

# GLACIOLOGICAL DATA

## WORKSHOP ON THE U.S. ANTARCTIC METEOROLOGICAL DATA DELIVERY SYSTEM

World Data Center A  
for  
Glaciology  
[Snow and Ice]



January 1988

## DESCRIPTION OF THE WORLD DATA CENTER SYSTEM<sup>1</sup>

The World Data Centers (WDCs) were established in 1957 to provide archives for the observational data resulting from the International Geophysical Year (IGY). In 1958 the WDCs were invoked to deal with the data resulting from the International Geophysical Cooperation 1959, the one-year extension of the IGY. In 1960, the International Council of Scientific Unions (ICSU) Comite International de Geophysique (CIG) invited the scientific community to continue to send to the WDCs similar kinds of data from observations in 1960 and following years, and undertook to provide a revised *Guide to International Data Exchange* for that purpose. In parallel the CIG inquired of the IGY WDCs whether they were willing to treat the post-IGY data; with few exceptions, the WDCs agreed to do so. Thus the WDCs have been serving the scientific community continuously since the IGY, and many of them archive data for earlier periods.

In November 1987 the International Council of Scientific Unions (ICSU) Panel on World Data Centers prepared a new version of the *Guide to International Data Exchange*, originally published in 1957, and revised in 1963, 1973 and 1979. The new publication, *Guide to the World Data Center System, Part 1, The World Data Centers (General Principles, Locations and Services)* was issued by the Secretariat of the ICSU Panel on World Data Centers. This new version of the *Guide* contains descriptions of each of the twenty-seven currently operating disciplinary centers, with address, telephone, telex, and contact persons listed. The reader is referred to the new *Guide* for descriptions of the responsibilities of the WDCs, the exchange of data between them, contribution of data to WDCs, and the dissemination of data by them. The WDCs for Glaciology are listed below.

### World Data Center A for Glaciology [Snow and Ice]

Address:	WDC-A for Glaciology CIRES, Campus Box 449 University of Colorado Boulder, Colorado 80309-0449 USA
Telephone:	(303)492-5171
Telex:	257673 WDCA UR
Telefax:	(303)497-6513
Network Address:	[NSIDC/OMNET] MAIL/USA VAX Mail (via SPAN) KRYOS::NSIDC
Director:	Dr. R.G. Barry

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Director:	Dr. R.G. Barry

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Address: World Data Center B1 for Glaciology  
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Moscow 117296  
USSR

Telephone: 130-05-87  
Telex: 411478 SGC SU  
Director: Dr. V.I. Smirnov

### World Data Center C for Glaciology

Address: WDC-C for Glaciology  
Scott Polar Research Institute  
Lensfield Road  
Cambridge CB2 1ER  
UNITED KINGDOM

Telephone: (0223)336556  
Telex: 81240 CAMSPL G  
Network Address: (JANET)ADM13@UK.AC.CAMBRIDGE.PHOENIX  
Manager: Mrs. Ailsa D. Macqueen

The following organization provides international data services including data analyses and preparation of specialized data products. It merges the previous activity of the Permanent Service on the Fluctuations of Glaciers and the Temporary Technical Secretariat for World Glacier Inventory. These activities are not part of the WDC system but the center cooperates with WDCs in the discipline. Users wishing assistance in seeking data or services from this group may contact an appropriate WDC.

### World Glacier Monitoring Service (WGMS)

Dr. W. Haeberli  
Section of Glaciology  
VAW/ETH, ETH Zentrum  
8092 Zurich  
SWITZERLAND

<sup>1</sup>Adapted from *Guide to the World Data Center System. Part 1. The World Data Centers (General Principles, Locations and Services)*. International Council of Scientific Unions. Panel on World Data Centers, November 1987, 91 pp.

## FOREWORD

The United States has been involved in research in Antarctica on a regular basis since the International Geophysical Year (1957-58); there are now up to thirty years of meteorological observations from some stations. These data, while small in volume compared with similar data from the remainder of the globe, are vital to our complete understanding of global weather and climate. The data must be fully available to potential users now, and in future years, as analysis techniques become more sophisticated and as research priorities change over time. Without such access, the data will be buried in archives and in the offices of researchers, and the data collection investment will have been wasted.

With this objective in mind, twenty-eight participants met in Boulder on 10-11 September 1987 to develop recommendations for improving the current status of archives of meteorological data from U.S. Antarctic stations and other research programs. The workshop, convened by the National Snow and Ice Data Center (NSIDC) at the request of the National Science Foundation/Division of Polar Programs/Polar Coordination and Information Section (NSF/DPP), brought together representatives of the research community, data managers and Antarctic support operations. The participants drew on the material assembled in *Glaciological Data, Report GD-15* and previous NSF and World Meteorological Organization (WMO) reports. The findings are addressed to NSF/DPP, but should be of interest to all Antarctic researchers. Appendices provide preliminary inventories of existing data and their whereabouts. Any additional information on other data sets will be welcomed.

We thank Guy Guthridge and John Talmadge of NSF/DPP for supporting this workshop, Charles Stearns, University of Wisconsin, for his able chairmanship, Claire Hanson for her meticulous organization of the meeting and the report, and the participants for their thoughtful discussion and written material. Special thanks to Carol Pedigo for her patient word processing support.

R.G. Barry  
Director  
WDC-A for Glaciology (Snow and Ice) and  
National Snow and Ice Data Center

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WORKSHOP ON THE U.S. ANTARCTIC METEOROLOGICAL DATA DELIVERY SYSTEM  
BOULDER, COLORADO, 10-11 SEPTEMBER 1987

Introduction

Concerns over access to meteorological data from U.S. Antarctic stations (Figure 1) have been the subject of much discussion among the key organizations involved: the NSF/DPP, the National Weather Service (NWS), and the U.S. Naval Support Force Antarctica (USNSFA). Several factors have apparently led to a somewhat confused picture of data access in the minds of potential data users. Antarctica's remote location has made communication of data to and from the continent difficult, leading to delays in data receipt both at the ultimate archive(s) and at transmission stations along the route to the archive(s). Personnel turnover among USNSFA and civilian contractor staff, who are responsible for most of the actual data collection within Antarctica, is nearly complete each season, so reporting methods and formats are not always standardized. Formal designation of a permanent archive for the data in question has not been made by NSF/DPP, nor is there a permanent source of funding to process and archive the data. Delays in receipt of data at the archive(s) lead potential users to conclude the data are not available, and, indeed, the archive locations of many Antarctic meteorological data are not widely known within the research community.

NSF/DPP requested this workshop be convened in order to address the problems of data access, hoping to generate creative solutions by bringing together knowledgeable representatives of the organizations involved in collection, processing, archiving, and use of Antarctic meteorological data. The workshop participants (Appendix A) were selected by virtue of long involvement with some aspect of these data, and each one participated fully in the discussions generated during and following the workshop.

"The opportunities in Antarctica's developing role in global, interdisciplinary science lie in deriving the most benefit for the most people through greater scientific understanding and utilization of its results." (Kimball, 1987, p. 3) Such understanding can be fostered if the data delivery system is responsive to the requirements of data collectors, data archives and data users. These workshop recommendations are a starting point for fine-tuning the delivery system, providing NSF/DPP with an action plan to begin solving the decades-old problem of delivering Antarctic meteorological data to users.

