

***NATIONAL SNOW AND ICE  
DATA CENTER***

***WORLD DATA CENTER-A  
FOR GLACIOLOGY***



***ANNUAL \_\_\_\_\_ 1994  
REPORT***

The cover photograph, taken during the Arctic Ice Dynamics Joint Experiment (AIDJEX), shows a pressure ridge in the Arctic sea ice. It is one of a collection of AIDJEX photographs archived at NSIDC. AIDJEX was a U.S. - Canadian cooperative research program during 1970 - 1979 which collected information on sea ice dynamics.

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# ANNUAL REPORT

1994

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

# NSIDC/WDC ANNUAL REPORT

FY 1994

## Table of Contents

INTRODUCTION.....	1
CURRENT PROGRAMS .....	2
Data Activities .....	2
Project Activities .....	9
ESDIM .....	9
DMSP Data Management.....	10
NSIDC Distributed Active Archive Center (DAAC) .....	14
EASE-Grid.....	22
Global Snow Cover Mapping.....	23
Arctic System Science (ARCSS).....	24
FUTURE PLANS.....	26
RESEARCH ACTIVITIES.....	29
FUNDING.....	37
Funding Sources .....	37
Data Request Statistics.....	37
REFERENCES.....	40
NATIONAL AND INTERNATIONAL COLLABORATION .....	41
PUBLICATIONS .....	42
COMMITTEES .....	46
MEETINGS.....	48
ACRONYMS .....	51

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

## **ANNUAL REPORT FY1994**

### **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), and the National Environmental Satellite, Data, and Information Service (NESDIS) of NOAA. Within CIRES, NSIDC/WDC is a part of the Cryospheric and Polar Processes division. NSIDC/WDC is completing its eighteenth year of service to the snow and ice research community from its Boulder location.

NSIDC/WDC is funded by various federal agencies, including the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF). Some of the data management and administrative functions are supported by NOAA, with major project support from all the above mentioned agencies.

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. The latter mandate calls for information to assist policy formulation and decision-making regarding the oceans, atmosphere, and coasts, and to ensure related public health and safety and national resource development (Byrne, 1984). Examples of such activities directly relating to NSIDC/WDC include the acquisition and dissemination of global environmental satellite data, data on earth surface properties, including snow cover, on ocean variables, including sea ice extent and on paleoclimates, with ice core information (NOAA, 1992, Appendix, C, D). These data sets serve as cryospheric components in inter-disciplinary global change research.

This report discusses NSIDC/WDC activities for the 1994 fiscal year (October 1, 1993 to September 30, 1994).

## CURRENT PROGRAMS

The ongoing activities of NSIDC/WDC fall into three broad inter-related areas: 1) data – archiving, managing, disseminating; 2) projects – limited-scope or defined-period activities relating to specific data sets; 3) research – scientific study which expands our knowledge of the role of the cryosphere in the global climate system. Staff members are often involved in a variety of complementary activities.

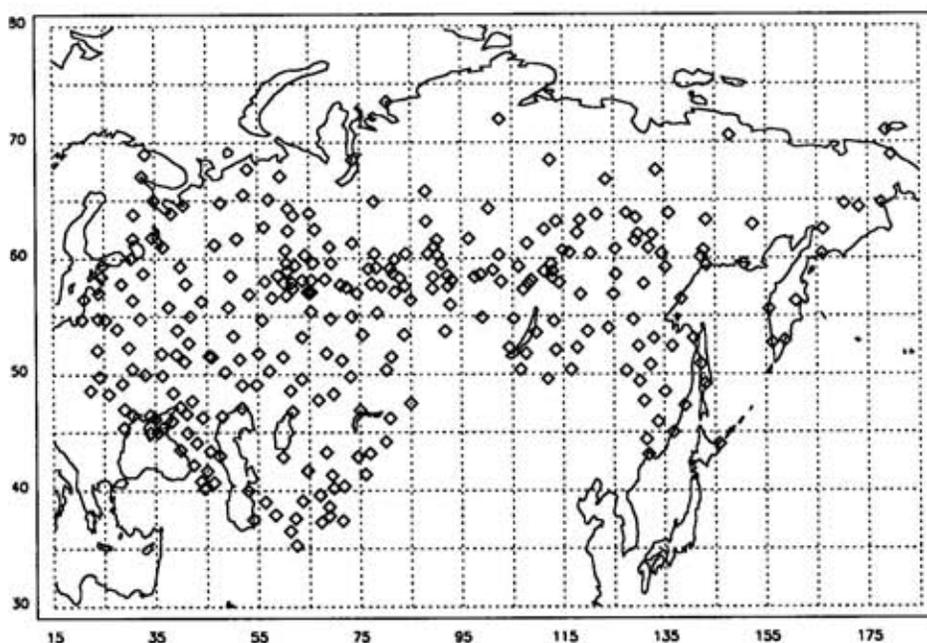
### DATA ACTIVITIES

#### *Data Set Administration*

The following data sets were added or updated in FY94.

1. An inventory of over 11,000 glaciers in Russia and other states of the former Soviet Union (FSU) has been received at NSIDC. These data, provided by Dr. V.M. Kotlyakov of the Institute of Geography, Russian Academy of Sciences, are part of a program to acquire an inventory of all Russian glaciers. This is about one-half of the data we expect to acquire for this important NOAA/ESDIM-funded rescue effort.
2. Runoff, precipitation, mass balance, and ice velocity measurements for the South Cascade Glacier, Washington, for the years 1992 and 1993 have been added to the NSIDC archive. The data are available for distribution on PC diskette and were provided by Dr. Robert Krimmel of the Ice and Climate Project, U.S. Geological Survey.
3. Snow cover data, primarily snow course transects, for Central Asia covering the years 1969 to 1990 have been received at NSIDC. These data were provided by V. Konovalov, B. Tsaryev, and E. Pichugina of the Central Asian Hydrometeorological Research Institute, (SANIGMI), Tashkent, Uzbekistan. Quality checking of the data will be done in FY95.
4. Snow cover data for the former Soviet Union covering the years 1979 to 1990 have been received at NSIDC. This data set covers over 1,000 WMO stations throughout the FSU. These data were provided to NSIDC by Professor Krenke of the Institute of Geography, Moscow.

5. NSIDC has produced a one-off CD-ROM of historical Soviet daily snow depth (HSDSD). The one-off is being tested, with mastering and replication scheduled for December 1994. This data set was developed based upon the snow cover data received from the National Climatic Data Center through the U.S.-U.S.S.R. Bilateral. This CD-ROM includes daily snow depth files, synoptic order files, and monthly products. The data set encompasses 284 WMO stations over the years 1881 to 1985. (Figure 1)



**Figure 1. Historical Soviet Daily Snow Cover Sites, 1881 to 1985**

6. Iceberg data from the International Ice Patrol (IIP) for the 1993 and 1994 seasons have been received at NSIDC, extending the archive from 1960 to the present.
7. Iceberg drift buoy data, provided by IIP, have been received at NSIDC. These data supersede and expand an earlier data set held at NSIDC. Icebergs were tracked in several years (1977, 1978, 1980, 1983, and 1989) for periods ranging from one week to two years.
8. Raw ARGOS buoy data from the International Arctic Buoy Program (IABP), University of Washington, are being archived on 3480 cartridges. This is the Level 1 data stream from which the daily

gridded IABP temperature, pressure and ice velocity are derived. The raw data archived are from 1979 to 1991.

Please see NSIDC Distributed Active Archive Center, p. 14 and Arctic System Science Data Coordination, p. 24 for information on other NSIDC data sets which are managed within a project,

### ***Information Center and CITATION Data Base***

To support the research activities of the Center's scientific staff, to document the data holdings, and to meet the increasing demands for information on cryosphere climate studies on a global-scale, NSIDC/WDC maintains an active program to acquire published materials on snow, ice and permafrost research.

Currently, the Information Center contains 6500 monographs and technical reports and 14,500 reprints; 90 serial publications are regularly received. During 1994, approximately 1500 items were added to the collection.

All materials received are catalogued and assigned subject and geographic descriptors, including articles in journals and individual papers in conference proceedings. Primary access to the collection is provided by CITATION, the in-house on-line catalog. We are now using INMAGIC and SearchMAGIC software at NSIDC, which allows CITATION to be implemented in-house. SearchMAGIC, a user-friendly system for searching the data base and outputting reports, has been installed in the Information Center.

At the end of FY94, there were over 32,000 records in the data base. The file is updated regularly. The subject headings in CITATION are those used by the Cold Regions Research and Engineering Laboratory in their CRREL bibliography and COLD data base. Our collection holds materials on all aspects of snow and ice research, however, our focus in recent years has concentrated on snow cover and sea ice data and information and the effects of the cryosphere on climate. On-line searches of the collection are performed on request.

Bibliographic access to the information holdings of NSIDC/WDC for the snow and ice community is also available through CD-ROM. The entire data base is included on the Arctic and Antarctic Regions disc produced by the National Information Services Corporation (NISC) for the Library of Congress, Cold Regions Bibliography Project. Currently,

the disc holds over 675,000 references on various aspects of polar regions science and technology. Data have been contributed by the Cold Regions Bibliography Project and NSIDC/WDC (U.S.), the Arctic Science and Technology Information System, the Centre for Cold Ocean Resources Engineering, the Department of Indian and Northern Affairs, Northern Development, and two data bases from the Canadian Circumpolar Institute (Canada) and the Scott Polar Research Institute (U.K.). This disc provides access to the most comprehensive bibliographic collections of polar regions science in the world.

### ***Publication Program***

Two series, *New Accessions List* and *Glaciological Data*, have been published by NSIDC/WDC since 1977. *New Accessions List* (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 World Data Center System guidelines is mailed worldwide to about 350 scientists, research institutions, and libraries. One issue, comprising four quarterlies for 1993, was printed and distributed in FY94.

*Glaciological Data* (GD) is the principal publication of NSIDC/WDC. Issues usually focus on a single topic and include specialized bibliographies, inventories and survey reports, and workshop proceedings relating to snow and ice data research prepared by NSIDC/WDC staff, as well as invited or contributed articles on data sets, data collection and storage, methodology, and terminology in glaciology. Current circulation of GD is approximately 950 copies, 50 percent of which are mailed to addresses outside the United States, generally in exchange for publications submitted to the WDC. Whenever possible, GD publication costs are obtained through specific agency or project support.

One volume in this series was published in 1994. *Glaciological Data, Report GD-27, Permafrost and Climatic Change: An Annotated Bibliography* was published in cooperation with the International Permafrost Association Working Group on Present Global Change and Permafrost. It provides an extensive guide to literature on permafrost as an indicator of climatic change. It complements the more general bibliographies on permafrost literature published in the *Glaciological Data* series (Reports 14, 21 and 26).

Four issues of *NSIDC Notes*, a quarterly newsletter, were distributed in FY94. The mailing list for this series continues to grow. This year, circulation has increased almost 40%; over 900 copies are distributed to a worldwide audience. *NSIDC Notes* provides information about activities at NSIDC including the NSIDC Distributed Active Archive Center (DAAC), the Arctic System Science (ARCSS) data management, DMSP OLS digital and analog data distribution, passive microwave data distribution, and research projects underway. This newsletter is part of NSIDC's commitment to foster communication within the cryospheric research community.

Under the auspices of the Polar Libraries Colloquy, WDC-A participated in the compilation and printing of the *Polar and Cold Regions Library Resources: A Directory*. This directory, which lists 149 libraries, archives and collections in 20 countries, was prepared by WDC-A (A. Brennan), the Institute of Arctic and Alpine Research (University of Colorado) and the Arctic Centre (University of Lapland, Finland). It offers detailed information about collections and services, including access directions. It is available in a printed version as well as on-line via the Polar Libraries Bulletin Board on the Internet. We plan to keep the on-line version continually updated.

