature, air temperature, and surface reflectance over a range of surface conditions, including multiyear ice, first-year ice, young ice, and refreezing leads. Measurements were coordinated with satellite and aircraft overpasses, and with fixed-location instruments. The objectives of this field component are to document the spatial variability of energy balance parameters in relation to ice and atmospheric conditions.

J. Maslanik also took part in NCAR C-130 flights over the SHEBA study area during July. The C-130 data are being used to map surface conditions in conjunction with detailed atmospheric information collected by the C-130 and by sensors at the SHEBA site. Mapping instruments on board the C-130 include a passive microwave radiometer, scanning visible- and thermal-band radiometer, and video cameras. In addition to extensive overflights of the SHEBA vicinity, the C-130 observed ice and atmospheric conditions during the entire flight route from Barrow to the SHEBA site (at approximately 76°N, 163°W in late July). The C-130 data, in conjunction with satellite imagery and field observations, will serve to map the evolution of open water fraction and melt pond coverage, and for algorithm validation.

Analyses of Controlling Mechanisms for Sea Ice Anomalies in the Arctic

J. Maslanik and M. Serreze are collaborating with other investigators to characterize and understand the factors affecting interannual variations in sea ice coverage in the Arctic. Passive microwave data, NCEP and ECMWF reanalyses, station observations, and climate modeling are providing insight into the sensitivity of the ice pack to synoptic-scale atmospheric conditions. Various NSIDC-supplied data sets are also being used to assess the performance of the ARCSyM full-Arctic simulations. Results from ARCSyM simulations suggest that the record ice-extent minimum in the summer of 1990 was due to an unusual combination of enhanced melt and northward ice transport. Work is underway to understand the causes for

below-normal ice extent in the western Arctic in 1998, when similar conditions of enhanced melt and northward transport appear to be key factors.

Anne W. Nolin

Snow Remote Sensing

A. Nolin is an EOS Validation Scientist for snow albedo from the Moderate Resolution Imaging Spectroradiometer (MODIS) and is developing a snow bidirectional reflectance algorithm for the Multiangle Imaging SpectroRadiometer (MISR) instrument. The first validation field campaign was held in March, 1998 during which Anne and Julienne Stroeve collected airborne and ground-based data in the California Sierra Nevada. Anne was the principal investigator on a contract with Raytheon Systems to develop a snow mapping algorithm for the NPOESS satellite to be launched in ~2001.

Snow Acccumulation in Greenland

Studies assessing the role of sublimation of snow in mass loss over north Greenland, based on isotopic records, are being carried out with Drs. K. Steffen and J. White. Records from shallow ice cores and automatic weather station data show an NAO-related signature. Two co-authored papers on the surface albedo of Greenland have been published and one on optical remote sensing of Martian polar ice caps.

Ted A. Scambos

Innovations in the Use of AVHRR Imagery for Polar Ice Sheet Study

Two new techniques for applying AVHRR data to the polar ice sheets have been developed and demonstrated: data cumulation and photoclinometry. Data cumulation combines the data from several AVHRR scenes taken of the same area to generate an image with enhanced spatial and radiometric resolution beyond what any single AVHRR scene can provide. Both techniques are now described in recent papers submitted by Ted Scambos in collaboration with Geir Kvaran (a geography graduate student) and Mark Fahnestock (who is visiting NSIDC for six months in 1998/99 in part to develop and apply the photoclinometry technique further). Several areas have already been imaged by preliminary versions of the data cumulation technique: Siple Dome (see above); Ice Stream C; an ice stream in northeastern Greenland, and the major ice shelves of Antarctica. Photoclinometry from AVHRR has been successfully applied at Siple Dome, Roosevelt Island, and Greenland. The greatest potential for AVHRR in this application is to improve coarse-resolution DEM's (digital elevation models) by using the image data at a guide to local (1-km) variations from a 5- or 10-km resolution DEM. Two grants have recently been approved to apply this technique to Greenland and West Antarctica.