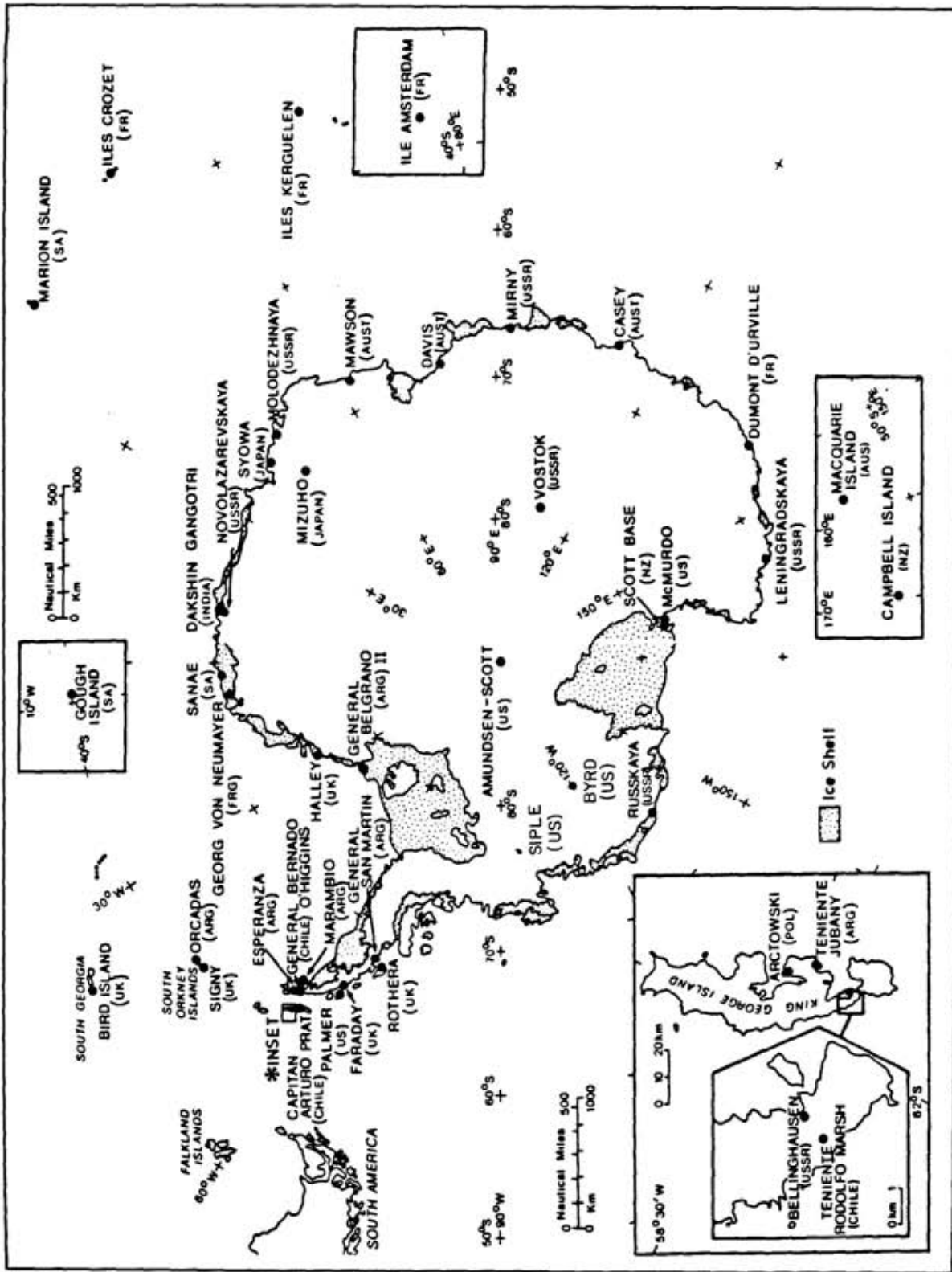


Figure 1. Map of Antarctic research stations. (Adapted from a British Antarctic Survey map.)



**Workshop on U.S. Antarctic Meteorological Data Delivery System  
Boulder, Colorado, 10-11 September 1987  
Agenda**

Thursday, September 10, 1987

- 08:30 - 11:00      Convene Plenary Session  
Welcome, Introductory Remarks,  
Logistics: Roger Barry, Guy Guthridge, Claire Hanson  
Opening Statement: Charles Stearns, Chairman
- Roundtable:  
                    1. Statement of problem and suggested solutions - each  
                            participant  
                    2. Inventory of U.S. Antarctic meteorological data types
- 11:00 - 12:00      Presentations on existing data management systems:  
                    BEES, CLICOM, PCDS, UNIDATA
- Organization of Working Groups: Chairman  
                    1. Data Collection and Processing  
                    2. Data Archiving and Distribution
- 12:00 - 13:00      Lunch
- 13:00 - 17:00      Working Group discussions: towards system requirements  
                    definition
- 17:30 - 19:00      Dinner
- 19:00 - 21:00      Plenary Session: Presentation and discussion of Working  
                    Group Reports

Friday, September 11, 1987

- 08:30 - 09:30      Plenary Session: Continue discussion of Working Group  
                    presentations
- 09:30 - 12:00      Working Groups: Begin drafting system requirements defini-  
                    tion
- 12:00 - 13:00      Plenary Session:  
  
                    Roundtable: Final statements from participants  
                    Concluding remarks: Chairman
- 13:00 - 16:00      Meeting Rooms available for continued work on draft  
                    system requirements definition.  
  
                    Demonstrations of CLICOM and PCDS/NCDS  
  
                    Video of Antarctic SMMR sea ice

## Recommendations of the Workshop

Workshop recommendations include both general and quite specific points, addressing all aspects of the data delivery and data access problem. Table 1, describing the U.S. Antarctic meteorological data system, illustrates the diverse nature of the problem. In organizing the recommendations, it became apparent that overall responsibility for implementation had to be assumed by an Oversight Committee made up of the organizations directly involved. The Polar Research Board (1983, p. 43) noted that:

Perhaps the most important of considerations [for the U.S. Antarctic Program] is ensuring rapid and complete reduction of data,...and the placement of the data in efficient storage and dissemination systems. The responsibility for ensuring that this is done lies squarely on the agency funding the data collection and on the data collector.

The Oversight Committee structure would place monitoring responsibility in the hands of the NSF/DPP, and maintain involvement of the other major players in the process of devising methods to deliver data to the users as efficiently as possible.

### I. Oversight Committee.

The Director of the National Science Foundation/Division of Polar Programs (NSF/DPP) should appoint an Oversight Committee composed of one representative from each of the following organizations concerned with U.S. Antarctic meteorological data: NSF/DPP (Chair), U.S. Naval Support Force Antarctica (USNSFA), ITT/Antarctic Services (the civilian contractor, known as ANS), NOAA/National Weather Service (NWS), NOAA/National Climatic Data Center (NCDC), and two data users.

The function of the Oversight Committee should be to monitor the following items with regard to meteorological data from U.S. Antarctic stations:

1. The proper collection, transmission, receipt, distribution and archiving of synoptic and operational data;
2. the archiving and distribution of U.S. Antarctic meteorological and related data;
3. the operation of a system, whether currently in place or developed in the future, to distribute Antarctic data to the user community;
4. the consideration of a means to incorporate U.S. data from outside the U.S. Antarctic Research Program.

With an Oversight Committee in place, organizations can begin to work toward implementation of specific recommendations of the workshop, presented here with background material prepared by workshop participants.

Table 1. Outline of the U.S. Antarctic Meteorological Data Delivery System. C. Stearns, September 1987.

- Measurements of meteorological variables
- 1.1 Surface data
    - 1.1.1 Staffed stations
      - 1.1.1.1 Human observations (visibility, clouds)
        - 1.1.1.1.1 Sensor observations
        - 1.1.1.1.2 Meteor scatter
      - 1.1.2 Automatic weather stations
      - 1.1.3 Field parties
      - 1.1.4 Special experiments
      - 1.1.5 CMCC data (Geophysical Monitoring for Climatic Change)
        - 1.1.5.1 Upper air data
        - 1.1.5.2 Radiosondes
        - 1.1.5.3 Special soundings
        - 1.1.5.4 Ozone sondes
        - 1.1.5.5 High altitude balloon wind speed and direction
    - 1.2 Special experiments
      - 1.2.3.1 CMCC surface data
      - 1.2.3.2 CMCC soundings
  - 1.2 Satellite data
    - 1.2.1 Displayed satellite images
      - 1.2.1.1 U.S. Air Force Defense Meteorological Satellite Program (DMSP) - OLS visual and infrared imagery
    - 1.2.2 Digital satellite data
      - 1.2.2.1 DMSP - OLS, SSM/1, SSM/T
      - 1.2.2.2 NOAA - AVHRR, TOVS
      - 1.2.2.3 Nimbus 5/6 - ESMR
      - 1.2.2.4 Nimbus 7 - TOMS, SMMR, SBUV, SAMII, SAMS, THIR, LIMS, ERB
    - 1.2.3 U.S. Navy Geosat
  - 1.3 Surface and upper air analyses (maps and soundings)
    - 1.3.1 Fixed sites
    - 1.3.2 Traverses
  - 1.4 Special experiments
    - 1.4.1 Aircraft in-flight winds and temperatures
    - 1.4.2 Aircraft flights with high-speed meteorological data collection systems for specific experiments
    - 1.4.3 Ground level remote sensing
    - 1.4.4 Boundary layer measurements
    - 1.4.5 Drifting buoy data
    - 1.4.6 Ship observations
2. Data transmission within Antarctica
- 2.1 Real time between stations
    - 2.1.1 HF radio by voice
    - 2.1.2 HF radio by teletype
    - 2.1.3 Meteor scatter
    - 2.1.4 Geostationary satellite
    - 2.1.5 Polar orbiting satellite
  - 2.2 Delayed time
    - 2.2.1 Written records
    - 2.2.2 Recorded digital data
    - 2.2.3 Recorded analog data
3. Intercontinental data transmission
- 3.1 Minimum time
    - 3.1.1 HF radio by voice
    - 3.1.2 HF radio by teletype
      - 3.1.2.1 McMurdo Station to N.Z. Meteorological Service
      - 3.1.2.2 Palmer Station to British Antarctic Survey at Faraday, then to U.S.
  - 3.2 Delayed time
    - 3.2.1 Geostationary satellite
    - 3.2.2 Polar orbiting satellite
    - 3.2.3 HF radio
    - 3.2.4 Geostationary satellite
    - 3.2.5 Transport by ship or airplane
4. Data receipt in the U.S.
- 4.1 Station data for the GTS
  - 4.2 ARGOS data
  - 4.3 Geostationary satellite
    - 4.3.1 Low bit rate data - by telephone line
    - 4.3.2 High bit rate data
  - 4.4 Ship and aircraft data
5. Data archives
- 5.1 National Climatic Data Center
  - 5.2 Other data centers
6. Data distribution
- 6.1 GTS
  - 6.2 National Climatic Data Center
  - 6.3 Other data centers
7. Data feedback to Antarctica for climate archives at stations