#### ***Data-Related Committees***

WDC/NSIDC staff participates in numerous data-related national and international working groups, several of which are listed below. For a complete list of committee involvement and meetings attended, please see p. 46-50.

#### **Arctic System Science (ARCSS) Ocean-Atmosphere-Ice Interactions (OAI) Steering Committee**

NSIDC provides data management services for three components Ocean-Atmosphere-Ice Interactions (OAI), Land-Atmosphere-Ice Interactions (LAI), and Greenland Ice Sheet Program (GISP2) of the ARCSS Program. Claire Hanson is the Project Manager

#### **NOAA/NASA Pathfinder Program SSM/I Science Working Group and Inter-Pathfinder Project**

The Pathfinder Program was developed to enhance access to currently archived satellite data sets, which have been scientifically validated. The

Program will also ensure that the data are distributed in standard format at minimal cost. R.L. Armstrong is the principal NSIDC contact.

#### Arctic Environmental Data Directory (AEDD) Working Group

C. Hanson, A. Brennan and R. Barry are members of the AEDD, an activity sponsored by the Interagency Working Group on Data Management for Global Change to enhance the accessibility of Arctic data collected by U.S. agencies and organizations. The group meets annually, with periodic teleconferences to address issues of directory format, content, and population.

#### SEDAAR Science Advisory Group

C. Hanson represented NSIDC as part of a civilian science advisory panel reviewing the "Strategic Environmental Data Active Archive Resource (SEDAAR-1) being developed by CIESIN with funding from the DOD Strategic Environmental Research and Development Program (SERDP). The database and data visualization system is intended to help meet DOD and global change research requirements for data access and analysis tools. Negotiations with CIESIN and NOAA/NESDIS are underway for a joint beta test site of the system at NGDC and NSIDC, involving a graduate student from the University of Colorado Department of Geography in the scientific evaluation of the ARC/INFO-based system.

#### U.S. Polar Bibliographic Working Group

This group, sponsored by the National Science Foundation, aims to ensure effective access to polar regions information for the user community. Discussions at the July meeting focused on preparation of an update to *Arctic Information and Data: a Guide to Selected Resources* which will be published in FY95 with printing support from the Arctic Research Consortium of the U.S. Ann Brennan is a member of the Working Group.

#### SCAR-COMNAP ad hoc Planning Group on Antarctic Data Management

As the U.S. member of the SCAR-COMNAP ad hoc Planning Group on Antarctic Data Management, C. Hanson reported to the Polar Research Board on the status of the proposed prototype Antarctic Data Directory System (ADDS). After its second meeting in Boulder, 9/93, the Planning Group has proposed to SCAR (Scientific Committee on Antarctic

Research) and COMNAP (Council of Managers of National Antarctic Programs) that a directory of Antarctic data be developed based on the Directory Interchange Format (DIF) of the Global Change Master Directory/International Directory Network. The prototype ADD, developed by International Centre for Antarctic Information and Research (ICAIR) in Christchurch, New Zealand, was demonstrated by the Planning Group at the XXIII SCAR meeting in Rome, August 1994. The requirement to develop an Antarctic data directory arose from concerns by the Antarctic Treaty nations regarding the accessibility and comparability of scientific and environmental monitoring data collected in Antarctica.

#### International Arctic Environmental Data Directory

R. Barry and C. Hanson are U.S. alternate delegates to the International Arctic Environmental Data Directory Steering Committee. This committee is the result of an initiative put forward by USGS and UNEP/GRID-Arendal to develop a "directory of directories" based on existing DIF-based activities such as the Global Change Master Directory. The group has members from Canada, Finland, Norway, Russia, the U.S., New Zealand (the SCAR liaison), and has met in Arendal, Norway, San Francisco, and Tromso, Norway. The main focus of the activity is environmental data. Iceland, Sweden and Denmark will be invited to join the Steering Committee; the Ministry of Environment Protection of Russia is actively involved in the group.

National Snow and Ice Data Center/WDC-A for Glaciology [Snow and Ice] has re-started negotiations with UNEP/GRID in Arendal, Norway, to collaborate in development of a CD-ROM of environmental data sets for the Arctic regions. NGDC has been involved in such discussions with GRID-Arendal, and suggested that NSIDC/WDC also join in the project. NSIDC/WDC-A has provided SSM/I, SMMR, Arctic rawinsonde, and CEAREX sea ice-related data on CD-ROMs to GRID-Arendal for their environmental data and information service of providing information about available CD-ROMs to GRID clients worldwide.

## **PROJECT ACTIVITIES**

### ***ESDIM***

NSIDC has continued our programs to rescue critical data and address access needs for snow and ice data. This effort has been funded by the NOAA Earth Science System Data and Information Management (ESDIM) Initiative via NGDC. The stated objectives of the ESDIM program are to :

- Provide an integrated Earth System view of NOAA's environmental data and information;
- Provide science-quality data and information that will lead to high-quality scientific results;
- Provide integrated, efficient environmental data and information services through NOAA-wide distributed capabilities.

There are numerous examples of data which are not already held by NSIDC, not available to NOAA scientists, and which also may be at considerable risk in their current location. These include the operational sea ice data generated by the Navy/NOAA Joint Ice Center, instrumental snow, ice and meteorological observations in the Antarctic, and non-U.S. data from both the Arctic and Antarctic, e.g., snow cover ground observations from Russia and data on the fluctuation of glaciers ~~in the~~ Caucasus.

#### **FY94 Accomplishments:**

- 3480 cartridges were verified, containing 5849.7 mbytes and covering 18 NSIDC-held NOAA data sets.
- Access software (permitting user search by time and geographic coordinate box specification) was written and modified for 9 of the 18 archived data sets.

Several data sets have been made available electronically via ftp. Plans are underway to make most NSIDC data sets available via the World Wide Web (WWW) early in 1995, as part of the NGDC Geophysical On-line Data (GOLD) System. A description of NSIDC/WDC-A and a data catalog (under construction) are also available electronically in GOLD. During FY95 NSIDC will be linked directly to the NGDC WWW home page, providing seamless access to data holdings in both centers.

The following data sets are currently available on-line:

- International Ice Patrol Iceberg Data - 1960 to present
- Iceberg Data Buoys
- Sea Ice Concentration, 1953 to 1990
- National Meteorological Center/Climate Analysis Center Arctic and Antarctic Sea Ice, 1973 to present
- Great Lakes Ice Concentration Data Base
- Great Lakes Air Temperature - Degree Day Climatology, 1897 to 1983
- Great Lakes NOAA/National Ocean Survey Water Level Gage Ice Reports
- Radiation Transfer Through Ice at Two Points in the Great Lakes
- Great Lakes Ice Thickness Data Base, 1966 to 1979

### ***Defense Meteorological Satellite Program Data Management***

#### ***Analog OLS Image Archive***

NSIDC is in the twelfth year of service as the national archive for analog Operational Linescan System (OLS) data from the U.S. Air Force Defense Meteorological Satellite Program (DMSP). These images were the primary means of DMSP data distribution until the implementation of the present digital capability at Air Force Global Weather Central (AFGWC) about 3 years ago. Few images were added to the collection this year since hard-copy is only generated at selected receiving sites and for special cases. The collection now amounts to about 1.4 million pieces of imagery. In FY94, 1038 requests for data and information were processed, resulting in data sales of about \$6,800. The continuing usage of these data in light of the decrease in receipts of new images reflects the scientific value of this project.

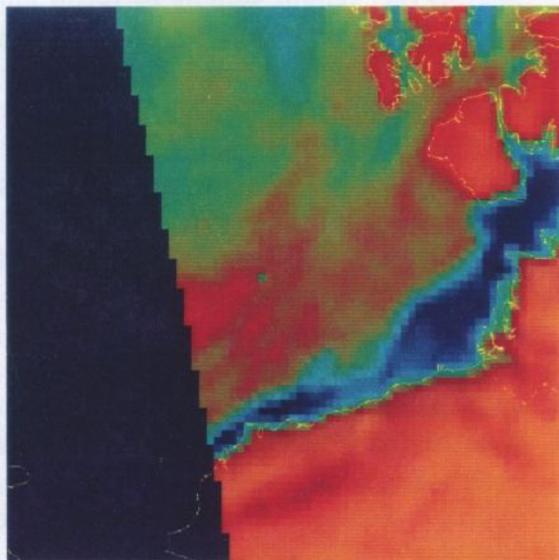
NSIDC began the transfer of the DMSP collection to the Federal Records Center (FRC) last year. This transfer is in accordance with NOAA/NESDIS policy and will take several years to complete. NSIDC is attempting to minimize the impact to the user community by retaining the most widely used data sets for as long as feasible. Almost 900 boxes were transferred in FY94, however, the remainder of the collection is actively used.

## DMSP Coverage of the Beaufort Arctic Storm Experiment Area

Sample DMSP co-incident multispectral data for 21-Sept-1994 15:04:41 UTC (F11-14526)  
produced by the National Snow and Ice Data Center from data archived at NOAA/NGDC



OLS Visible Band

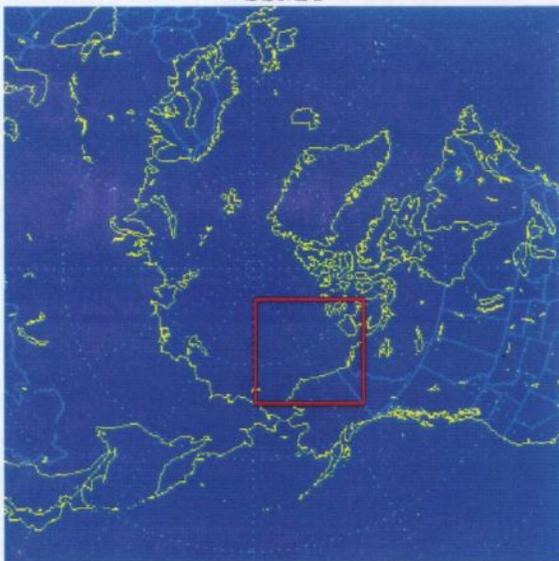


SSM/I

37H



OLS Thermal IR



Map of Area Coverage

resources permit.

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### *DMSP Digital Data Archive*

NSIDC and the National Geophysical Data Center have made considerable progress in their joint effort to archive digital DMSP data. This effort will make the complete DMSP data stream available for the first time. Financial support has been provided by the DOD, NASA and NOAA, and is being coordinated by NOAA/NGDC. A memorandum of agreement was negotiated between the Air Force and NOAA/NESDIS. NSIDC has been directly involved with development of many of the archive functions including system design, archive formats, geolocation, image display, and the search/browse/order graphic user interface. An example of this work is the design and implementation of DMSP OLS Geolocation, Image Display and Graphical Orbit Mapping Tool. This package of tools provides users with the ability search and browse data and to scroll through orbits of DMSP visible and infrared imagery, overlay coastlines, political boundaries and graticules, and to adjust image brightness and contrast. Data can be geolocated approximately for time-critical applications or more accurately if time permits.

NSIDC is also contributing scientific expertise in data interpretation stemming from the DMSP/OLS analog archive and the DAAC project and considerable experience in the management of satellite data in support of cryospheric and climate system studies. While the archive of digital DMSP data will reside at NGDC, user services will be provided by both by NSIDC and NGDC, depending on the scientific discipline and type of request. NSIDC is gearing its operation to the provision of data and data products related to the cryosphere. Funding for the activity at NSIDC has come from NOAA/NGDC, NOAA Climate and Global Change Program and NASA.