Radarsat Antarctic Mapping Project

A project led by Dr. K. Jezek, Ohio State University, is underway to map the entire Antarctic continent using SAR imagery from the Canadian satellite Radarsat. This effort involves rotating the satellite 180 degrees to a southward- looking mode for a three-week period. NSIDC's contribution consists of identifying, gathering and delivering ancillary data such as Digitial Elevation Maps, ice motion data, etc. to support the initial processsing of the data. Several DEMs of the entire continent and selected areas of interest were contributed to

the project to facilitate creating the most comprehensive DEM yet of the continent, for use in geololcation and terrain correction. Acquisition of the south-looking mode was completed in September/October 1997, and a 1-km version of the early processing is available to the general public. High-resolution images are expected to be available early in 1999.

Landsat Applications to Antarctica Project

A new project was begun as part of the Science Team research program for Landsat 7. The objective is to use existing LANDSAT 1, 2, 3, 4 and 5 data to map the ice velocity of glaciers in the Western Antarctic, and to search for changes in glacier outflow over the 25-year record provided by the archive of LANDSAT images stored at Eros Data Center (with Dr. Robert Bindschadler at PI, Dr. Mark Fahnestock and Dr. Ted Scambos as Co-PI). Ice velocity mapping will be conducted using a semi-automated technique that relies on grey-value correlation in image chips in sequential images. Initial work under this grant has centered on the selection of suitable cloud-free images from the thousands of images at EDC, mapping Ice Stream D and F outflow, and mapping of several outlet glaciers on the northwestern West Antarctic coast. Plans for next year focus on mapping the Institute ice stream, a previously unmapped large glacier feeding the Ronne Ice Shelf.

Greg R. Scharfen

Global Lightning

NSIDC is in its final year of the NASA Global Lightning Project. This project consists of automated analysis of Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) visible-band data (archived at NOAA/NGDC) for the detection of characteristic nighttime lightning signatures. Lightning appears as a horizontal streak on the nighttime images, corresponding to the portion of the imaged cloud that is scanned while the cloud is illuminated during a lightning flash. NSIDC developed an automated analysis system using neural network training techniques following years of doing the analysis manually on hard-copy and then digital images. Operating under a no-cost extension for much of the year, NSIDC extended the analysis with more data being processed than during any other year of this project. The resulting global data base of nighttime lightning occurrence now extends (with some gaps) from 1983 to 1997. Data are being used to extend the study of newer lightning climatologies derived from the Lightning Imaging Sensor (LIS) being flown on NASA's Tropical Rainfall Measuring Mission (TRMM). Ross Swick is Database Administrator for the Global Lightning Project. Rob Bauer is the research analyst for the Global Lightning Project.

Mark C. Serreze

Western U.S. Snow Cover

Efforts continued to assess variability/change in western U.S. snowpack water resources. A climatology of western U.S. snow water equivalent was compiled using SNOTEL records - results were submitted for publication in Water Resources Research. A companion paper, addressing snow cover variability over Eurasia, has been accepted by International Journal of Climatology. Two other papers, examining western U.S. snowpack variability in relation to ENSO forcings and the phase angle of the North American tropospheric wavetrain are nearing

completion. A new proposal was submitted (A. Frei, PI) to evaluate reconstructed Northern Hemisphere snow cover variability back the early part of the 20th century. A second proposal, addressing impacts of snow cover on western U.S. climate is nearing completion (A. Nolin, PI).

Arctic Climate from Reanalysis Data

Studies of modeled Arctic surface fields from the NCEP and ECMWF "reanalysis" efforts resulted in two papers. The first, which examines NCEP downwelling shortwave fields, appeared in *Journal of Climate* (Serreze *et al.* 1998A). As part of this study, a new gridded data set of Arctic global radiation was compiled and archived at NSIDC for release to the user community. The second paper, focusing on the NCEP precipitation fields, appeared in *Annals of Glaciology* (Serreze and Maslanik, 1998B). A more comprehensive precipitation study, looking at both the NCEP and ECMWF reanalysis products and led by Ciaran Hurst (recently graduated), has been accepted for publication in Journal of Climate. As part of this effort, a new gridded Arctic precipitation climatology was assembled by blending the existing Legates and Willmott analysis with gauge-corrected data from land stations and measurements from the Russian "North Pole" drifting stations. These studies complement ongoing evaluation of the atmospheric components of the Arctic freshwater budget using rawinsonde data. Improved estimates of precipitation minus evaporation have been provided for the period 1973-1995 for the major Arctic watersheds and the Arctic basin as a whole. In collaboration with D. Bromwich (Ohio State University), results have been compared with P-E derived from NCEP and ECMWF reanalysis fields. Findings were presented by Serreze and Barry at a NATO-sponsored workshop on the Arctic freshwater budget held in Talinn, Estonia, in April 1998 and are scheduled to appear in three resulting book chapters. A manuscript summarizing the representation of P-E from reanalysis fields has been submitted to Journal of Climate. The NCEP data were also used to compile an improved climatology of northern hemisphere cyclone activity over the period 1958-1997. I am Co-PI on two new grants (A. Lynch, PI). The first seeks to "scale up" climate and ecological studies under the NSF ARCSS Land Atmosphere Ice Interactions (LAII) effort to provide a circum-Arctic view. The second focuses on Arctic sea ice variability and climate feedback processes. A review paper synthesizing observational evidence of environmental change in the Arctic over the past several decades is in press. A paper addressing the ability of a regional climate model to reproduce observed sea ice anomalies has been submitted.