## II. Data collection, entry and display at observing stations.

### A. Data collection.

Because U.S. Antarctic stations are staffed by the USNSFA and by a civilian contractor (currently ITT/Antarctic Services), there is a large turnover in personnel each field season. Meteorological observations are taken by persons who may have no previous Antarctic field experience, or who are not familiar with required reporting formats and procedures. In addition, manuals are not always available to provide guidance for new or returning observers. ITT/Antarctic Services representatives at the workshop, themselves Antarctic meteorological observers, noted the importance of communicating requirements to station personnel, as a means of improving the quality of data collected.

**Recommendation:** Prior to duty at an Antarctic station, weather observers should receive specific training in reporting requirements and data formats, which should be standard at all U.S. stations. In addition, training in observational practices and instrument operation in low temperature and polar darkness environments would improve data quality.

### B. Data entry and display.

Requirements exist for surface data in two forms: operational hourly reports for aviation, and three- to six-hourly reports for basic synoptic purposes. Observational data are recorded on forms, encoded into the appropriate formats for the time of transmission, and transmitted over HF radio. The group considered that this procedure could be made more efficient by the introduction of suitable automated equipment, with the proviso that the workload of the station staff must not be increased.

Conceptually, an observer could enter the observed weather conditions in response to prompts from a microprocessor. Rudimentary quality control and limits checks could be performed by the computer software, which could, for example, compare the current observation with previous observations that had been stored, and flag questionable values. The observer would have the option of validating or correcting the element flagged. Once this process was completed, the processor could encode the observation in the appropriate format(s) and prepare a message for transmission. With an appropriate communications interface, the processor could then transmit the message at the scheduled time. The processor could also run appropriate applications software for storage and display of observational data on site, and limited data processing capability for the computation of monthly means could easily be incorporated.

It is important to note that USNSFA should not carry the entire burden of digitizing data on site if that is determined to be the optimal method of data collection. USNSFA would be responsible for McMurdo Station and possibly the remote sites, while the contractor would be responsible for Amundsen-Scott Station, Palmer Station, and the larger-scale seasonal camps.

Automation of data collection in Antarctica offers significant advantages including improvement of the submission of data for archiving at NCDC. Pre-formatting at the field stations could reduce by two-thirds the cost per unit to enter and verify the data at NCDC. It is, however, unclear whether those costs would be transferred, in terms of dollars or manpower, to personnel on site. Therefore, digitizing data that is in addition to the routine surface synoptic and upper air data submitted to NWS for the WMO Global Telecommunication System (GTS) should be investigated in light of computer and communications upgrades now taking place in Antarctica.

**Recommendation:** In light of computer and communications equipment upgrades now taking place at McMurdo Station, NSF/DPP, USNSFA and NWS should investigate the feasibility of installing automated equipment for the entry and encoding of operational and synoptic surface and upper air observations, that would increase station staff efficiency by digitizing data at the collection point. This recommendation applies to data collected in addition to the routine surface synoptic and upper air data now submitted to the NWS for entry in the GTS.

A progress report should be distributed by 15 April 1988, including recommendations for further action. A Data Automation Task Group composed of Erick Chiang, NSF/DPP, Mark Mickelinc, USNSFA, and James Neilon, NWS, was established to implement this recommendation, and to assure that implementation places no additional burden on operational staff at McMurdo, beyond the transition phase.

### III. Transmission of real-time U.S. data from Antarctica.

A considerable amount of real-time data from U.S. Antarctic stations are now lost before they reach the NMC in Washington. The workshop analyzed the flow of data from the U.S. stations onto the GTS, and into archives where vital quality control procedures are applied.

The current telecommunication arrangements for U.S. stations in Antarctica involve collection by HF radio. McMurdo Station collects the observational data from Amundsen-Scott (South Pole), Byrd and Siple Stations. McMurdo transmits these observations by HF radio to the U.S. Naval station at Christchurch, New Zealand. Christchurch passes the data to the New Zealand Meteorological Service for entry on the GTS. These data reach Washington through GTS nodes at Wellington, Melbourne and Tokyo. Figures 2 and 3 depict international telecommunications within Antarctica and onto the GTS.

Palmer sends its observations by HF radio to the United Kingdom base at Faraday, which transmits data it has collected via the Data Collection System on the GOES-East satellite. The NWS in Washington receives the data and enters them on the GTS. There are many problems associated with HF communications in the Antarctic. There is typically significant interference over long periods and there are occasional interruptions for many hours. These factors affect the quality, timeliness, and availability of data.