Data from all DMSP satellites and sensors have been copied to 8 mm tape since March 1992. Although the archive includes digital data beginning then, routine processing of OLS data did not begin until March 1994. Routine processing of the SSM/I passive microwave imager, SSM/T microwave temperature sounder, and SSM/T-2 water vapor profiler did not begin until September 1994. Data prior to these dates form the "backlog" and will be processed on demand for specific requests, or as resources permit.

The color plate on the previous page is an example of a test product made for the Beaufort and Arctic Storms Experiment (BASE) using digital DMSP data from the NGDC archive. NSIDC co-registered the OLS visible and infrared data with SSM/I data. A map of the area using

NSIDC's DMSP tools is also shown. A cold front and related high and low clouds obscure the sea ice surface in the OLS data, but the sea ice edge is clearly visible in the SSM/I data.

#### ***NSIDC Distributed Active Archive Center (DAAC)***

NSIDC is in the third year of a five-year contract with NASA participating as one of eight Distributed Active Archive Centers (DAACs) in the Earth Observing System Data and Information System Project (EOSDIS). The Earth Observing System (EOS) is a long-term interdisciplinary and multidisciplinary research effort to study global-scale processes that shape and influence the Earth as a system. EOSDIS will manage the data resulting from NASA's research satellites and field measurement programs, and other data essential for the interpretation of these measurements. It will also provide access to data held in the archives of other government agencies, organizations, and countries.

The discipline focus of the NSIDC DAAC is on snow and ice processes, especially interactions between snow and ice and the atmosphere and ocean. The primary areas in which the DAAC supports research are global change detection, Earth system model validation, and process model development and validation relating to the cryosphere, (Barry et al., 1994).

Currently, snow and ice products are generated from DMSP SSM/I data. Nonsatellite data, such as meteorological fields, station data, and buoy measurements, are archived for comparison to satellite information and for input into sea-ice and climate models. The NSIDC DAAC supports the development of products to monitor ice-surface temperature and motion by providing access to 1 km AVHRR, DMSP OLS and SSM/T2, and TOVS satellite data. Satellite altimetry data are being archived and distributed to support ice-sheet topography studies.

As of FY94, data sets held by the DAAC include those of the heritage NSIDC Cryospheric Data Management System (CDMS). The suite of DAAC holdings is summarized in Table 1, with additional information provided in the following discussion.

The paragraphs below contain a discussion of current data sets. Additional data sets that may be included in the DAAC in the future are discussed beginning on p. 26.

**Table 1. NSIDC DAAC - Summary of Data Holdings as of July 1994**

Data Type	Volume (GB)	Remarks
DMSP SSM/I	70	Level-1.5 and Level-3 brightness temperatures; Level-3 ice extent and concentration (daily) and ice concentration (monthly)
Nimbus-7 SMMR	7	Level-3 brightness temperatures and sea-ice concentration
Geosat and Seasat altimetry data	15	Gridded elevations, height profiles, and wave forms for Greenland and Antarctica
Nimbus-5 ESMR	3	Level-1.5 and Level-3 monthly and 3-day brightness temperatures and sea-ice concentration products (monthly)
AVHRR: Polar Subsets	120	Level-0 and swath data
LEADS: ARI	20	Level-3 AVHRR scenes
<i>In situ</i> data	1.9	Multiple source and data types

***DMSP SSM/I Data***

NSIDC DAAC processes the SSM/I data into gridded, full global, and polar data products. All products are available on CD-ROM. Orbital data from the SSM/I instrument are held by NOAA Satellite Data Services Division (SDSD). Within the EOSDIS DAAC structure, the Marshall Space Flight Center (MSFC) DAAC is designated as the Level-1.5 data archive. Products generated at the NSIDC DAAC from SSM/I data include gridded sea-ice concentration and brightness temperature. Currently, a polar stereographic projection covering the polar regions is employed. The Equal Area SSM/I Grid (EASE-Grid) will be produced in parallel with the polar stereographic products to provide improved radiometric fidelity, temporal resolution, and coverage. See p. 22 for more information on EASE-Grid. A loose-leaf User's Guide containing complete documentation is part of the package. Sea ice concentration data, and F11 brightness temperature data are distributed in Hierarchical Data Format (HDF) and can be displayed and manipulated using software from the National Center for Supercomputing applications (NCSA) or commercial packages such as IDL.

### *Nimbus-7 SMMR Data*

The SMMR on Nimbus-7 operated from 1978 to 1987. Current DAAC products include gridded SMMR brightness temperatures and sea ice concentration in the SSM/I polar-grid format, which were generated by Dr. Per Gloersen of Goddard Space Flight Center in conjunction with the NSIDC DAAC. The complete time series has been published on CD-ROMs. Version 1 of the User's Guide for Nimbus-7 SMMR Polar Radiances CD-ROMs has been distributed. This document was in an extended development and review process in order to provide the proper amount of information in a format that would be helpful to users. The User's Guide supplements the SMMR Atlas (Gloersen et al., 1992). Gridded sea ice concentration estimates from both the SMMR and SSM/I data have been issued on CD-ROM, covering 1978 to 1991. This combined data set is one of the longest satellite-era measurements of a cryospheric parameter.

### *AVHRR Data*

Recent polar AVHRR data of both polar regions, at 1.1 km resolution (LAC and HRPT data types), are available from NSIDC. The Polar AVHRR 1-km data set at NSIDC consists of Antarctic scenes acquired since April 1992, and Arctic scenes acquired since August 1993. All five bands of the AVHRR sensor (primarily from the NOAA-11 satellite) are archived in orbit swath format, in uncalibrated sensor units. Several derived data products, such as sea ice motion and ice surface temperature, are under development in conjunction with the polar science community.

### *Radar Altimetry Data*

NSIDC DAAC distributes a data set derived from the Geosat and Seasat radar altimeters that contains georeferenced and corrected data collected over Greenland and Antarctica. The data are available as either point elevations or interpolated onto a 20 km grid. NSIDC has arranged with NASA's GSFC to provide data distribution from its archive of Seasat and Geosat data (supervised by Dr. Jay Zwally of GSFC). Gridded digital elevations, height profiles, and waveform data are available for both missions. For requests of data over limited areas, NSIDC will select the data from the archive and deliver them (floppy diskette, tape, or ftp transfer). The entire data set, with browse and retrieval software, will be available on CD-ROM and will be distributed by both NASA GSFC and NSIDC.

### *Nimbus-5 ESMR Data*

ESMR monthly and 3-day brightness temperatures and monthly sea ice concentration grids for 1973 to 1976 for Arctic and Antarctic regions are distributed on 9-track tape. Ancillary data include surface air temperature and pressure mapped to the same grid as the ESMR products. These data are currently being moved from 9-track tape to magneto-optical media, with documentation improvements scheduled in early FY95.

### *In Situ Data*

The following summarizes the more important in situ data available from the NSIDC DAAC. A more complete list can be obtained from the NSIDC DAAC User Services Office.

Drifting Buoy Data—Arctic Ocean drifting buoy data (1979 to present) collected by the Polar Science Center (PSC), University of Washington, are archived at NSIDC DAAC. This set of pressure, temperature, and interpolated ice-velocity values is derived from an average of about 10 Argos buoys per day. A related data set is the historical drifter data, also assembled by PSC and archived at NSIDC, containing 2-day interpolated velocities for 34 polar tracks spanning 1893 to 1973.

Arctic Sounding Data—The Historical Arctic Rawinsonde Archive (HARA) of Arctic temperature soundings above 65° N from the beginning of record through 1987 is archived at NSIDC DAAC. Approximately 1.2 million soundings are contained in the archive, representing nearly 100 land stations. For most stations the record begins in 1958, a few begin in 1947 or 1948. The data are one file per year per station. Coverage is relatively uniform, except in the interior of Greenland. Typically 20-40 levels are available in each sounding. Documentation is provided on the CD-ROM volumes, and in hard copy (Serreze et al., 1992). Software (Fortran and C) is provided on the CD-ROM volumes to retrieve a subset of the sounding data. Data for 1988-1991, and monthly averaged data, will be prepared for CD-ROM volume 4 during 1993. Sounding data were obtained from the National Center for Atmospheric Research (NCAR), Boulder, Colorado, and the National Climatic Data Center (NCDC) of NOAA in Asheville, North Carolina. The HARA CD-ROM set is being distributed at no charge as an NSIDC DAAC product. The daily sounding data base is available on three CD-ROMs.

### *Additional Data*

NSIDC archives and supports polar subsets of satellite data that have primary archives at other DAACs or affiliated data centers, as well as cryospherically relevant *in situ* data. This section presents the current status of these data sets. Satellite data sets are listed first, followed by *in situ* data sets.

AIDJEX—During the 1970s, the Arctic Ice Dynamics Joint Experiment (AIDJEX) generated data sets relating the response of sea ice to its environment. NSIDC holds three track-lines of sonar data collected in April 1976, containing a 777-nautical-mile profile of the sea ice. Wind, current, and position data from four manned camps on ice floes are also held for April–October 1975. The location of most of the AIDJEX data sets is unknown at this time. NSIDC continues to seek out information that may lead to the recovery of these data.

MIZEX—The Marginal Ice Zone Experiment (MIZEX), which was conducted in the Fram Strait and Greenland Sea in June to July 1983, May to July 1984, and March to April 1987, and in the Bering Sea in February 1983, provided data from shipborne platforms on processes in the marginal ice zone. Supporting data sets on meteorology, oceanography, sea-ice conditions, and biology are archived at NSIDC. Meteorology data are distributed on the CEAREX CD-ROM Vol. 1.

CEAREX—The Coordinated Eastern Arctic Experiment (CEAREX), carried out in the East Greenland Sea west of Svalbard from September 1988–June 1989, used satellite-, ship-, aircraft-, helicopter-, and ice-floe-based sensors. Surface platforms provided meteorological, oceanographic, biological, acoustic, and sea-ice data. NSIDC is the designated archive for the CEAREX data sets, and was funded by ONR to generate a CD-ROM series containing CEAREX and other important eastern Arctic data. This was released in November 1991.

Birdseye Data—NSIDC holds over 11,000 ice observations from U.S. Navy “Birdseye” and other ice reconnaissance operations spanning 1964 to 1975. Airborne sensors flown during MIZEX and CEAREX also generated SAR and SLAR data; microwave, infrared, and visible imagery; radar altimetry; and boundary-layer meteorology. If funding becomes available, these data sets will be prepared for incorporation in the eastern Arctic CD-ROM series. They are an invaluable resource for better understanding the meso- to small-scale processes in the exchange of

momentum, heat, and biomass within ocean eddies, internal waves, and the ocean/atmosphere boundary layer.

*Intercomparison of Sea-Ice Concentrations Derived from Polar Stereographic and EASE-Gridded SSM/I Brightness Temperatures*

NSIDC has compared a six-month time series of sea ice concentrations derived from two different gridding schemes. The polar-stereographic sea ice concentrations (produced on CD-ROM by NSIDC) were compared with sea ice concentrations derived from EASE-Grid processing.

The polar stereographic binning method is a “drop-in-the-bucket” averaging of all brightness temperatures falling into a grid cell for a given day. The EASE-Grid method uses coefficients derived from the antenna pattern to artificially increase swath sampling density. Brightness temperatures are assigned to grid cells by selecting the value of the nearest neighbor in the oversampled array. Two images are produced per day (one from the ascending passes and one from the descending). Both methods start from swath data produced by Remote Sensing Systems. The EASE-Grid data have advantages of increased temporal sampling and no averaging of data. EASE-Grid was developed by NSIDC in collaboration with the SSM/I Products Working Team as a structure for Earth-gridded SSM/I data which provides global coverage. From the brightness temperatures, sea ice concentrations are calculated using the NASA Team algorithm.