Julienne C. Stroeve

Snow Albedo from EOS AM-1 Instruments

In March 1997, Drs. Stroeve and Nolin participated in the NASA sponsored EOS validation field campaign in the California Sierra Nevada. This campaign involved scientists from the University of California, Santa Barbara, NASA/Jet Propulsion Laboratory (JPL) and the University of Colorado. The objectives were to validate and calibrate snow albedo, snow angular reflectance and surface temperature from instruments flying on the NASA ER 2 high altitude aircraft. Working with the JPL team, extensive measurements were made of snow and atmospheric properties.

Modeling the effects of aerosols on the MISR and MODIS visible and near infrared spectral channels is underway. A series of sensitivity studies will be performed for the MISR and MODIS spectral channels.

Tingjun Zhang

Atmosphere-Active Layer Permafrost Modeling

This is a continued collaborative study with Professor K. Stamnes at the Geophysical Institute, University of Alaska Fairbanks. During the Academic Year 1997-98, the following research has been accomplished:

(1) Sensitivity of the active layer and permafrost to climate change T. Zhang and K. Stamnes.

A finite difference model for one-dimensional heat flow with phase change was used to investigate the effect of climatic factors on thermal processes of the active layer and permafrost at Barrow, Alaska. Results show that the effective depth hoar fraction of the seasonal snow cover ranged from 0.11 through 0.35, with average of 0.18. The thickness of the depth hoar layer varied from 2.7 cm to 4.8 cm, with an average value of 3.7 cm. The calculated mean annual ground and permafrost surface temperatures were about 0.7°C higher than the measured values. The calculated active layer thicknesses were close to the measured values. Results from sensitivity analysis indicate that among the variable climate factors, air temperature is the most important single factor controlling the soil temperatures, while seasonal snow cover and soil moisture are also important but secondary factors. The existence of thin depth hoar layer within the seasonal snow cover is crucial to its insulating effect, while snow thickness becomes a secondary factor. Thawing index and soil moisture conditions are the most important factors influencing active layer thawing processes. Freezing index and seasonal snow cover influence the development of the active layer but their effects are very limited. This work will appear in *Permafrost and Periglacial Processes*.

(2) Toward a better understanding of the response of deep permafrost temperature to climatic change.

To understand the response of permafrost temperature to climate change, two key variables need to be considered: magnitude of the permafrost warming and the penetration depth of the warming signal. Using the long-term mean surface temperature of the permafrost of -12.2°C extrapolated from deep linear permafrost temperature profiles near Barrow, Alaska, as initial condition, numerical modeling results reveal that changes in air temperature since 1880s in the Arctic indeed produces a warming of permafrost by 2 to 4°C. This implies that the long-term equilibrium permafrost surface temperature was established around or before 1880. Recent results from the PALE program indicate that temperature was a few degrees lower from the mid-1600s to late 1800s in the Alaskan Arctic and the Arctic as a whole. Therefore, the establishment of the long-term mean surface temperature of the permafrost around 1880s was very likely. The numerical modeling results also reveal that the penetration depth of the warming signal was deeper than the measured values. The model predicts an approximately correct penetration depth with lower thermal diffusivity. Some studies indicate that there is extremely high salinity of the pore water in permafrost, which supports the low thermal diffusivity assumptions.