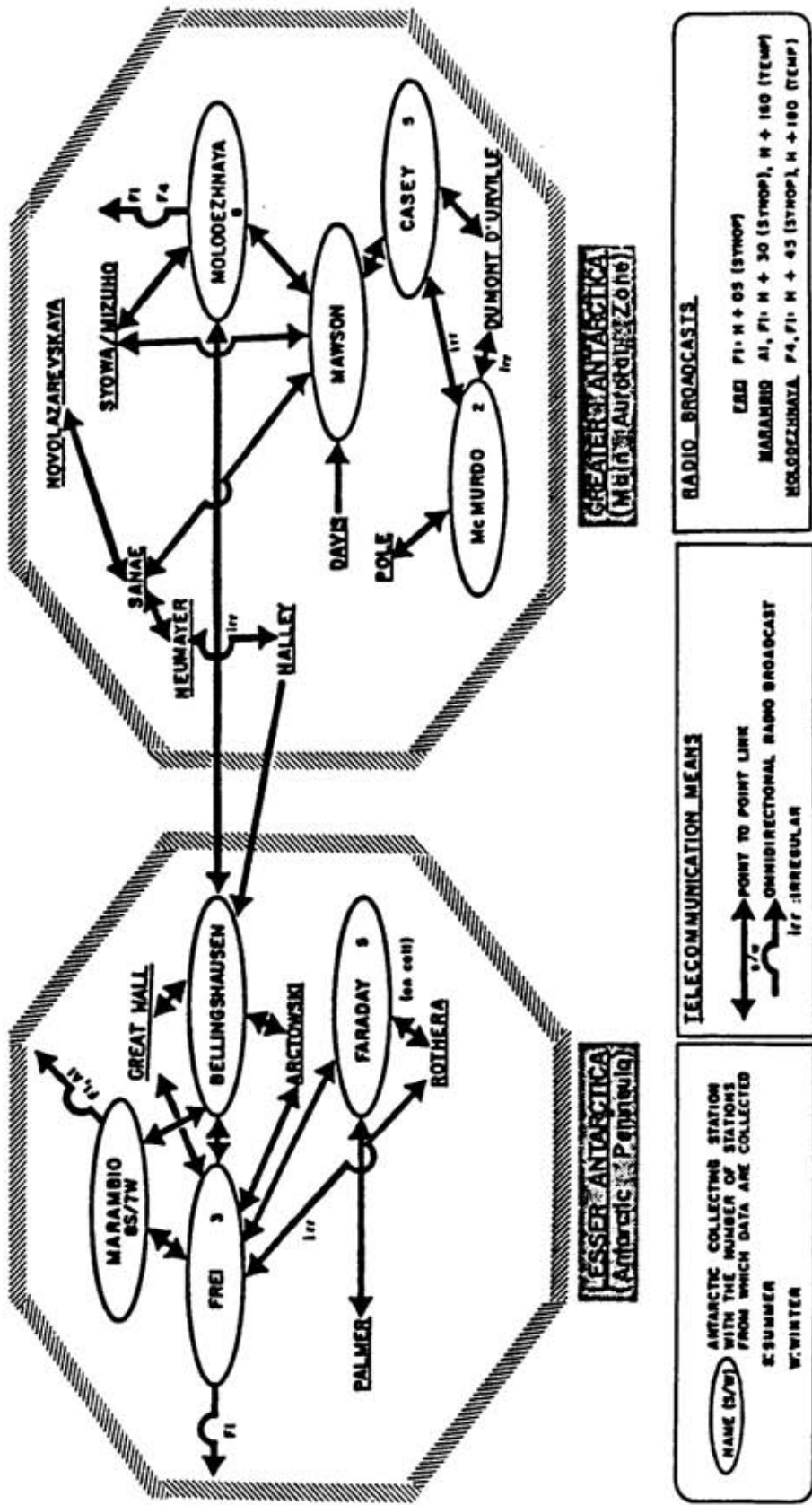
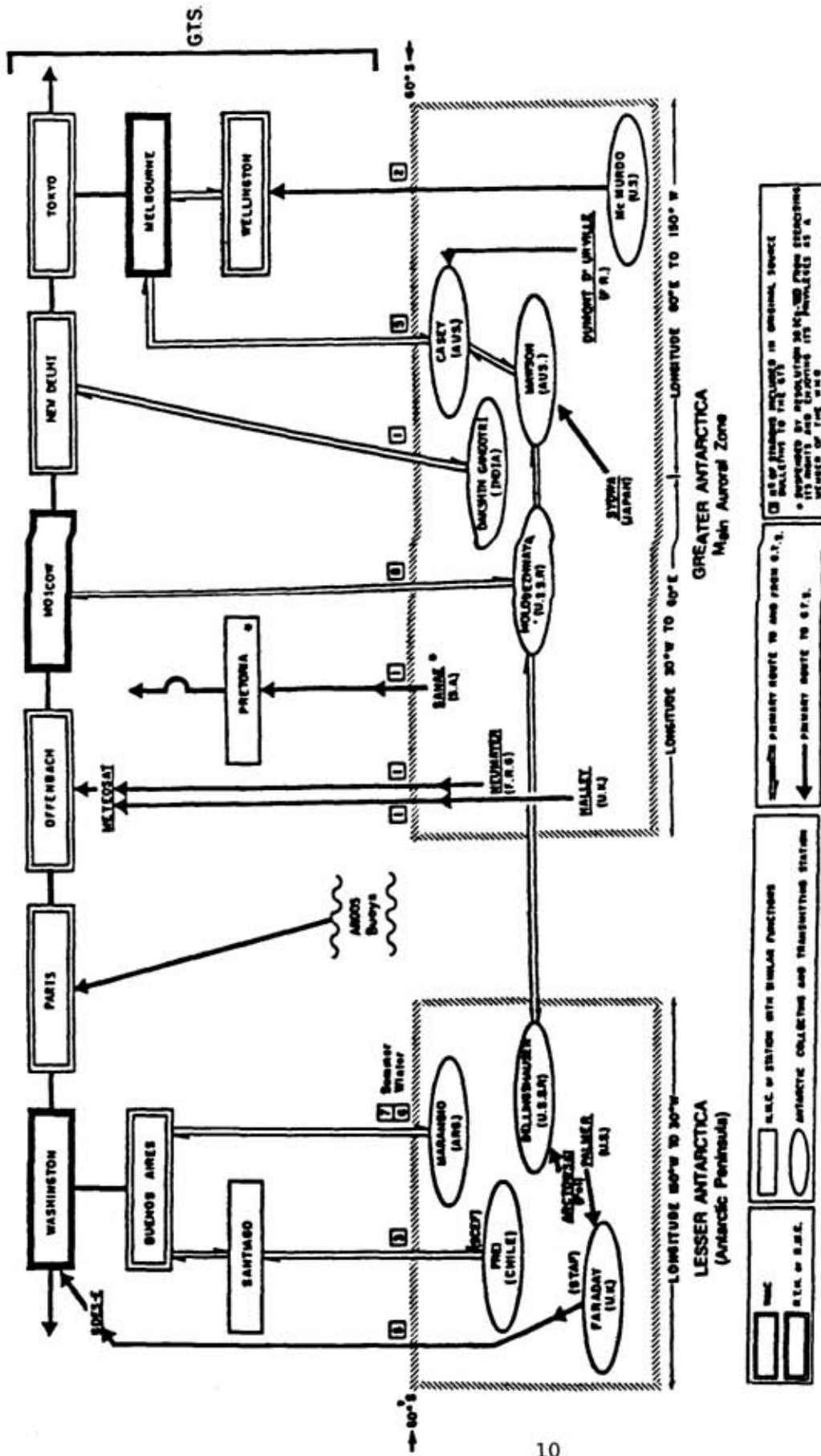


Figure 2. Existing links for the daily international exchange of meteorological data within the Antarctic. F1 indicates radio teleprinter broadcasts, F4 indicates facsimile broadcasts, A1 is a Morse transmission. (From WMO, 1986)



Note : SHIP and AIREP reports will be collected from south of 60°S and compiled in Antarctic bulletins by appropriate GTS centres.

Figure 3. Principal routes by which Antarctic meteorological data enters the GTS. (From WMO, 1986)

A number of improvements in telecommunication procedures could be made that would meet operational requirements both inside and outside of Antarctica. It is proposed that each station transmit its observational data via an appropriate satellite system such as INMARSAT, NOAA/ARGOS, or ATS-1. However, changes to existing links must ensure that U.S. Antarctic stations' access to GTS data for operational forecasting is unaffected. The proposed inter- and intra-continental satellite links can be configured as shown in Figure 4.

There are two primary advantages to the application of satellite communication links among Antarctic stations. First, there would be minimum interference with timely transmission off-station. Under the current operational system, data are lost due to ionospheric disturbances that disrupt HF radio links. Second, data would be sent directly to NWS/Washington for entry in the GTS. The two coastal stations (Palmer and McMurdo) could send data directly to NWS, and could serve as relay nodes for Amundsen-Scott Station and other summer camps or stations when such relays are needed.

**Recommendation:** Satellite, HF radio, meteor scatter and other available technologies, should be considered as a means to improve transmission and reception of operational and synoptic meteorological data within Antarctica and onto the Global Telecommunications System (GTS). NWS would still be required to put the data onto the GTS. The Data Automation Task Group (section II.B.) should be responsible for implementation, with a target date of 3 October 1988.

**Recommendation:** The HF radio link from McMurdo to Christchurch should be kept in operation, primarily for the transmission from Christchurch of data required at McMurdo, and secondarily for backup of the proposed INMARSAT link. Changes to existing communications links should be configured such that access to any data from the GTS needed by the Antarctic stations for operational forecasting is not degraded or reduced.

#### IV. Current Antarctic real-time data receipt at the World Meteorological Center.

##### A. Daily synoptic reports.

Antarctic synoptic surface and upper air data are transmitted via the GTS to the World Meteorological Center (colocated with the National Meteorological Center) in Washington. Monitoring of the data reports (Tables 2 and 3) shows that only a fraction of the potential data are received at WMC. This level of data receipt has not been adequate for day-to-day monitoring of Antarctic weather, nor has it been sufficient to form the monthly and seasonal summaries required for climate monitoring. Of the five active U.S. Antarctic stations, data are typically available from only two, and the receipt of data from these two is relatively poor in comparison with the amount of Antarctic data received from other nations.