For the time series analyzed, ascending and descending images of the EASE-Grid were averaged and resampled to a polar stereographic projection. A statistical analysis on the two data sets was then performed. The difference is small in the winter months; however, as melt occurs, the difference increases. These observed differences between the data sets as a whole are within the precision of the sea ice algorithm. That is, they are within the noise level.

Examination of the distribution of differences between the data sets revealed largest differences at the ice margin where variability in concentration is greatest on both temporal and spatial scales. To further investigate the ice margin, NSIDC has examined nine subregions of 3x3 pixels (75km x 75km). Again, differences were small in summer months and increased with melt. This trend was most apparent for static areas of ice concentration. More dynamic areas, the Sea of Okhotsk and the ice margin off the east coast of Greenland, showed greater variability throughout the time series. Again this is expected for areas where sea ice

concentration is changing quickly spatially and temporally. Comparisons were also made with ascending and descending sea ice concentrations alone in order to investigate the effects of the increased temporal sampling. Only one subregion showed a consistent behavior/bias between the ascending and descending data sets, the area off the east coast of Greenland. NSIDC is continuing examination of this point.

#### *SSM/I Quality Control Using Artificial Intelligence Techniques*

Under a one-year DAAC supplemental grant, NSIDC designed a system to apply knowledge-based methods to automate and improve quality-control testing within the SSM/I data processing stream. This processing stream involves the conversion of orbital-format brightness temperatures into gridded, averaged brightness-temperature products, and subsequently to geophysical products such as sea-ice concentrations and snow depths. A variety of quality control checks are possible within this processing stream, but these steps typically require some human intervention that can be time-consuming, and may require expert knowledge beyond that offered by most operations staff. Our objective was to test the use of artificial intelligence methods to minimize the need for manual QC and to apply high-level skills within the processing stream.

NSIDC developed software to apply QC decision rules at the gridding stage of the processing stream. We developed rules coded in 'C' and the CLIPS rule-based language to check data ranges, to determine general conditions of the data, and to compare the brightness temperatures to other ancillary information such as surface temperatures and masks. We stored the results of these checks as metadata, and summarized this metadata using a weighting scheme to determine whether a particular orbit scan should be flagged as suitable for gridding. We successfully tested the system to determine its ability to read in, process, and write out SSM/I data in a form compatible with the current operational processing software. In its current form, the software offers a range of possible extensions, additions, and enhancements that could be applied to the SSM/I processing stream. Similar techniques could be used for other data sets, and offer a variety of potential applications for algorithm selection and tuning.

#### *NSIDC DAAC Systems Development Activities*

The NSIDC Version 0 DAAC system consists of the following elements: Product Generation System (PGS), Data Archive and Distribution System (DADS), Information Management System (IMS)

and User Services Office. Each of these elements were officially deemed operational in August 1994 when the NASA Project Office announced that the EOSDIS Version 0 was available for use by the Earth Science research community.

#### PGS

During 1994 NSIDC acquired an SGI Challenge-L multiprocessing system to support the SSM/I product generation and AVHRR 1km polar subset ingest and archive activities. The SSM/I processing environment was transferred to the Challenge. The Land Analysis System (LAS), acquired from EDC, was installed on the Challenge. The LAS software is used to generate subsampled browse images and level 1B products.

#### DADS

The DADS is configured with a Cygnet WORM jukebox subsystem. Software has been developed to provide archive storage and archival management of the data residing on WORM platters residing in the jukebox. Data residing on 1600/6250 bpi magnetic tapes are being transferred to the optical media. Copies of the WORM volumes are being made on 8mm cartridge tape media and will be transferred to NGDC for off-site storage. A 10-cartridge 4mm DAT auto changer was added to the DADS configuration. The DAT auto changer was acquired to support archive and distribution activities associated with the AVHRR KM polar subset.

#### IMS

##### *Cryospheric Information Management System (CIMS)*

The NASA EOSDIS Version 0 IMS is based on the distributed client/server model. Each DAAC manages a server which services requests for metadata, browse or data products from remote clients. NSIDC continues to populate its local IMS server (CIMS) data base with metadata as well as maintain a data dictionary which described the information architecture of the metadata. The following enhancements were made to the CIMS over the past year:

- accept product requests from remote clients and forward requests to NSIDC User Services staff
- service requests for browse products (stored in HDF) to be transferred in real-time to remote clients for visualization
- completed rolodex and mailing lists applications
- completed prototype of data request tracking system

Another component of the IMS is a GUIDE subsystem. The GUIDE is an electronic document handling system which uses the WWW and WAIS technologies to organize documents on-line. Documents can be accessed using MOSAIC-like interfaces. During 1994, NSIDC populated a variety of data set-related documents into the NSIDC GUIDE server. Documents were formatted using HTML and include links to graphics and images.

NSIDC has been very impressed with the way the WWW and WAIS technologies organize and service textual and graphical information over the network and the Data Center is in the process of developing an on-line information system using the WWW and WAIS protocols. Services include access to the following:

- Data Announcements
- New Accessions Lists
- *NSIDC Notes* (a quarterly newsletter published by NSIDC)
- general news
- a gallery of images
- a calendar of events

### ***An Earth-Gridded SSM/I Data Set for Cryospheric Studies and Global Change Monitoring***

NSIDC has developed a data system to produce, archive, and distribute validated global-scale geophysical products derived from the DMSP Special Sensor Microwave Imager (SSM/I). Based on the recommendations of the NASA SSM/I (Land) Products Working Team (SPWT), guidance from the Polar DAAC Advisory Group (PoDAG) and the NOAA/NASA Pathfinder Program, NSIDC has been evaluating various data formats, resampling techniques, grids and projections. The resultant format is the Equal Area SSM/I Earth-Grid (EASE-Grid) which the Pathfinder Program has adopted for the Pathfinder Level 3 geophysical products which include both SSM/I and SMMR (Scanning Multichannel Microwave Radiometer) data (1978 to 1987). Providing both data sets in the EASE-Grid will result in a 15-year time-series of satellite passive microwave data in a common format. Results of the evaluation of two prototype versions of the EASE-Grid, distributed to the user community during 1993 and 1994, form the basis for the current version. The basic purpose of the EASE-Grid is to provide the general user of remote sensing data with an optimal earth grid format representing a design which is between swath data (one file per orbit) and an averaged

(time and space) daily or multi-day product with its inherent reduction in precision. The EASE-Grid methodology preserves the highest level of data precision and accuracy while still maintaining ease of application. The availability of a standard gridding scheme is a requirement for systematic time-series studies and also supports the direct digital comparison of different algorithm outputs as well as the validation of the algorithms through quantitative comparison with EASE-Gridded surface station and other ancillary data.

EASE-Grid provides full global coverage using equal-area projections with cell sizes of 25 km for all channels (19, 22, 37 and 85 GHz) and 12.5 km for the 85 GHz channel. The user can display the data using either of two earth projections: azimuthal equal area for north and south high latitude/polar regions and cylindrical equal area for applications at lower latitudes and for those studies requiring complete global coverage. The first product in the EASE-Grid to be produced and distributed by NSIDC will be global brightness temperatures for the NOAA/ NASA Pathfinder Benchmark Period (August 1987 through November 1988). Cryospheric products will include snow cover extent and sea ice concentration. Beyond snow and ice parameters, NSIDC will create additional geophysical products using algorithms recommended by the Pathfinder SSM/I Science Working Group. Currently this product list includes: vegetation index; land surface classification and land surface temperature; ocean wind speed, cloud water, and water vapor.

### ***Global Snow Cover Mapping***

The extent and variability of seasonal snow cover is recognized to be an important parameter in climate and hydrologic systems and trends in snow cover serve as an indicator of global climatic changes. Passive microwave data from satellites afford the possibility to monitor temporal and spatial variations in snow cover on the global scale, avoiding the problems of cloud cover and darkness. NSIDC is developing the capability to produce daily snow products from the DMSP-SSM/I satellite with a spatial resolution of 25 km. Algorithm validation studies include the technique of digital image subtraction to directly compare surface station data, interpolated to the EASE-Grid, with satellite measurements. NSIDC has compiled a validation data set of station measurements for the northern hemisphere with specific focus on data with high spatial density from the United States and the former Soviet Union. Specific snow depth and water equivalent data sets from point measurements and along extensive transects from the FSU are being digitized and transferred to

NSIDC through collaborative efforts with the Academy of Sciences (Moscow, Russia) and the Central Asian Hydrometeorological Research Institute (Tashkent, Uzbekistan). This "data rescue" effort is being funded in large part by NOAA's National Geophysical Data Center and Climate and Global Change Program.

The digital image comparison techniques are being applied to longer time-series to determine whether or not the differences between the algorithm output and the validation data are systematic, and if so, can the regions of the greatest consistent errors be correlated with specific conditions identifiable using ancillary data (e.g. topography, vegetation, snow structure, temperature). Using data from the SSM/I F11 satellite, we are evaluating algorithms employing the 85 GHz channels. It is expected that the increased scattering produced at this frequency will enhance the capability to identify areas of shallow snow cover. We will also analyze the feasibility of applying polarization difference algorithms in order to better discriminate between wet and dry snow. By coordinating with the Jet Propulsion Laboratory (JPL), NSIDC plans to produce a 16-year record of global passive microwave data by combining SMMR with SSM/I in the EASE-Grid format. This data set will represent an important tool for use in monitoring of high-latitude snow and ice parameters that are likely to respond to climate change. NSIDC will continue to develop the concept of a snow cover data set based on passive microwave but which is produced through continuous interaction with a dynamic data base of surface changes that includes both station snow depths and visible-band satellite measurements.

#### **Arctic System Science (ARCSS) Data Coordination Center at NSIDC**

During FY94 the ARCSS Data Management pilot project, for Ocean-Atmosphere-Ice Interaction (OAI) and Land-Atmosphere-Ice Interaction (LAI), began seeking ways to develop linkages between the project and with the Greenland Ice Sheet Program 2 (GISP2) and Paleoenvironments from Arctic Lakes and Estuaries (PALE) components of ARCSS. By attending PI meetings for LAI and PALE, and the OAI Steering Committee, some cross-cutting requirements for particular data types were identified: solar radiation in particular, and land parameters such as soil texture and snow extent/depth for both regional and global scale modeling, for example. The crucial need for the ARCSS Data Management Working Group (DMWG) and the ARCSS Modeling Working Group became even more apparent as NSIDC tried to prioritize these requirements in an effort to develop and deliver data products to the

ARCSS community. These working groups will provide a forum for discussion of data and modeling issues across ARCSS, and the DMWG will be a mechanism for NSIDC to receive advice and counsel in the emerging ARCSS Data Coordination Center role (funded 9/94 for three years). As of this report date, the Working Groups are expected to meet for the first time in February 1995.

The primary ARCSS activity at NSIDC during FY94 was the ingest and documentation (editing) of the data sets for the LAII Data Series Volume 1: Alaska North Slope Data Sampler CD-ROM. Several important data sets from ARCSS PIs, collected prior to the existence of ARCSS, are being released to the Arctic community on this first disk. Climate data from the Innavaik Creek watershed (D. Kane, University of Alaska Department of Civil Engineering); climate, soils, plant biomass, and nutrients from the Long-Term Ecological Research site at Barrow (J. Hobbie, Marine Biological Laboratory, Woods Hole), and from U.S. Army CRREL-funded active layer (permafrost) work in the 1960s are among the most important sets made accessible. We expect the disk to be ready for distribution in November 1994; the data are available via ftp as well.