Overall, general conclusions from this study are that (1) the long-term mean surface temperature was established before or around the 1880s, (2) permafrost started warming at about the same time as the atmosphere around the 1880s, (3) variations in the penetration depth might be related to changes in thermal properties of permafrost, (4) variations in the magnitude of the permafrost surface warming might be related to local factors, such as soil type, vegetation, microrelief, soil moisture condition, and seasonal snow cover.

Thaw Lake Study on the North Slope of Alaska

(1) Two-dimensional numerical model development and thaw lake simulation. T. Zhang and M.O. Jeffries

A physically based, two-dimensional, non-steady model is under development to investigate the heat and mass transfer between the atmosphere and permafrost, through the intervening seasonal snow cover, lake ice and lake water. Some preliminary results show that for a lake of 3 m in depth and 800 m in diameter, the talik thickness ranges from about 73 m at the center to a few meters near the shore after 3200 years of the initiation of a thaw lake. The thawing rate of permafrost from the top ranges from greater 10 cm/yr at the beginning to a few millimeters after 25,000 years. Permafrost also starts to thaw from the bottom after 1800 years, the time constant in the Prudhoe Bay area, of initiation of a thaw lake. The upward thawing rate is relatively small comparing to the downward thawing rate from the top.

(2) Heat fluxes over tundra and lake ice on the North Slope of Alaska. M.O. Jeffries and T. Zhang

Field measurements indicate that conductive heat flux through the snow on tundra, grounded ice, and floating ice over lakes in northern Alaska were 1.5, 5.4, and 18.6 Wm^{-2}, respectively. The simulated fluxes using a numerical model reproduce very well the magnitudes and differences that were observed in the field. The flux variability is due to differences in the energy available in a system. The tundra active layer freezes completely and becomes coupled to the underlying permafrost in the autumn, while the complete freezing of the thawed zones at the bottom of lakes occurs later in the winter and depends on the water depth-dependent timing of the contact between the growing ice cover and sediments. The largest heat fluxes occur in lakes where the water depth exceeds the maximum ice thickness. The greater heat flux through the snow cover over the lake ice may have a significant impact on climate of the Alaskan North Slope.

NSIDC PUBLICATIONS

Four issues of the quarterly newsletter *NSIDC Notes* were distributed in 1997. About 1520 are now distributed worldwide. *NSIDC Notes* provides information about activities at NSIDC, including the NSIDC DAAC, ARCSS Data Coordination Center, the Antarctic Data Coordination Center, passive microwave data distribution, and research projects underway. It also offers information from other centers thought to be useful to the *NSIDC Notes* audience. This newsletter is part of NSIDC's commitment to foster communication within the cryospheric research community and is available online at http://www-nsidc.colorado.edu/NSIDC/NOTES/.

The *New Accessions List (NAL)* has been published by NSIDC/WDC since 1977. *NAL*, a product of the CITATION data base, is a quarterly list of documents, categorized by subject,

received and catalogued during a given period. This publication, which fills much of the information exchange role stipulated by WDC System guidelines, is available on NSIDC's home page. http://www-nsidc.colorado.edu/NSIDC/PUBS/

NATIONAL/INTERNATIONAL COLLABORATION

The World Climate Research Programme Climate and Cryosphere Task Group.

The World Climate Research Programme (WCRP) has established a new Task Group on Climate and Cryosphere (CLIC). The first meeting of the Task Group took place in Utrecht, Holland, 8-11 July 1998 and was chaired by Roger G. Barry. The Task Group is drafting a Science and Coordination Plan for WCRP that addresses the role of the cryosphere in climate, cryospheric signature of climate and climate variability, and the potential impacts of climate changes on the cryosphere. The coordination of CLIC activities with those of other WCRP components, and of other international programs, institutions and activities is also addressed. The plan will be reviewed by the ACSYS Scientific Steering Group and submitted to the Joint Scientific Committee of WCRP in March 1999.

A new WMO publication: *WMO1998: The Global Climate System Review (Dec.1993- May 1996)* WMO no. 856 contains contributions to Chapter 8 on the Cryosphere. Information is provided on recent changes in the extent of Arctic sea ice by R.G. Barry, J. Maslanik and M. Miles, WDC-A for Glaciology. Miles was a former doctoral student of Roger Barry, who is now employed at the Nansen Center for Remote Sensing in Bergen, Norway.