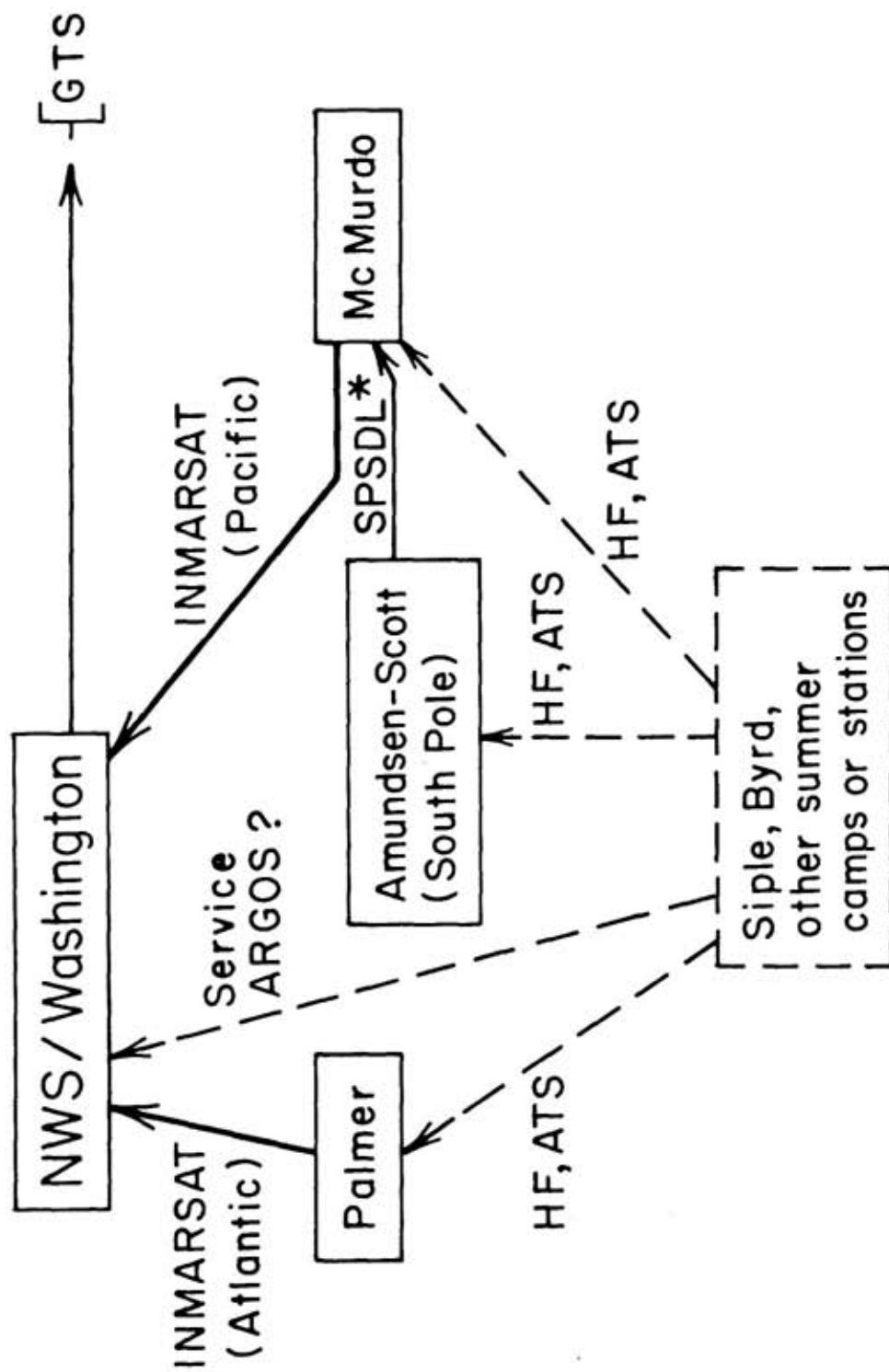


Figure 4. Proposed communications links for data collection in Antarctica. (E. Chiang, 11 September 1987)  
 \* South Pole Satellite Data Link. Comberiate, M., et al., 1986.

Table 2. Synoptic surface reports received at World Meteorological Center, Washington, June 1-30, 1987. Prepared by National Meteorological Center.

Station ID	Total reports received				Total
	0000Z	0006Z	1200Z	1800Z	
89001	25	27	29	19	= 100
89009*	4	0	1	2	= 7
89022	23	23	23	15	= 84
89034	27	0	26	26	= 79
89042	16	0	19	0	= 35
89050	30	29	30	29	= 118
89051	0	0	0	1	= 1
89055	26	29	25	28	= 108
89056	29	30	29	30	= 118
89057	29	30	28	30	= 117
89058	28	28	29	29	= 114
89059	28	29	29	30	= 116
89060	0	0	0	0	= 0
89061*	21	1	24	22	= 68
89062	17	16	22	18	= 73
89063	23	25	25	21	= 94
89065	0	0	0	0	= 0
89066	27	27	27	26	= 107
89512	30	29	30	29	= 118
89532	25	26	26	27	= 104
89542	30	29	30	29	= 118
89564	26	27	26	27	= 106
89571	27	27	26	26	= 106
89592	30	29	28	29	= 116
89606	30	29	30	29	= 118
89611	27	25	25	25	= 102
89642	25	23	21	24	= 93
89657	30	29	30	29	= 118
89664*	24	4	5	23	= 56

\* U.S. Antarctic station

Table 3. Summary of upper air data received at the World Meteorological Center, Washington for June 1-30, 1987. The U.S. stations, Amundsen-Scott and McMurdo, are underlined. Produced by the National Meteorological Center.