The NSIDC ARCSS group continues to work closely with the National Geophysical Data Center's (NGDC) Paleoclimate Division and the GISP2 Science Management Office (SMO), University of New Hampshire, on management and distribution plans for the GISP2 ice core data. One distribution method being discussed is a CD-ROM with GISP2 and other relevant core data sets, developed collaboratively by NSIDC and NGDC/Paleoclimate with the cooperation of the GISP2 SMO. This disc would include the core curator's inventory from the National Ice Core Laboratory, as well as any GRIP (Greenland Icesheet Program, the European ice coring project) data that are documented and deposited in the World Data Center-A by GRIP investigators.

## FUTURE PLANS

### ***FORMATION OF A COMPREHENSIVE AVHRR IMAGE DATA ARCHIVE FOR BOTH POLAR REGIONS***

The proposed Polar 1-km AVHRR Archive, to be housed at NSIDC, is an attempt to gather digital, daily AVHRR imagery from several sources and compile it as a way to synoptically view both poles with the AVHRR sensor (visible, near-IR and thermal IR bands) on a daily or even more frequent basis. The applications of this data set to problems of global change, climatology, and several aspects of polar science are numerous, and the community has given strong support to the effort. This effort is funded by NASA and NSF.

### ***FACILITY PLAN***

NSIDC continues negotiations with the University of Colorado to seek out an acceptable location for the new facility required because of DAAC growth and the addition of EOSDIS Core System staff. NSIDC seeks to avoid either splitting the facility or moving it off campus.

### ***FUTURE EOS DATA SETS***

In future years of the EOS era NSIDC will be involved with numerous new data sets . The following table summarizes them.

**Table 2: Summary of EOS Mission data sets with which NSIDC will be involved**

Product ID	Platform	Instrument	Data Set Name	Product Level	Data Producer
GLA07	ALT	GLAS	Ice Sheet Elevation	2	NSIDC
GLA08	ALT	GLAS	Ice Sheet Roughness (R)	2	NSIDC
MIM07	PM	MIMR	Snow Depth	2	NSIDC
MIM08	PM	MIMR	Snow Water Equivalent	2	NSIDC
MIM11	PM	MIMR	Sea Ice Concentration	2	NSIDC
MIM12	PM	MIMR	Sea Ice Type	2	NSIDC
MIM18	PM	MIMR	Gridded Snow Depth	3	NSIDC
MIM19	PM	MIMR	Gridded Snow Water Equivalent	3	NSIDC
MIM22	PM	MIMR	Gridded Sea Ice Concentration	3	NSIDC
MIM23	PM	MIMR	Gridded Sea Ice Type	3	NSIDC
MOD10	AM,PM	MODIS	Snow Cover Extent	2	GSFC
MOD29	AM,PM	MODIS	Sea Ice Max Extent	2	GSFC
MOD33	AM,PM	MODIS	Gridded Snow Cover Extent	3	NSIDC
AST16	AM	ASTER	Glacier Extent, Temperate	4	EDC
AST17	AM	ASTER	Glacier Velocity, Polar Outflow	4	EDC
AST18	AM	ASTER	Sea Ice Albedo	2	EDC

### ***AM-1 (1988 Launch)***

*Moderate-Resolution Imaging Spectroradiometer (MODIS)*. NSIDC is responsible for snow-cover and sea-ice-related products from MODIS on AM-1. These products will be generated either at NSIDC or at GSFC pending review of resources availability at the two DAACs. Exact interface requirements for this processing must be decided between GSFC and NSIDC in FY 95. In addition, NSIDC will be monitoring the MODIS Instrument Team development of these products.

*Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)*. NSIDC is collaborating with EDC-DAAC on glacier-related products derived from ASTER. We are discussing with EDC- DAAC how glacier products will be distributed.

### ***PM-1***

*MODIS*. Similar snow and ice products will be derived from MODIS on PM-1 as on AM-1. Discussion above under AM-1 applies to PM-1 MODIS as well.

*Multifrequency Imaging Microwave Radiometer (MIMR)*. NSIDC will produce and distribute snow cover and sea ice products derived from MIMR. MIMR instrument development and its availability for PM-1 are in a state of flux. We are uncertain which of several options will be employed to acquire passive microwave data.

### ***ALT (Laser)***

*Geoscience Laser Altimeter System (GLAS) (2003 Launch)*. NSIDC plays an important role in the processing of GLAS products. The primary mission of GLAS is the monitoring of ice sheet elevation. NSIDC will produce the products derived from the level 1 data stream for ice sheet elevation. Other products derived from the GLAS data stream include determination of aerosols, polar cloud composition, as well as various vegetation related products. NSIDC will interface with the GLAS instrument team to aid the development of the ice sheet and other cryosphere related products. NSIDC has proposed the re-location of the GLAS low level archive from GSFC to NSIDC since the primary mission and most of the products are polar related.

### ***Scanning Multichannel Microwave Radiometer (SMMR)***

The SMMR on Nimbus-7 operated from 1978 to 1987. The SMMR data extends the passive microwave observational record of sea ice and snow cover extent an additional 9 years.

Dr. Eni Njoku at the Jet Propulsion Laboratory (JPL) has completed recalibration of the SMMR time series. It is our understanding that the re-calibration performed by Dr. Njoku closely follows techniques used by Dr. Per Gloersen and, therefore, may not greatly change the sea-ice-concentration product already in distribution. There will be two SMMR Pathfinder products of interest to the snow and ice community, each containing 10 channels (5 frequencies, 2 polarizations) of brightness temperature data. The first consists of recalibrated SMMR level-1B data in swath (orbital) format, with spatial resolution varying from 21 x 33 km for the 37 GHz channels to 105 x 160 km for the 6.6 GHz data. Marshall Space Flight Center DAAC will archive the complete set of swath data. The second Level-2 product will contain SMMR data mapped to NSIDC's 25-km EASE-Grid format. Production of this data set is being considered for FY95.

## RESEARCH ACTIVITIES

The Cryospheric and Polar Processes Division of CIRES (NSIDC's home base at University of Colorado) focuses on the role of the cryosphere and the polar regions in the global climate system. Its activities involve basic and applied research and the related projects of the World Data Center-A for Glaciology and the National Snow and Ice Data Center. The work of the Division is carried out by three Fellows, six Senior/Research Associates, twenty-eight Senior/Professional Research Assistants, four staff, nine graduate students and ten undergraduates. Total funding for the Division increased to over \$3.3 million for FY94.

Activities are supported by a mix of research- and data management-related grants and contracts. The major components involve:

1. A five-year NASA contract for operation of the Snow and Ice Distributed Active Archive Center (DAAC);
2. A new three-year grant from NSF/OPP support for the data management for the Arctic System Science (ARCSS) program;
3. A three-year ESDIM grant from NGDC for support of data rescue and access;
4. On-going support provided by NOAA for WDC-A Glaciology;
5. Research grants for remote sensing-based of Arctic sea ice using ERS-1 synthetic aperture radar data (NASA), SSM/I data for snow cover mapping (NASA) and AVHRR data for detection of leads in sea ice (NASA), analysis of satellite imagery for global lightning (NASA), archive of OLS products from DMSP, for field studies on physical climatology on the Greenland ice sheet (NASA), on the Ross Ice Shelf in the Antarctic (NSF) and on sea ice in the eastern Canadian Arctic (NSF), and for data analysis and modeling studies on Arctic climate processes (NOAA), NSF, NASA), ice – climate interactions (NSF, NOAA, NASA), atmospheric Arctic water vapor transport (NSF), atmospheric controls on Arctic cryospheric variability (NSF), evolution of sea ice in the Beaufort Sea, and modeling sea ice sensitivity to radiative forcing (NSF).

## **ROGER G. BARRY**

### **Cryospheric Indices of Global Change**

A collaborative study on "Cryospheric Indices of Global Change" under agreements between Roger G. Barry (Cooperative Institute for Research in Environmental Sciences and WDC-A Glaciology, University of Colorado) and V.M. Kotlyakov (Institute of Geography, Russian Academy of Sciences) as well as with the Central Asian Hydrometeorological Research Institute (SANIGMI), Tashkent, Uzbekistan, is continuing. The project, initiated through support from the NSF Geography, Climate Dynamics and International Programs, the Russian Academy of Sciences, NOAA's Climate and Global Change Program and a NATO Linkage grant, is focused currently on snow cover observations from surface data and passive microwave satellite remote sensing and on glacier mass balance fluctuations in the Caucasus and Central Asia. Barry and R. Armstrong visited Tashkent, 10-20 September 1993, to attend a conference and hold discussions on Central Asian data. During August 8-22, 1994, Dr. Vladimir Konovalov, Dr. Boris Tsarev, Dr. Elena Pichugina, Ms. Taissia Oleinikova from SANIGMI visited NSIDC. The group is involved in research and operations in the areas of modelling snowmelt runoff and glacier mass balance in the Pamir and Western Tien Shan mountain regions. Working meetings were held to present the various snow and ice modelling and remote sensing/image processing techniques in use at NSIDC. In addition, there were discussions regarding exchange of various snow and ice data sets available from SANIGMI. The funding which supported the current travel for the SANIGMI visitors was provided through a NATO Linkage Grant to Richard Armstrong and Roger Barry of NSIDC. A return visit to Tashkent by NSIDC personnel will be scheduled for 1995. Plans are underway to develop specific collaborative research projects between SANIGMI and NSIDC.

### **Global Digital Sea Ice Data Bank**

Efforts continued on the WMO project to develop a Global Digital Sea-Ice Data Bank (GDSIDB) involving the Arctic and Antarctic Research Institute (AARI) in St. Petersburg, Russia, and WDC-A for Glaciology in Boulder, Colorado, USA. The fourth session of the steering group for the project met in Suitland, Maryland, USA, 4-6 October 1993. R. G. Barry and V. J. Troisi attended for WDC-A for Glaciology. The session was also attended by representatives of AARI, the WMO Secretariat, the U.S. National Oceanographic Data Center, the U.S. National Ice Center, and NOAA/NESDIS.

Sea ice data in SIGRID format for the period 1989-1990 have been exchanged, extending the full exchange period from 1972 through 1990. Recommendations concerning the project were submitted to the WMO Commission for Marine Meteorology, including a proposal for implementation of a condensed SIGRID format. The steering group completed a document describing the revised SIGRID-2 format.

The steering group also completed a work plan for the period from October 1993 to October 1994. The exchange of data between AARI and WDC-A will continue and the agencies will jointly develop more robust formats for the packaging and distribution of the data. Distribution of portions of the data was scheduled to begin in 1994.

#### **Rescue and Analysis of Russian Sea Ice Data**

This work concerns (1) the acquisition, documentation and management of Arctic sea ice data from the Arctic and Antarctic Research Institute (AARI), St. Petersburg, and (2) related research on ice conditions in the Eurasian Arctic. The activity is based on an agreement between AARI and WDC-A for Glaciology signed by R.G. Barry and I. Frolov in St. Petersburg in July 1992 that expanded collaboration under the auspices of the World Meteorological Organization (1990, 1991) for the development of a Global Digital Sea Ice Data Bank at the two centers to include FSU Arctic data. The importance of these data sets was endorsed at a meeting on Data Rescue and Prioritization in May 1993 (Crane, 1993). Digital data on Arctic sea ice were transferred from AARI to WDC-A for Glaciology as scheduled in late 1992, June 1993, and August 1993. Data at WDC-A include 1967-73 and 1992.