Collaboration with WDC-D

Richard Armstrong received a grant from the NSF Division of International Programs to establish initial collaborative work in support of a research project to assess the hydrology and snow cover water resources of China and Mongolia. This work is in collaboration with the Lanzhou Institute of Glaciology and Geocryology (LIGG) and the World Data Center-D for Glaciology, Lanzhou, China, the National Natural Science Foundation of China, and the GEWEX Asian Monsoon Experiment (GAME) and the Glaciology Division, Institute of Geoecology, Mongolian Academy of Sciences. The first direct scientific contact in this effort will be a visit to NSIDC by two scientists from LIGG during October and November of 1998.

2002 Olympics

Julienne Stroeve is working with Michael Splitt from University of Utah NOAA Cooperative Institute for Regional Prediction to derive snow surface temperature from satellite data in the Utah Mountains for use in the 2002 Olympics. This data could be used to help build an expanded climatology of the snow skin temperature in the Wasatch Mountains.

NSIDC STAFF

A number of significant staffing changes took place during the year. Claire Hanson left her position as User Services Manager after 18 years in November 1997. Claire's many contributions culminated in her extensive work to ensure the completion of the CAPS CD-ROM in time for the Seventh International Permafrost Conference.

Ann Brennan Thomas retired from her position as Head of Information Services in May 1998. She joined WDC-A for Glaciology in 1978 and during her time at the center she served a Technical editor for *Glaciological Data Reports* 7 through 29 as well as editing many manuscripts and compiling *NSIDC Notes*. A committee is reviewing staffing needs for the Information Center.

New employees

Ann M. Bessenbacher	August 24, 1998 - Ingest/Distribution Technician
Martyn P. Clark	September 1, 1998 - Remote Sensing Scientist
Cathy A. Copeland	October 27, 1997 - Database Administrator
Karen E. DeClerk	August 1997 - Employment Supervisor
Todd A. Edmands	November 10, 1997 - Systems Administrator
Allan H. Frei	June 22, 1998 - Remote Sensing Scientist
Melinda C. Marquis	June 22, 1998 - Science Writer
Julie A. Soja	August 24, 1998 - Database Applications Programmer
Tracy L. Thrasher	January 5, 1998 - User Services Representative
Robin J. Welsh	July 27, 1998 - Technical Writer
Matthew W. Wolf	March 30, 1998 - Operations Technician
Jason D. Wolfe	August 18, 1997 - User Services Representative

Promotions

Renea F. Ericson	September 1, 1998 - Operations Supervisor
Michelle M. Holm	November 7 1997 - User Services Manager
Chris K. McNeave	August 15, 1997 - ARCSS Data Coordinator
Mike J. Meshek	June 22, 1998 - Information Architect
I-Pin Wang	April 1, 1998 - Sr. Ingest/Distribution Technician

VISITORS

Dr. Julia Branson, Geodata Institute, University of Southampton, UK, 19-20 February 1998. (R.G. Barry)

Dr. Michael Clark, Geodata Institute, University of Southampton, UK, 15-17 February 1998. (R.G. Barry)

Adm. Craig E. Dorman, Ph.D.; Office of Naval Research, 22 July 1998. (R.G. Barry, F.M. Fetterer, R.L. Weaver)

Dr. David Gilichinsky, Insitute of Soil Science, Russian Academy of Sciences, Pushchino, Russia, 30 June-3 July. (R.G. Barry, T. Zhang)

Dr. Daniel Hiltbrunner, Institute of Applied Physics, University of Bern, Bern, Switzerland, 1 June-22 July, 1998. (R.L. Armstrong)

Dr. Marina Leibman, Earth Cryology Council, Moscow, Russia, 10 February - 13 March 1998. (R.G. Barry)

Matt Lythe, British Antarctic Survey, Cambridge, UK. (T.A. Scambos, G.R. Scharfen, R. Bauer)

Dr. Nick Pepin, Faculty of Environment, Portsmouth, UK, August 1998. (R.G. Barry)

Dr. Drew Pilant (Michigan Tech) on 21 November 1997. He gave a CPP seminar on remote sensing of lake ice. (A.W. Nolin)