** NUMBER OF TEMP/TEMP SHIP REPORTS RECEIVED ** WITHIN THE SPECIFIED PERIOD AFTER ** OBSERVATION TIME								*** ** NUMBER OF PILOT/PILOT SHIP REPORTS RECEIVED *** ** WITHIN THE SPECIFIED PERIOD AFTER *** ** OBSERVATION TIME											
STATION**	HH+ 180 MIN				*	HH+ 720 MIN				***STATION**	HH+ 180 MIN				*	HH+ 720 MIN			
INDEX NUMBER**	00Z	06Z	12Z	18Z	*	00Z	06Z	12Z	18Z	INDEX NUMBER**	00Z	06Z	12Z	18Z	*	00Z	06Z	12Z	18Z
78762 **	0	0	29	0	*	0	0	29	0	*** 78762 **	0	0	0	0	*	0	0	0	0
78806 **	10	0	6	0	*	14	0	21	0	*** 78806 **	0	0	0	0	*	0	0	0	0
78861 **	0	0	9	0	*	0	0	14	0	*** 78861 **	0	0	0	0	*	0	0	0	0
78866 **	0	0	19	0	*	0	0	25	0	*** 78866 **	0	0	0	0	*	0	0	0	0
78954 **	27	0	22	1	*	28	0	26	1	*** 78954 **	0	0	0	0	*	0	0	0	0
78970 **	29	0	27	0	*	30	0	29	0	*** 78970 **	0	0	0	0	*	0	0	0	0
80001 **	0	0	7	0	*	0	0	28	0	*** 80001 **	0	0	0	0	*	0	0	0	0
80222 **	12	0	6	0	*	20	0	18	0	*** 80222 **	0	0	0	0	*	0	0	0	0
80241 **	0	0	0	0	*	0	0	10	0	*** 80241 **	0	0	0	0	*	0	0	0	0
80413 **	0	0	18	0	*	0	0	23	0	*** 80413 **	0	0	0	0	*	0	0	0	0
80444 **	0	0	9	0	*	0	0	16	0	*** 80444 **	0	0	0	0	*	0	0	0	0
81405 **	0	0	26	0	*	0	0	26	0	*** 81405 **	0	0	0	0	*	0	0	0	0
82599 **	0	0	4	0	*	0	0	24	0	*** 82599 **	0	0	2	0	*	0	0	10	0
82765 **	0	0	5	0	*	0	0	10	0	*** 82765 **	0	0	0	0	*	0	0	2	0
82900 **	0	0	14	0	*	0	0	19	0	*** 82900 **	0	0	6	0	*	0	0	6	0
82983 **	0	0	16	0	*	0	0	19	0	*** 82983 **	0	0	3	0	*	0	0	5	0
83378 **	4	0	2	0	*	6	0	5	0	*** 83378 **	0	0	1	0	*	1	0	2	0
83612 **	12	0	8	0	*	28	0	26	0	*** 83612 **	6	0	4	0	*	12	0	13	0
83650 **	0	0	0	0	*	0	0	9	0	*** 83650 **	0	0	0	0	*	0	0	0	0
83746 **	26	0	15	0	*	28	0	29	0	*** 83746 **	14	0	4	0	*	14	0	9	0
83780 **	0	0	23	0	*	0	0	29	0	*** 83780 **	0	0	11	0	*	0	0	15	0
83840 **	0	0	21	0	*	0	0	27	0	*** 83840 **	0	0	5	0	*	0	0	6	0
83971 **	11	0	20	0	*	28	0	28	0	*** 83971 **	5	0	2	0	*	12	0	7	0
84628 **	5	0	0	0	*	10	0	0	0	*** 84628 **	0	0	0	0	*	0	0	0	0
85201 **	0	0	1	0	*	0	0	16	0	*** 85201 **	0	0	0	0	*	0	0	0	0
85442 **	22	0	22	1	*	26	0	28	1	*** 85442 **	3	0	7	1	*	3	0	9	1
85469 **	6	0	0	0	*	9	0	0	0	*** 85469 **	0	0	0	0	*	0	0	0	0
85543 **	24	0	20	0	*	28	0	27	0	*** 85543 **	0	0	0	0	*	0	0	0	0
85799 **	19	0	16	0	*	26	0	25	0	*** 85799 **	2	0	2	0	*	3	0	2	0
85934 **	21	0	16	0	*	29	0	26	0	*** 85934 **	2	0	2	0	*	3	0	2	0
87047 **	0	0	25	0	*	0	0	25	0	*** 87047 **	0	0	2	0	*	0	0	2	0
87155 **	0	0	27	0	*	0	0	28	0	*** 87155 **	0	0	2	0	*	0	0	2	0
87344 **	0	0	14	0	*	0	0	21	0	*** 87344 **	0	0	2	0	*	0	0	3	0
87418 **	0	0	21	0	*	0	0	24	0	*** 87418 **	0	0	3	0	*	0	0	3	0
87576 **	0	0	24	0	*	0	0	26	0	*** 87576 **	0	0	5	0	*	0	0	5	0
87623 **	0	0	22	0	*	0	0	24	0	*** 87623 **	0	0	3	0	*	0	0	4	0
87715 **	0	0	20	0	*	0	0	24	0	*** 87715 **	0	0	1	0	*	0	0	2	0
87748 **	0	0	9	0	*	0	0	12	0	*** 87748 **	0	0	1	0	*	0	0	1	0
87860 **	0	0	12	0	*	0	0	14	0	*** 87860 **	0	0	4	0	*	0	0	5	0
88468 **	0	0	0	0	*	1	0	0	0	*** 88468 **	0	0	0	0	*	0	0	0	0
89001 **	17	0	24	0	*	20	0	27	0	*** 89001 **	4	0	2	0	*	4	0	5	0
<u>89009</u> **	11	0	0	0	*	15	0	2	0	*** <u>89009</u> **	0	0	0	0	*	0	0	0	0
89022 **	0	0	0	0	*	0	0	20	0	*** 89022 **	0	0	0	0	*	0	0	0	0
89050 **	26	0	0	0	*	28	0	0	0	*** 89050 **	0	0	0	0	*	0	0	0	0
89512 **	29	0	0	0	*	30	0	0	0	*** 89512 **	0	0	0	0	*	0	0	0	0
89532 **	20	0	1	0	*	20	0	18	0	*** 89532 **	0	0	0	0	*	0	0	0	0
89542 **	29	0	26	0	*	30	0	28	0	*** 89542 **	0	0	0	0	*	0	0	0	0
89571 **	25	0	0	0	*	25	0	0	0	*** 89571 **	23	0	0	0	*	23	0	0	0
89592 **	23	0	0	0	*	28	0	0	0	*** 89592 **	0	0	0	0	*	0	0	0	0
89606 **	22	0	0	0	*	30	0	0	0	*** 89606 **	0	0	0	0	*	0	0	0	0
89611 **	15	0	1	0	*	15	0	1	0	*** 89611 **	15	0	0	0	*	15	0	0	0
<u>89664</u> **	3	0	1	0	*	4	0	3	0	*** <u>89664</u> **	0	0	0	0	*	0	0	0	0
91066 **	27	0	26	0	*	29	0	28	0	*** 91066 **	0	0	0	0	*	0	0	0	0
91165 **	30	0	29	0	*	30	0	29	0	*** 91165 **	0	0	0	0	*	0	0	0	0
91217 **	30	0	28	0	*	30	0	29	0	*** 91217 **	0	0	0	0	*	0	0	0	0
91245 **	29	1	27	0	*	29	1	27	0	*** 91245 **	0	0	0	0	*	0	0	0	0
91285 **	29	1	29	0	*	30	1	29	0	*** 91285 **	0	0	0	0	*	0	0	0	0
91334 **	26	0	0	0	*	26	0	0	0	*** 91334 **	0	0	0	0	*	0	0	0	0
91348 **	28	0	0	0	*	28	0	0	0	*** 91348 **	0	0	0	0	*	0	0	0	0
91366 **	26	0	25	0	*	27	0	28	2	*** 91366 **	0	0	0	0	*	0	0	0	0

Table 4. Fifteen day summary of Antarctic data receipt at World Meteorological Center, Washington, 1-15 October 1986, for surface (SYNOP) and upper air (TEMP) data. From WMO, 1987.

RESULTS OF THE ANNUAL GLOBAL MONITORING OF THE MMW

Availability (%) of SYNOP and TEMP reports from Antarctic received at an MTN centre

Monitoring period : 1-15 October 1986

Members operating the stations	SYNOP (MH-360 min.)						TEMP (MH-720 min.)					
	Number of stations			Availability (%) of reports received			Number of stations			Availability (%) of reports received		
	00	06	12 18	00	06	12 18	00	06	12 18	00	06	12 18
Argentina	5	5	5	30.7	48.0	73.3	2			96.7		0
Australia	3	3	3	97.8	80.0	84.4	2	1		0		93.3
Chile	3	3	3	71.1	60.0	86.7	2			73.3		
France	1	1	1	86.7	80.0	53.3	1					0
Germany, Federal Republic of								1				
India												
Japan	1	1	1	93.3	80.0	86.7	1	1		73.3		80.0
New Zealand												
Poland												
South Africa*	1	1	1	26.7	86.7	86.7	1	1		93.3		53.3
United Kingdom	5	4	5	62.7	31.7	66.7		1				0
Uruguay												
U.S.A.	2	2	2	50.0	43.3	23.3	2	2		60.0		63.3
U.S.S.R.	6	6	6	92.2	90.0	100	6	1		90.0		86.7
<b>Total :</b>	<b>27</b>	<b>26</b>	<b>27</b>	<b>67.9</b>	<b>63.8</b>	<b>77.3</b>	<b>15</b>	<b>10</b>		<b>72.9</b>		<b>44.0</b>

\* The Government of the Republic of South Africa has been suspended by Resolution 38(Cg-VII) from exercising its rights and enjoying its privileges as a Member of WMO.

The receipt of data from the global observing system (Table 4) is monitored on a regular basis in Washington. Summaries are generally available on a monthly basis for both surface data at the four main synoptic hours (0000, 0600, 1200, 1800 UTC) and upper air data at 0000 and 1200 UTC. A large number of centers participate in the annual GTS monitoring from 1-15 October.

**Recommendation:** Data entry into the GTS should be at the earliest possible time **AFTER QUALITY CONTROL**, with duplicate entry points, including the present GTS entry system, with confirmation of the entry at NWS. Monthly results of the monitoring of GTS data receipts from the U.S. and other countries' Antarctic stations should be available to the Oversight Committee Chair.

#### B. Monthly summaries.

In addition to the synoptic surface and upper air sounding data, monthly summaries (CLIMAT) are also transmitted via the GTS. Receipts of these data are also far below the potential, as shown in Table 5. Hard copy monthly summaries are received at NCDC six months after the fact. Because of this long delay, these data are not routinely included in the published *Monthly Climatic Data for the World*, and thus are not generally available. It is clear from the receipt statistics that special provisions must be made for both electronic and hard copy transmission of Antarctic data.

Table 5. Monthly CLIMAT data received at World Meteorological Center, Washington, July 1982 - June 1987. Prepared by National Meteorological Center.

	Number of reports per month, all years											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Palmer Station	1	1	1	1	1	2	1	1	1	0	0	1
McMurdo Station	5	4	4	3	2	3	3	3	2	5	4	5

**Recommendation:** NWS and NCDC should ensure that U.S. Antarctic stations are designated WMO CLIMAT and CLIMAT.TEMP exchange stations for monthly data exchange, as are other U.S. climate stations outside of Antarctica. (See WMO, 1986, p. 26 and Annex IX.)

#### V. Flow of data from U.S. stations into permanent archives.

- A. Collection of U.S. Antarctic surface and upper air data in delayed time.

The National Climatic Data Center (NCDC) has digitized and processed meteorological data for the five principal Antarctic stations, received on various types of hard copy forms from the stations. Appendix B.2 is a preliminary inventory of Antarctic surface and upper air data at NCDC.

Amundsen-Scott and McMurdo data are sent twice each year, and have been processed through 1986. Data from Siple, Palmer, and Byrd are received intermittently. Processing for these sites is completed through 1985 for Byrd and through February 1984 for Siple and Palmer. Missing data from Byrd may be due to either suspension of operations or missing forms.