#### **KONRAD STEFFEN**

##### **Assessment of Climate Variability of the Greenland Ice Sheet**

The objectives of the project are to monitor surface properties of the Greenland ice sheet based on multispectral satellite data in combination with ground truth observations. Several key parameters of the surface energy balance are parameterized using satellite and ground measurements to derive a ten-year surface climatology of the entire ice sheet.

In spring of 1994 we completed a successful field expedition (April 26 to June 11). All measurements throughout the past summer, fall, winter and spring (10 months) were successfully retrieved from the three different data loggers. For the first time the annual cycle of net radiation and the shortwave radiation balance were measured at the ETH/CU camp

(1150 m, 70°N, 49°W). During the field campaign, we made high resolution GPS measurements (cm-accuracy) in addition to the standard microclimatological recordings for two NASA aircraft overflight missions equipped with Laser altimeter, ice thickness RADAR instruments.

### **Feasibility of Sea Ice Typing with Synthetic Aperture Radar**

Coregistered ERS-1 SAR and Landsat Thematic Mapper (TM) images were acquired for an area in the Beaufort Sea, April 16 and 18, 1992. A supervised ice type classification was performed on the TM images in order to classify ice free, nilas, gray ice, gray-white ice, thin first-year ice, medium and thick first-year ice and old ice. Comparison of the collocated SAR pixels showed that ice-free areas within pack ice during the cold month of the year (Sept. to May) can only be identified with ERS-1 C-band SAR for calm wind conditions (wind speed < 3 ms<sup>-1</sup>) and for moderate to high wind conditions (wind speed 10 to 15 ms<sup>-1</sup>). For surface winds between 3 ms<sup>-1</sup> and 10 ms<sup>-1</sup> the ice-free backscattering coefficients are indistinguishable from first-year and old ice due to wind roughening of the water surface. For nilas two distinct backscatter classes were found at -17 dB and at -10 dB. The higher backscattering coefficient is attributed to the presence of frost flowers on nilas. Gray and gray-white ice have a backscatter signature similar to first-year ice and therefore can not be distinguished by SAR alone. First-year and old ice can be clearly separated based on their backscattering coefficient.

The performance of the Geophysical Processor System (GPS) ice classifier was tested against the Landsat derived ice products. It was found that smooth first-year ice and rough first-year ice were not significantly different in the backscatter domain. Ice concentration estimates based on ERS-1 C-band SAR showed an error range of 5 to 8% for high ice concentration regions mainly due to misclassified ice-free and smooth first-year ice areas. This error is expected to increase for areas of lower ice concentration. Classification of ice concentration and ice types based on C-band SAR backscattering coefficients for a single scene shows severe limitations. A combination of C-band SAR and TM channels 2, 4 and 6 resulted in ice typing performance with an estimated accuracy of 90% for all seven ice classes.

## **UWE RADOK**

### **Ice sheet weather and climate**

Atmospheric surface pressures recorded by automatic weather stations on the East Antarctic ice sheet are being freed of elevation effects with a new differential analysis procedure. The aim is to find small pressure differences created by the vertical circulation which drives the katabatic surface layer winds.

## **JEFF KEY**

### **Radiation balance**

Over the ice-covered oceans the exchange of sensible and latent heat with the atmosphere is relatively small, and radiative fluxes dominate the energy balance. Sea ice grows and melts largely in response to the radiation balance, which is in turn strongly influenced by cloud cover. Research has continued on the Arctic radiation balance and factors that affect it: what *in situ* data are available and what parameters can be estimated from satellite data. *In situ* surface radiation data from Canada, Alaska, Russia and central Arctic drifting ice stations are being collected and compared to radiative fluxes computed using a satellite-derived cloud product. On the annual average the Arctic surface radiation balance is negative and surface cloud forcing is positive, in contrast to lower latitudes. Spatial and temporal patterns of satellite-derived tropospheric and stratospheric temperatures in the Arctic show small but statistically significant trends over the past 10 years.

### **Cloud retrieval**

Methods for the retrieval of high-latitude cloud and surface properties from satellite data will continue to be investigated. Specifically, procedures have been developed to estimate surface temperature and albedo, cloud droplet effective radius, cloud optical depth, and radiative fluxes using shortwave and longwave satellite data. Validation will be done with field measurements from the Beaufort Sea (J. Key and R. Stone), the Canadian Archipelago (J. Key, M. Serreze, and J. Maslanik), and Greenland (K. Steffen).

## **JAMES MASLANIK**

### **Assimilation of observations and two-dimensional ice models.**

Combining remotely-sensed information and surface observations with a sea-ice model can constrain various elements of the model physics, and can generate new fields that are difficult to observe (such as ice thickness). Through related projects to generate ice motions (Emery, P.I.), ice temperatures and ice albedos (J. Key, P.I.), we are revising our current sea-ice model to assimilate these data as well as information on cloud cover and ice concentration. Objectives are to determine the sensitivity of sea-ice simulations to different forcings, and to refine and simplify model physics to achieve realistic sea-ice treatments in global climate models.

### **Artificial intelligence applications**

A rule-based system was developed to explore the role of automated quality-control within the National Snow and Ice Data Center's SSM/I processing stream. The system assesses general conditions determined from the SSM/I brightness temperatures and, through a set of rules, creates metadata. These metadata are used to determine the relative quality of individual SSM/I scans prior to gridding of the brightness temperatures. The design of the system allows the inclusion of a range of "expert" decisions typical of the steps that a human analyst would take to assess the quality of the data. We conclude that the automation of such intelligent decision-making may be particularly valuable for EOS-era processing.

## **TED SCAMBOS**

### **The Measurement of Ice Velocity in Antarctic Glaciers Using Landsat Images**

Ice velocity measurement, and the development of a semi-automated velocity mapping algorithm, has generated a great deal of interest in the polar science community because of its application to the problems of polar ice mass-balance and mechanics of large glacier flow ('ice stream' flow).

### **Ice Dynamics around Siple Dome, Antarctica**

This research will include field work in Antarctica (9/94 - 12/94). My contribution to this group scientific proposal is satellite image data processing and analysis to support the field measurements, and field GPS data acquisition.

## MARK C. SERREZE

### Water vapor over the Arctic

Research during 1993 and 1994 focused on examining the distribution and transports of water vapor over the Arctic, using an extensive record of rawinsonde profiles. As a major part of this study, variations in water vapor flux convergence and precipitation minus evaporation (P-E) were examined for the Arctic Ocean. Research proceeded in collaboration with Dr. John Walsh (Univ. Ill., Urbana-Champaign), who is using rawinsonde data to reconstruct records of P-E for major Arctic drainage basins. Quality-control software was developed jointly with Dr. Walsh and is detailed in Serreze et al. [1994a].

In the Serreze et al. [1994a] study, rawinsonde data from 1974-1991 were used to examine the major transport patterns of water vapor across 70°N and to provide climatological values of water-vapor flux convergence and P-E over the north polar cap. Annual P-E is most strongly controlled by large poleward vapor transports between Greenland and Scandinavia associated with the North Atlantic cyclone track. P-E, as averaged over the 70-90°N region, is positive in all months, peaking in September at 26 mm, with an annual value of 163 mm. In a subsequent study [Walsh et al., 1994] interannual variations in P-E were examined for a central Arctic Ocean domain and the Mackenzie River basin for 1973-1990. Over both regions, P-E was found to vary by a factor of nearly two.

In a related study [Serreze et al., 1994b], climatological values of E from Russian data were substituted into an 18-year (1974-1991) time series of monthly P-E over the 70-90°N, hence providing for first-order estimates of precipitation variability for the north polar cap. This time series was used in conjunction with National Meteorological Center (NMC) gridded analyses to examine relationships between precipitation and circulation variability. Precipitation ranges from a low of 228 mm in 1978, to a high of 306 mm in 1981. Composite analyses reveal that for every season, high precipitation is favored by a "winter type" circulation regime, characterized by a more dominant North Atlantic storm track and a deeper trough over the Atlantic side of the Arctic. Low precipitation is associated with essentially the opposite pattern of circulation anomalies. A tendency exists for high precipitation in one season to often be offset by small values in another. Consequently, the extreme year, 1981 is unusual in being characterized by persistence of the "high precipitation" circulation mode over several seasons.

Soundings for fixed land stations were subsequently combined with available Russian drifting station and ship reports to provide a climatological gridded data base of Arctic water vapor characteristics and related variables. Values are provided over NMC grid points (Octagonal Grid Format) north of 65°N of precipitable water, vertically-integrated vapor fluxes and vertical profiles (for 15 levels extending from the surface and then at every 50 mb from 950 mb to 300 mb) of specific humidity, zonal and meridional vapor fluxes, zonal and meridional wind speed and temperature. Serreze et al. [1994c] provide a summary of results. Efforts are underway to further refine this data base and archive it on CD-ROM for distribution to the data community. The sounding records for all fixed stations north of 65°N have been archived as a four volume CD-ROM data set, which is now being distributed to the user community.

The Serreze et al. [1994b] study made use of a data set of the position and central pressure of Arctic cyclones and anticyclones, based on an automated detection algorithm developed for a previous study. Serreze [1994] used an updated version of this data set, which now includes an objective determination of cyclone tracks, to examine climatological characteristics of cyclone development and decay, focusing on identifying regions of cyclogenesis and cyclolysis, and preferred regions of system intensification, based on sea-level pressure tendency.

## ANNE NOLIN

### **Snow reflectance**

During the September - July period, research focus was on measuring and modeling the spectral and angular reflectance signatures of snow. For the modeling work, a discrete ordinates radiative transfer model was adapted to calculate the spectral-directional reflected radiance from a snowpack. In April-May, 6 weeks were spent on the Greenland ice sheet at the ETH/CU research camp measuring the spectral and angular reflectance from snow. For this work, a newly-developed full-range portable field spectrometer produced by Analytical Spectral Devices was used. Model results have been produced for a wide range of snow properties and illumination conditions providing a complete characterization of both the angular and spectral reflectance signatures of snow. These model data have been animated for data visualization. The snow reflectance data are being used to validate the radiative transfer model and they comprise an important part of the limited snow bidirectional reflectance data currently in existence.

## FUNDING

### FUNDING SOURCES

The trend of the past several years continues in that NASA remains the largest funder of NSIDC/WDC programs, accounting for almost 80% of total funding. The NOAA contribution from various sources, DMSP, ESDIM and NGDC, adds about 13.2% of overall funding. See Figure 2. Total funding for FY93 was just over \$3 million. The trend in funding 1977-1994 is shown in Figure 3.

### DATA REQUEST STATISTICS

#### *Data Categories*

Passive microwave data, both SSM/I and SMMR, had the highest number of users again this year. These data, distributed on CD-ROM (41 volumes to date), are sent regularly to approximately 580 subscribers. DMSP data, both analog and digital, continue to lead data statistics in income generated. FY 94 saw 159 requests for DMSP data and information and over \$6K income.

Usage of the Information Center continues steady. Logged requests for bibliographic information account for about 20% of the total. However, in-house researchers at CIRES associates at INSTAAR and University students frequently use the collection without assistance and are consequently not logged into the system. We know that the impact of the Information Center is not truly reflected in the statistics.

#### *User Categories*

One of the variables by which NSIDC tracks users is by type of organization. Over the 17-year period of record, 1978-September 1994, the distribution of users by category has remained relatively stable. Of the over 1100 requests this year, not including the 580 subscribers to SSM/I and SMMR CD-ROMs, almost 30 percent of requests came from the U.S. academic community. Another 30 percent of requests came from outside the U.S.; 16% were from various Federal agencies; approximately 10% represented industry. (See Figure 4). Figure 5 displays the number of requests since 1978.