Dr. Vassili Smolianitski, Arctic and Antarctic Research Institute, St. Petersburg, Russia, 14-21 August 1998 (R.G. Barry, F.M. Fetterer)

COMMITTEE REPRESENTATION

International Commission on Snow and Ice (ICSI) Snow and Climate Working Group - R.L. Armstrong, Chairman

International Permafrost Association (IPA) Standing Committee on Data Information and Communications - R.G. Barry, Co-Chair

International Satellite Land Surface Climatology Project (ISLSCP) Science Panel - G. Scharfen

NASA Science Information Services (SIS) Study Team, Lead Customer Group - R.L. Armstrong

SCAR/COMNAP Joint Committee on Antarctic Data Management - G. Scharfen, R. Bauer

WCRP-ACSYS Data Management and Information Panel - R.L. Armstrong

WCRP-ACSYS Scientific Steering Group - R.G. Barry

WCRP Terrestrial Observations Panel - R.G. Barry

WMO Commission on Maritime Meteorology Steering Group for the Global Digital Sea Ice Data Bank - R.G. Barry, Co-Chair

MEETINGS

American Geophysical Union, Fall Meeting 8-12 December 1997, San Francisco, CA. (R.L. Armstrong, R.G. Barry, R.J. Bauer, J.A. Bohlander, M.J. Brodzik, M.J. Clark, A. H. Frei, C. Haggerty, C.S. Hanson, R. Hauser, M.M. Holm, C. Hurst, A.W. Nolin, T.A. Scambos, G.R. Scharfen)

AMSR Science Meeting on March 31, NASA/GSFC, Greenbelt, Maryland. (R.L. Armstrong, J.C. Stroeve)

AMSR Science Meeting on July 7, Seattle, Washington. (R.L. Armstrong, J.C. Stroeve)

West Antarctic Ice Sheet Initiative Fourth Annual Workshop, 10-13 September 1997, Sterling, VA. (R. Bauer and G. Scharfen)

Joint Committee on Antarctic Data Management, 20-24 July 1998, Concepcion, Chile. (R. Bauer and G. Scharfen)

Association American Geographers, Boston, MA, 25-28 March 1998. (R.G. Barry, T. Zhang)

Global Climate Observing System, Terrestrial Observations Panel for Climate (GCOS/TOPC), Corvallis, OR, 25-28 May 1998. (R.G. Barry)

Historical Ice Charts Conference, Seattle, WA, 5-6 August 1998. (R.G. Barry)

IGARSS'98, 6-10 July, Seattle, WA. (R.L. Armstrong, J.C. Stroeve)

International Conference on Permafrost, 7th, Yellowknife, NWT, Canada, 22-26 June 1998. (R.G. Barry, C. Haggerty, T. Zhang)

MODIS Science Team Meeting, 24-26 June 1998, Greenbelt, MD. (G.R. Scharfen, A.W. Nolin)

NATO Advanced Research Workshop on the Arctic Ocean Freshwater Balance, Tallin, Estonia, 27 April-1 May 1998. (R.G. Barry, M. Serreze)

EOSDIS MODLand - SDST Meeting, 11-13 February 1998, Greenbelt, MD. - G. Scharfen

ISLSCP Science Panel Meeting, 27-30 April 1998, Paris, France. (G.R. Scharfen)

Briefing on U.S. Antarctic Data Coordination Center at WDC/NSIDC, NSF/OPP, 9 September 1997, Arlington, VA. (G. Scharfen)

U.S. Russia Environmental Working Group on Arctic Meteorology Atlas, NSIDC, 17-19 August 1998. (R.G. Barry, F. Fetterer)

U.S. Russia Cooperation in Protection of the Environment, Data Exchange Coordinators (Working Group VII), NCAR, Boulder, CO, 15-17 September 1998. (R.G. Barry)

WCRP Climate and Cryosphere (CLIC) Task Group, Utrecht, Holland, 8-11 July, (R.G. Barry, meeting chair.)