The cost of processing the surface data (currently about \$2000 per station year) would be reduced to less than \$1000 if these data could also be recorded digitally at the sites as recommended in section II.B.

Upper air data have been received from Amundsen-Scott and McMurdo on various types of forms twice annually. The cost of preparation and processing these forms has ranged as high as \$8000 per year. Beginning in 1987 upper air data will be recorded digitally at the two stations. Because of this, processing costs are expected to be reduced to less than \$3000 per station year.

It should be noted that NCDC does not process GTS data at all, although data from other sources are verified before being added to the digital archive. The digital archive is stored in chronological order; files must be inverted to select data by station.

**Recommendation:** Surface and upper air meteorological data collected by the U.S. in Antarctica represent a valuable contribution to science. NCDC is the appropriate archive for permanent retention of these data, and should be so designated by NSF/DPP. The bulk of these data already reside at NCDC; to the extent not done, NCDC should verify and archive these data.

**Recommendation:** NSF/DPP and NCDC should develop a memorandum of understanding regarding responsibility for future entry of synoptic surface and upper air data into NCDC on a timely and regular basis.

**Recommendation:** U.S. Antarctic CLIMAT and CLIMAT.TEMP data should be provided to NCDC for inclusion in the publication *Monthly Climatic Data for the World*. Existing data gaps should be filled using data extracted from the present NCDC archive. The Oversight Committee should monitor progress in these areas.

#### B. Historical collections of meteorological observations and analyses.

The Naval Postgraduate School (NPS) in Monterey holds a collection of Antarctic weather observations and products, including surface and upper air analyses at several mandatory levels, that were produced by USNSFA at McMurdo and Christchurch, and unique sets of Antarctic observations from airfields, scientific stations, treks and research flights. A gross inventory (see Appendix B.4 for a preliminary listing) of the NPS archive reveals an estimated eighty cubic feet of material.

The existing collection must be organized and inventoried in some detail for the purpose of deciding on its disposition, as it cannot be maintained indefinitely at NPS. Subsequently, retained data should be incorporated into an appropriate, permanent, and secure archive. Consideration should be given to digitizing the analyses using the latest electronic technology, both to reduce storage space requirements and to assure a shelf life on the order of

twenty years for these deteriorating paper records. A minimum of two months of on-site professional effort would be required for this purpose, which should be funded by NSF/DPP. The Oversight Committee should make the final decision on disposition and location of the archive.

It is expected that increasing attention will be given to improving numerical weather analysis (and subsequent numerical prediction) over the Southern Hemisphere as a whole and the Antarctic in particular. Historical map series and complete surface and upper air data sets will be of great value for case studies involving energy transport, topographic modeling, troposphere/stratosphere interactions, and recent synoptic climatology trends.

**Recommendation:** The hard copy collection of surface and upper air observations and products produced by USNSFA, and unique observations taken at airfields, during research flights, on expeditions and at temporary scientific stations, now housed at the Naval Postgraduate School and several other locations, should be evaluated for retention or disposal. Several candidate archives exist for permanent retention of the designated data sets. The Naval Postgraduate School and NCDC should cooperate to prepare a proposal to NSF/DPP for the evaluation of these data.

#### VI. Geographic distribution of observations.

Automatic weather stations (AWS) in Antarctica can provide data in areas where manned observations are not routinely taken, as well as providing independent verification of observations from manned stations. The University of Wisconsin AWS network (Figure 5) has proved valuable in both regards. Other AWS are operated by the Naval Postgraduate School, Australia, Brazil, Chile, India, Japan, Norway and the Soviet Union. For a review of AWS currently in operation, see SCAR Group of Specialists, 1986, in Appendix B.8.

AWS data up to forty-eight hours old are useful for analysis purposes. The Oversight Committee should seek to determine whether AWS data should be included in the GTS data stream, and whether they should be exchanged globally.

It may be useful to prepare for archiving a set of AWS data from all U.S. arrays, and to incorporate, eventually, data from the European, Japanese and Australian arrays.

**Recommendation:** Meteorological data collection should be increased in data-sparse regions of Antarctica, such as the coast of West Antarctica, the interior of Queen Maud Land, and the area surrounding the South Pole. Automatic weather station networks should be evaluated as a partial means to this end.

#### VII. Drifting buoy data.

Validated buoy data for the FGGE year (12/78-11/79) have been prepared. The National Data Buoy Center (NDBC) will prepare "clean" data sets of drifting buoy data, probably starting with 1985 data. In addition, there are data

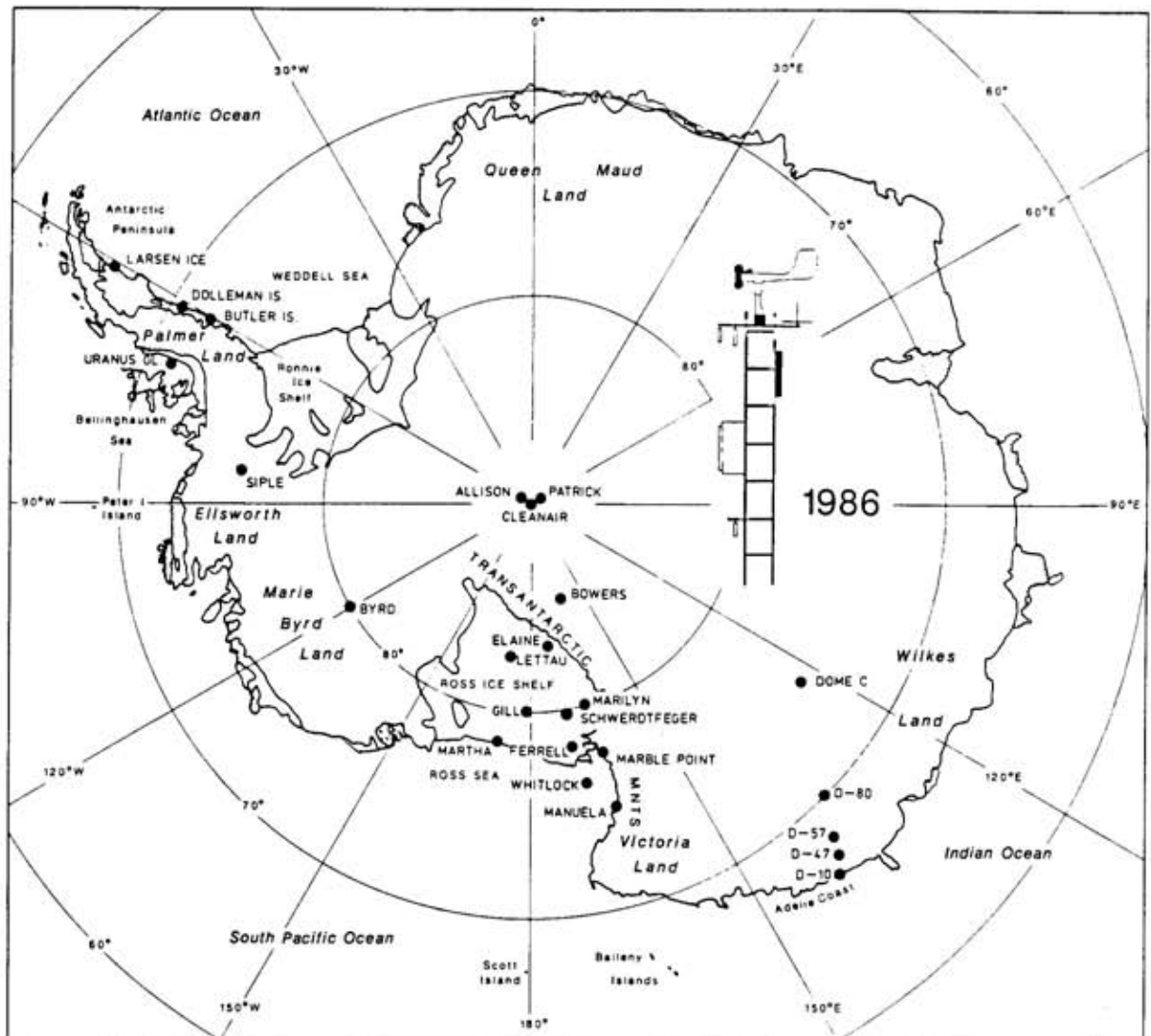


Figure 5. Antarctic automatic weather station network for 1986, University of Wisconsin, Department of Meteorology. (From Sievers, et al., 1986)



sets that have all buoy data as collected in real time by NMC. The real time data contain cases where sensors become faulty, where buoys wash up against islands, or are taken on ships, and are still transmitting "data." Therefore it would be useful to spend some additional effort to quality-check these data sets. The basic data, as collected by the ARGOS system, usually go to the GTS and to the PI. In some cases, a PI may have prepared a clean data set of his buoy array data, which ultimately should be preserved in a permanent archive such as NDBC.