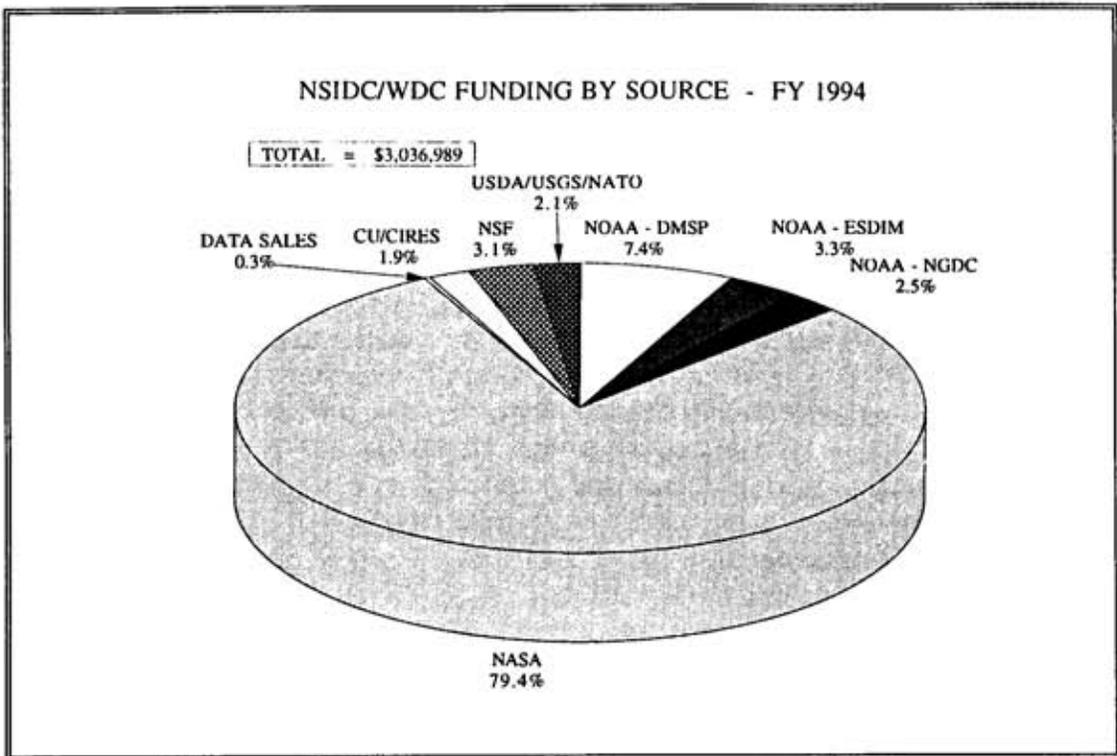


Figure 2.

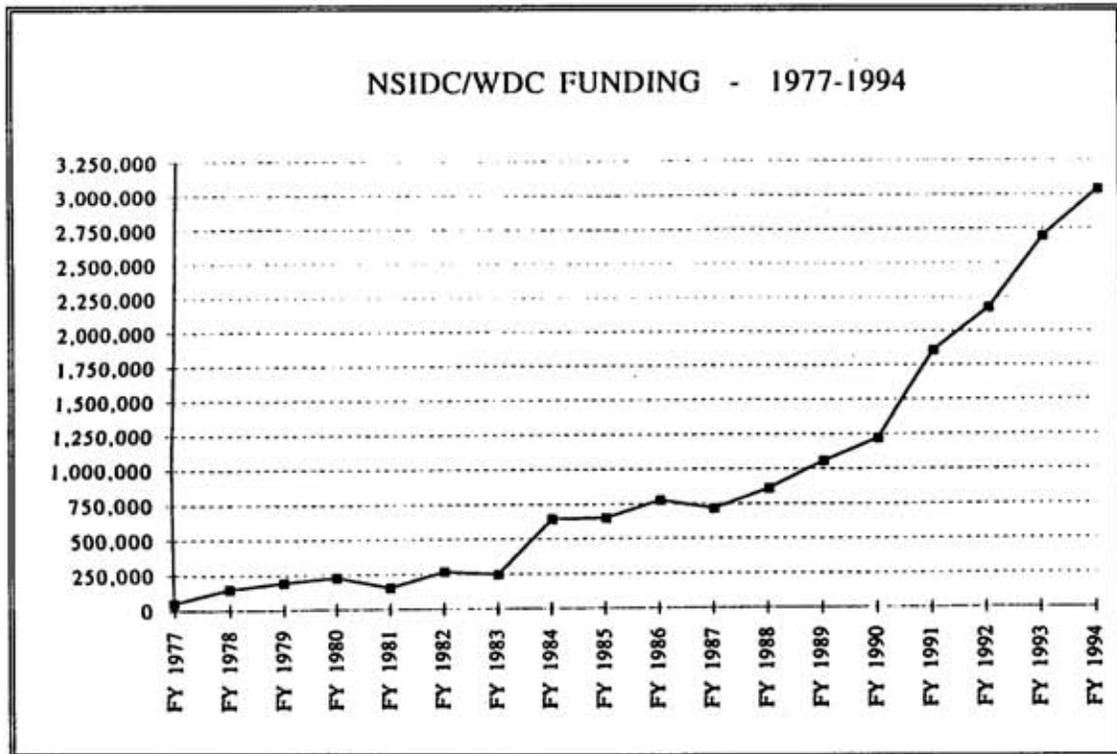


Figure 3.

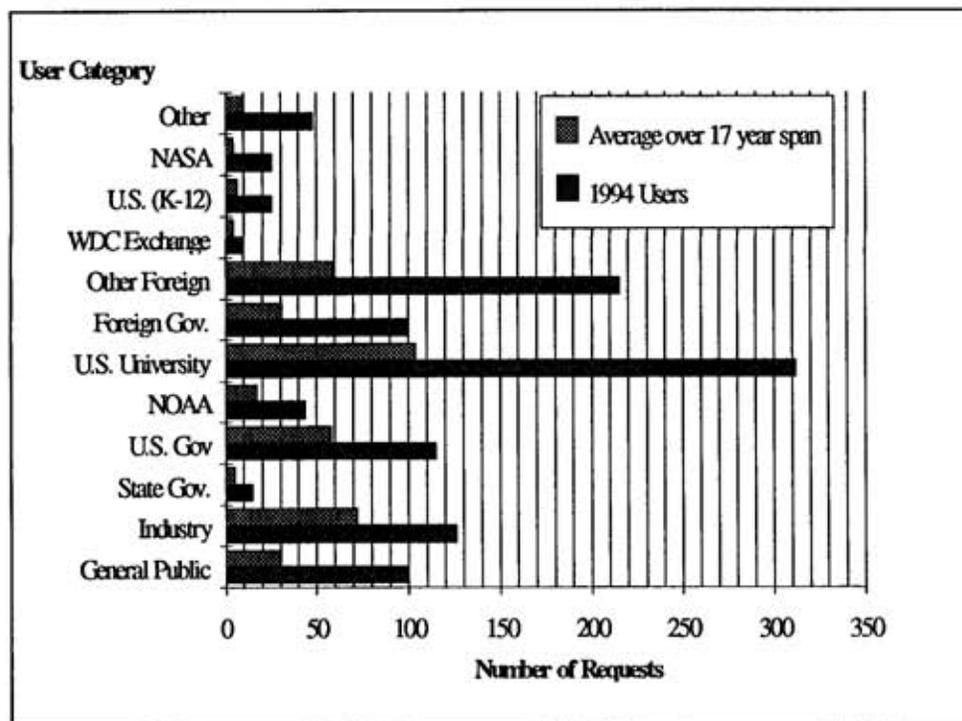


Figure 4.

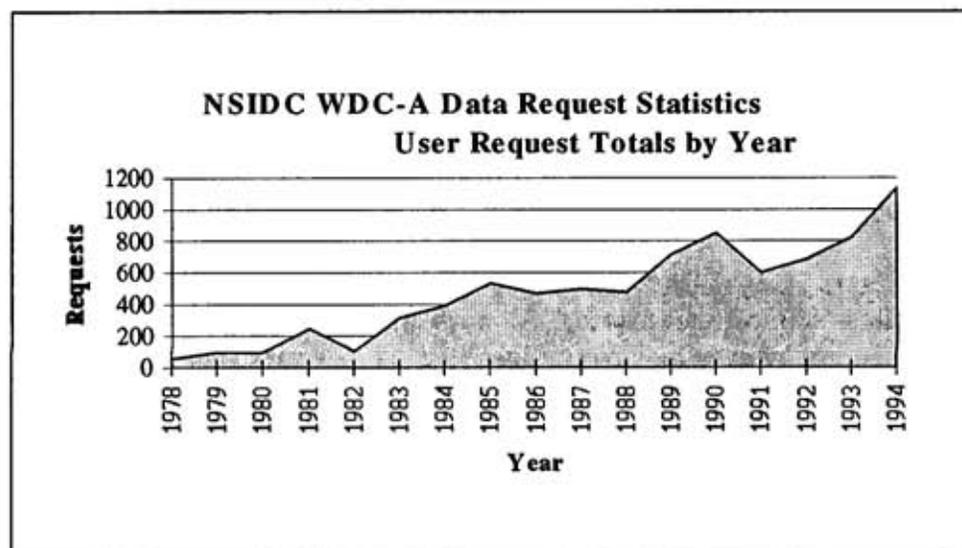


Figure 5.

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## **NATIONAL AND INTERNATIONAL COLLABORATION**

### **Canada**

Arctic Institute of North America, Calgary, Alberta  
Atmospheric Environment Service, Downsview, Ontario  
Canadian Circumpolar Institute, Edmonton, Alberta  
National Hydrology Research Institute, Saskatoon, Saskatchewan  
University of Waterloo, Ontario

### **China**

Institute of Glaciology and Cryopedology, Lanzhou  
(World Data Center-D for Glaciology)

### **Russia**

Arctic and Antarctic Research Institute, St. Petersburg.  
Institute of Geography, Moscow.  
Central Asian Hydrometeorological Center, Tashkent.  
World Data Center-B (State Hydrometeorological Service), Obninsk.

### **Switzerland**

Institute of Geography, ETH, Zurich.  
World Glacier Monitoring Service  
World Meteorological Organization, Geneva.  
Swiss Federal Institute for Snow and Avalanche Research.

### **United Kingdom**

Scott Polar Research Institute, Cambridge.  
World Data Center-C for Glaciology, Cambridge.

### **U.S.A.**

Cold Regions Research and Engineering Laboratory, Hanover, NH.  
Library of Congress  
NASA- Goddard; Jet Propulsion Laboratory; Marshall; Langley  
Research Center  
NOAA- NESDIS- National Ice Center, Suitland, MD.  
Ohio State University, Byrd Polar Research Center, Columbus, OH  
U.S. Air Force, Offut, NB  
University of Alaska, Geophysical Institute.  
University of Washington, Seattle.  
International Mountain Society (Univ. of California, Davis).