WMO - Commission on Maritime Meteorology, Scientific Steering Group meeting, NSIDC, Boulder, CO, 10-12 August 1998. (R.G. Barry, co-chair)

RESEARCH PUBLICATIONS

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ACRONYMS

AARI	Arctic and Antarctic Research Institute (Russia)
ACSYS	Arctic Climate System Program (WCRP)
ADCC	ARCSS Data Coordination Center
AGU	American Geophysical Union
AMD	Antarctic Master Directory
AMSR	Advanced Microwave Scanning Radiometer
ARCSS	Arctic System Science
ARCSyM	Arctic Regional Climate System Model
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVHRR	Advanced Very High Resolution Radiometer
CAPS	Circumpolar Active Layer and Permafrost System
CCAR	Colorado Center for Astrodynamics Research
CCRR	Canadian Center for Remote Sensing
CGED	Committee on Geophysical and Environmental Data
CIRES	Cooperative Institute for Research in Environmental Sciences
CLIC	Climate and Cryosphere (WCRP)
CMM	Commission on Marine Meteorology
COADS	Comprehensive Ocean-Atmosphere Datasets
COMNAP	Council of Managers of National Antarctic Programs
CRYSYS	Cryospheric System Program (Canada)
CU	University of Colorado
DAAC	Distributed Active Archive Center
DEM	Digital Elevation Map
DIF	Directory Interchange Format
DLT	Digital Linear Tape
DMSP	Defense Meteorological Satellite Program
DOE	Department of Energy
EASE-Grid	Equal Area SSM/I Earth Grids
ECMWF	European Centre for Medium Range Weather Forecasts
ECS	EOSDIS Core System
EDC	EROS Data Center
ENSO	El Niño - Southern Oscillation
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
EROS	Earth Resources Observations System
ESDIM	Earth System Data and Information Management
EU	European Union
EWG	Environmental Working Group
FTP	File Transfer Protocol
GAC	Global Area Coverage
GCMD	Global Change Master Directory
GD	Glaciological Data
GDSIDB	Global Digital Sea Ice Data Bank
GEOSAT	Navy Geodetic Satellite

GGD	Global Geocryological Database
GIS	Geographic Information System
GISP	Greenland Ice Sheet Program
GLAS	Geoscience Laser Altimeter System
GLIMS	Glacier Land-Ice Monitoring with Satellites
GRIP	Greenland Ice Sheet Program
GSFC	Goddard Space Flight Center
HARA	Historical Arctic Rawinsonde Archive
HTML	HyperText Markup Language
IAS	Ice Altimetry System
ICSU	International Council of Scientific Unions
IPA	International Permafrost Association
LAII	Land/Atmosphere/Ice Interactions
LANDSAT	Land Remote Sensing Satellite
LLIG	Lanzhou Institute of Glaciology and Geocryology
ISLSCP	International Satellite Land Surface Climatology Project
MIMS	Multiyear Ice Mapping System
MISR	Multiangle Imaging SpectroRadiometer
MODIS	Moderate Resolution Imaging Spectrometer
NAL	New Accessions List
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCEP	National Center for Environmental Prediction (NOAA)
NESDIS	National Environmental Satellite, Data and Information Service
NGDC	National Geophysical Data Center
NIC	National Ice Center
NISE	Near-Real Time SSM/I EASE-Grid Daily Ice Concentration and Snow Extent
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NSF	National Science Foundation
NSIDC	National Snow and Ice Data Center
OAII	Ocean/Atmosphere/Ice Interactions
OLS	Operational Linescan System
OPP	Office of Polar Programs
PALE	Paleoenvironments from Arctic Lakes and Estuaries
PI	Principal Investigator
RAS	Russian Academy of Sciences
SAR	Synthetic Aperture Radar
SCAR	Scientific Committee on Antarctic Research
SCICEX	Scientific Ice Expeditions
SEASAT	Sea Satellite
SGI	Silicon Graphics Incorporated
SHEBA	Surface Heat Budget of the Arctic Ocean
SMMR	Scanning Multichannel Microwave Radiometer
SMO	Science Management Office

SSM/I	Special Sensor Microwave Imager
TOVS	TIROS Operational Vertical Sounder
TRMM	Tropical Rainfall Measuring Mission
USGS	United States Geological Survey
V0	Version 0
WCRP	World Climate Research Programme
WDC	World Data Center
WGMS	World Glacier Monitoring Service
WMO	World Meteorological Organization
WORM	Write Once Read Many
WWW	World Wide Web