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## COMMITTEES

NASA EOSDIS Data Processing Focus Team - N. Sandoval

NASA EOSDIS Data Organization and Access Focus Team - K. Robinson, G. Mountain, M. Holm, V. Troisi

NASA EOSDIS Data Modeling Working Group - M. Holm, V. Troisi

NASA EOSDIS Data Science and Operations Focus Team - R.G. Barry, V. Troisi, R. Weaver

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International Commission on Snow and Ice, Representative to International Association of Hydrological Sciences - R.L. Armstrong

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SSM/I Products Working Team (SPWT), NASA - R.L. Armstrong

Western Snow Conference Executive Committee - R.L. Armstrong

International Snow Science Workshop Executive Committee - R.L. Armstrong

International Association of Hydrological Sciences, Snow Classification Working Group - R.L. Armstrong

Arctic Environmental Data Directory Working Group - C.S. Hanson, A.M. Brennan, R.G. Barry

International Arctic Environmental Data Directory (ADD) - R.G. Barry, C.S. Hanson

SCAR representative to ICSU Panel on World Data Centers - R.G. Barry

U.S. Polar Bibliographic Information Working Group - A. Brennan

U.S. - Canadian Great Lakes - St. Lawrence Ice Information Working Group - C.S. Hanson

U.S. Canada Joint Ice Working Group - G.R. Scharfen

SCAR - COMNAP ad hoc Planning Group on Antarctic Data Management - C.S. Hanson

Steering Group for the Global Digital Sea-ice Data Bank - R.G. Barry, V. Troisi

EOSDIS Version 0 Standard Data Formats Working Group - N. Sandoval

## MEETINGS

MODIS Science Team Meeting - T. Scambos, 29 September-1 October 1993 (Greenbelt, MD)

Global Digital Sea Ice Data Bank Steering Committee (WMO) - R. Barry, V. Troisi, 5-6 October 1993 (Suitland, MD)

EOSDIS V0 User Services Working Group - C. Hanson, M. Holm, 19-21 October 1993 (Saginaw, MI)

ARCSS OAI Steering Committee - C. Hanson, M. Cross, 3 December 1993 (San Francisco, CA)

American Geophysical Union Fall Meeting - R. Barry, R. Armstrong, C. Hanson, G. Scharfen, R. Bauer, M. Holm, M. Cross, 6-10 December 1993 (San Francisco, CA)

Arctic Environmental Data Directory (AEDD) Working Group/  
International AEDD Steering Committee - R. Barry, C. Hanson, 9-10 December 1993 (San Francisco, CA)

EOSDIS Progress Review - R. Weaver, V. Troisi, 15-16 December 1993 (Landover, MD)

EOS Investigator Working Group (IWG) - T. Scambos, January 1994 (San Antonio, TX)

ARCSS/LAI Flux Study PI Meeting - C. Hanson, M. Cross, 14-16 January 1994 (Seattle, WA)

EOSDIS Guide Document Workshop - V. Troisi, A. Varani, E. DeBolt, M. Holm, M. Kaminski, 21 January 1994 (LASP, Boulder, CO)

ARCSS/PALE PI Meeting - R.G. Barry, C. Hanson, M. Cross, 4-6 February 1994, (Boulder, CO)

GLAS Instrument Team Meeting - R. Barry, T. Scambos, R. Weaver, 1-2 March 1994 (NSIDC)

Information Management System (IMS) Developers' Team Meeting - M. Holm, V. Troisi, 1-4 March 1994 (Huntsville, AL)

EOSDIS Architecture Working Group - M. Holm, K. Robinson, 8-9 March 1994 (Greenbelt, MD)

EOSDIS Systems Operations Focus Team (SOFT) Meeting - R. Barry, V. Troisi, R. Weaver, 23-24 March 1994 (Landover, MD)

NOAA/NASA Inter-Pathfinder Conference - R. Armstrong, 30 March-1 April 1994 (Washington, DC)

Data Processing Focus Team (DPFT) Meeting - N. Sandoval, 6-7 April 1994

PoDAG Meeting - R. Barry, V. Troisi, R. Weaver, 21-22 April 1994 (Landover, MD)

U.S. MIMR Team Meeting - R. Armstrong, N. Sandoval, 26-27 April 1994 (Huntsville, AL)

Networld and Interop '94 - V. Troisi, G. Mountain, 1-5 May 1994 (Las Vegas, NV)

EOSDIS Version 0 User Services Working Group - C. Hanson, M. Holm, C. McNeave, 2-6 May 1994 (Goddard Space Flight Center, Greenbelt, MD)

Workshop on Climate System Data - R. Barry, 16-18 May 1994 (Quebec City, Canada)

CircumPolar Conference on Remote Sensing of Arctic Environments - R. Barry, 16-20 May 1994 (Fairbanks, AK)

ECS System Design Review - R. Weaver, V. Troisi, K. Robinson, N. Sandoval, 27-29 June 1994 (GSFC, Greenbelt MD)

ECS Cost briefing - R. Weaver, V. Troisi, 30 June 1994 (University of Maryland Conference Center)

EOSDIS SOFT - R. Weaver, 30 June-1 July 1994 (University of Maryland Conference Center)

EOSDIS Data Organization and Access Focus Team (DOAFT) - K. Robinson, 30 June-1 July 1994 (University of Maryland Conference Center)

Data Processing Focus Team - N. Sandoval, 30 June-1 July 1994  
(University of Maryland Conference Center)

Polar Libraries Colloquy - A. Brennan, 3-8 July 1994 (Cambridge, U.K.)

U.S. Polar Bibliographic Working Group - A. Brennan, 5 July 1994  
(Cambridge, U.K.)

EOS/Pathfinder Interuse Conference, 4th - N. Sandoval, July 1994  
(University of Colorado)

International Geoscience and Remote Sensing Symposium (IGARSS) - C.  
McNeave, 8-12 August 1994 (Pasadena California)

EOSDIS DOAFT Data Modelling Working Group - V. Troisi, M. Holm,  
30-31 August 1994

SCAR-COMNAP ad hoc Planning Group on Antarctic Data Management  
- C. Hanson, 29 August - 2 September 1994 (Rome, ITALY)

ARCSS/GISP2 PI Meeting - C. Hanson, M. Cross, 11-14 September 1994  
(Sterling, VA)

Geographical Information System for Antarctica - T. Scambos, 27-29  
September 1994 (Reston, VA)

International Working Conference on Scientific and Statistical Database  
Management, 7th - M. Kaminski, K. Robinson, 28-30 September 1994  
(Charlottesville, Virginia)

## ACRONYMS

AARI - Arctic and Antarctic Research Institute (Russia)  
ADDS - Antarctic Data Directory System  
AEDD - Arctic Environmental Data Directory  
AEDDWG - AEDD Working Group  
AFGWC - Air Force Global Weather Central  
AIDJEX - Arctic Ice Dynamics Joint Experiment  
AMD - Antarctic Master Directory  
AOBP - Arctic Ocean Buoy Program  
ARCSS - Arctic System Science  
ARCUS - Arctic Research Consortium of the U.S.  
ASTER - Advanced Spaceborne Thermal Emission and Reflection Radiometer  
AVHRR - Advanced Very High Resolution Radiometer  
BASE - Beaufort and Arctic Storms Experiment  
CDMS - Cryospheric Data Management System  
CEAREX - Coordinated Eastern Arctic Experiment  
CGC - Climate and Global Change Program  
CIESIN - Consortium for International Earth Sciences Information Network  
CIMS - Cryospheric Information Management System  
CIRES - Cooperative Institute for Research in Environmental Sciences  
COMNAP - Council of Managers of National Antarctic Programs  
CRREL - Cold Regions Research and Engineering Laboratory  
DAAC - Distributed Active Archive Center  
DADS - Data Archive and Distribution System  
DIF - Directory Interchange Format  
DMSP - Defense Meteorological Satellite Program  
DMWG - Data Management Working Group  
DOAFT - EOSDIS Data Organization and Access Focus Team  
DOD - Department of Defense  
DORIS - Doppler Orbitography and Radiopositioning Integrated by Satellite  
DPFT - Data Processing Focus Team  
DPP - Division of Polar Programs  
EASE - Equal Area SSM/I Earth Grids  
EDC - EROS Data Center  
EOS - Earth Observing System  
EOSDIS - EOS Data and Information System  
ESDIM - Earth Science System Data and Information Management  
ESMR - Electrically Scanning Microwave Radiometer  
ETH - Eidgenössische Technische Hochschule (Switzerland)  
EUBEX - Eurasian Basin Experiment  
FRC - Federal Records Center  
FSU - former Soviet Union

GAC - Global Area Coverage  
GD - Glaciological Data  
GDSIDB - Global Digital Sea Ice Data Bank  
GIS - Geographic Information System  
GISP - Greenland Ice Sheet Program  
GLAS - Geoscience Laser Altimeter System  
GPS - Geophysical Processor System  
GRID - Global Resource Information Database  
GRIP - Greenland Icesheet Program  
GSFC - Goddard Space Flight Center  
HARA - Historical Arctic Rawinsonde Archive  
HDF - Hierarchical Data Format  
HRPT - High Resolution Picture Transmission  
HSDSD - Historical Soviet Daily Snow Depth  
HTML- HyperText Markup Language  
IABP - International Arctic Buoy Program  
ICAIR - International Centre for Antarctic Information and Research  
ICSU - International Council of Scientific Unions  
IDN - International Directory Network  
IGBP - International Geosphere Biosphere Program  
IGS - International Glaciological Society  
IIP - International Ice Patrol  
IMS - Information Management System  
JPL - Jet Propulsion Laboratory  
LAC - Local Area Coverage  
LAII - Land/Atmosphere/Ice Interactions  
LAS - Land Analysis System  
LASP - Laboratory for Atmospheric and Space Physics  
MIMR- -Multifrequency Imaging Microwave Radiometer  
MIZEX - Marginal Ice Zone Experiment  
MSFC - Marshall Space Flight Center  
NAL - New Accessions List  
NASA - National Aeronautics and Space Administration  
NASDA - National Space Development Agency (Japan)  
NATO - North Atlantic Treaty Organization  
NCAR - National Center for Atmospheric Research  
NCDC - National Climatic Data Center  
NESDIS - National Environmental Satellite, Data and Information Service  
NGDC - National Geophysical Data Center  
NISC - National Information Services Corporation  
NMC - National Meteorological Center  
NOAA - National Oceanic and Atmospheric Administration  
NSF - National Science Foundation

NSIDC - National Snow and Ice Data Center  
OAI - Ocean/Atmosphere/Ice Interactions  
OLS - Operational Linescan System  
ONR - Office of Naval Research  
PALE - Paleoenvironments from Arctic Lakes and Estuaries  
PDS - Planetary Data System  
PGS - Product Generation System  
PoDAG - Polar DAAC Advisory Group  
PSC - Polar Science Center  
SANIGMI - Central Asian Hydrometeorological Research Institute  
SAR - Synthetic Aperture Radar  
SCAR - Scientific Committee on Antarctic Research  
SDSD - Satellite Data Services Division  
SEDAAR - Strategic Environmental Data Active Archive Resource  
SERDP - Strategic Environmental Research and Development Program  
SGI - Silicon Graphics Incorporated  
SIGRID - Sea Ice Grid  
SIMMS - Seasonal Ice Monitoring and Modeling Program (Canada)  
SLAR - Side-looking Airborne Radar  
SMMR - Scanning Multichannel Microwave Radiometer  
SMO - Science Management Office  
SOFT - EOSDIS Systems Operations Focus Team  
SPWT - SSM/I Products Working Team  
SSALT - Solid State Radar Altimeter  
SSM/I - Special Sensor Microwave Imager  
SSM/T - Special Sensor Microwave Temperature  
TM - Thematic Mapper  
TMR - TOPEX Microwave Radiometer  
TOPEX - Ocean Topography Experiment  
TOVS - Television Infrared Observing Satellite Operational Vertical Sounder  
TOVS - TIROS Operational Vertical Sounder  
UNEP - United Nations Environment Program  
USAF - United States Air Force  
USGS - United States Geological Survey  
V0 - Version 0  
WAIS - Wide Area Information Servers  
WDC - World Data Center  
WMO - World Meteorological Organization  
WWW - World Wide Web