**Recommendation:** Drifting buoy data centers should be asked to provide clean versions of selected data sets. Roy Jenne, National Center for Atmospheric Research (NCAR), will take responsibility to implement this recommendation.

#### VIII. Numerical analyses.

Twice-daily Southern Hemisphere analyses are available covering fifteen to twenty years. Some early analyses at the surface and 500 millibars cover the IGY and subsequent years. Routine analyses from Australia start in 1972; NMC analyses begin in 1976. Analyses at seven levels are available at the European Centre for Medium-Range Weather Forecasting (ECMWF) from 1980 onwards; NCAR has most of these analyses. ECMWF is defining a "research data set" of analyses and some forecasts that will be available for specialized users. Special analyses for FGGE (12/78-11/79) are available from several sources; the FGGE re-analysis, prepared during 1985-87, is being sent to NCDC. Only part of the FGGE analyses are also at NCAR. NCAR is coordinating with NMC to obtain a specialized archive of their analyses that will include boundary layer products. On 12 August 1987 NMC began using a forecast model (spectral, eighty waves) that includes a diurnal radiative cycle.

It is clear that efforts are needed to inventory the widely-scattered numerical analysis data sets, and to publish inventory and availability information so that best use can be made of these data.

**Recommendation:** Efforts to prepare enhanced archives of analyses should continue, and existing archives of analyses should be enhanced and maintained indefinitely. Inventory information should be published. Responsibility should be assigned and funds provided for these tasks. Roy Jenne, NCAR, will coordinate with the NWS/NMC and with the TOGA (Tropical Ocean Global Atmosphere) research community to assure implementation of this recommendation.

#### IX. Satellite data.

The Working Group is concerned that at this time the NOAA/Satellite Data Services Division (SDSD) collection of Antarctic AVHRR imagery, and after 1 October 1988 the NSIDC archive of Defense Meteorological Satellite Program (DMSP) imagery (Figure 6), are in jeopardy. Both collections are subject to budget cuts threatening their continuity in time and in space. Many of the pre-1978 AVHRR data are no longer available since funding for the mass storage device at NOAA/NESDIS/SDSD was eliminated. The DMSP collection is now the longest-running global meteorological satellite archive, 1973 to the present, with both visible and thermal infrared imagery. The DMSP satellites have the ability to collect these data with a resolution of six hundred

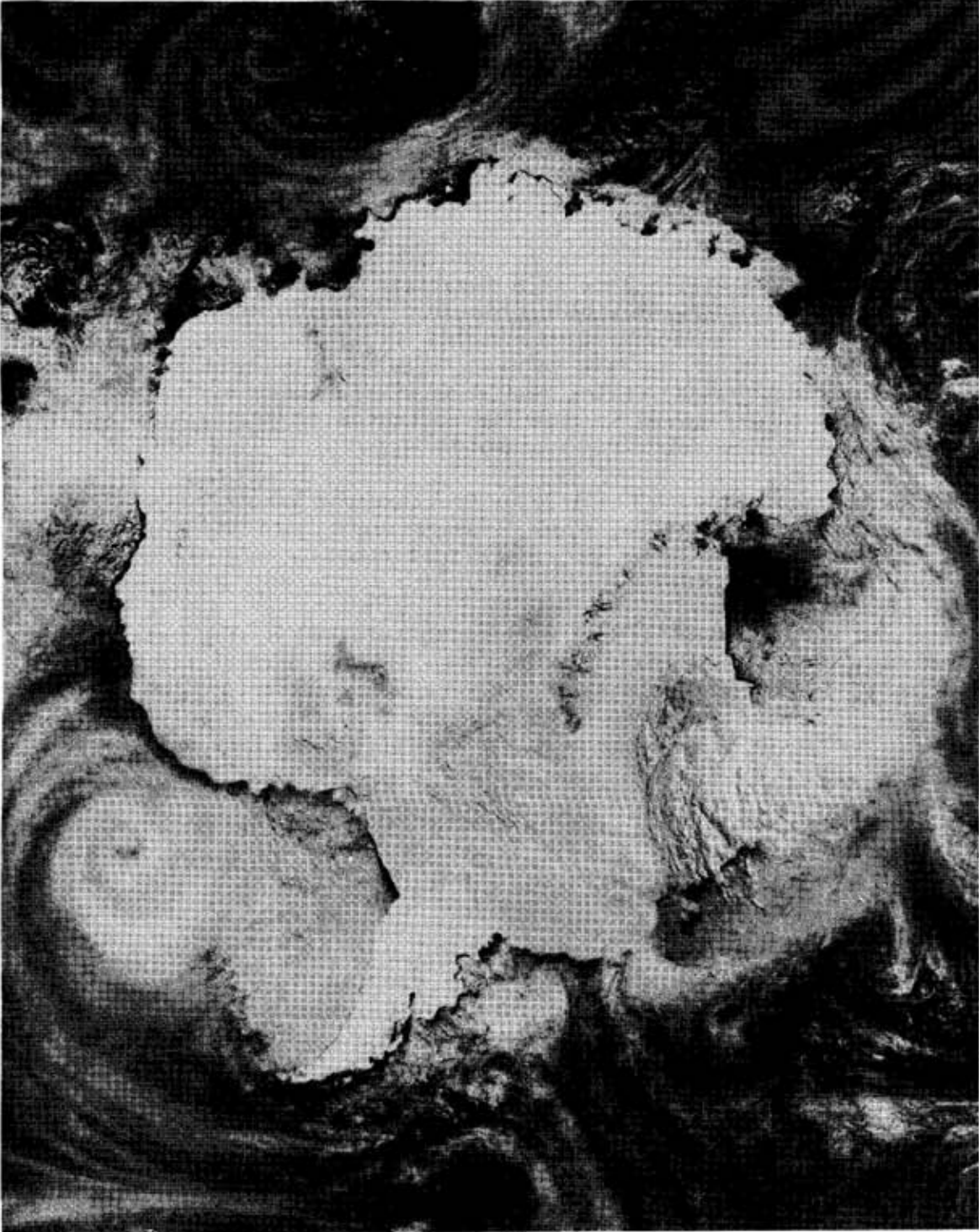


Figure 6. Mosaic of Defense Meteorological Satellite Program (DMSP) images collected near local noon during five passes of the F7 satellite in November 1986. Produced by DMSP Archive, National Snow and Ice Data Center.

meters, the highest of any meteorological satellite, an important quality for polar-regions research. The proposed Oversight Committee should ensure that all good quality Antarctic imagery collections, (AVHRR, DMSP, Landsat) are adequately protected for future research, especially in light of the Global Change program.

SSM/I, SSM/T, and DMSP/OLS direct readout data from the McMurdo receiving station of the Antarctic Research Center (Figure 7) and its planned Palmer Station site will cover approximately eighty percent of Antarctica on a daily basis. Selected data collected by this system must be properly archived in the U.S. and the availability of these data for research must be communicated to the user community.

**Recommendation:** All satellite data with Antarctic coverage should be inventoried by the archiving organizations. (See U.S. National Oceanic and Atmospheric Administration. National Environmental Satellite, Data, and Information Service, 1984, for an example of such a catalog in hard copy format.) The resulting computer-based catalog should be shared among all relevant data centers. This inventory could provide the mechanism to address the specific concerns expressed in the following recommendations.

**Recommendation:** NSF/DPP, with Naval Polar Oceanography Center support, should request NOAA digital AVHRR Local Area Coverage (LAC) data for the remaining areas of the Antarctic in order to ensure that complete digital coverage is maintained.

**Recommendation:** The feasibility of converting selected analog satellite imagery products, such as that from the DMSP, to digital form should be investigated. The study should consider such factors as the historical value of the data, the conversion technology's effect on the output data, and the cost of conversion. A responsible agency must be identified to carry out the feasibility study.

**Recommendation:** Valuable long-term satellite data sets should be protected despite short-term constraints such as budget reductions, and operational versus research mission conflicts.

#### X. Unique historical data sets.

There is a clear necessity to ensure that unique historical data sets be preserved and permanently archived for future researchers. This is especially true in light of the potential for global climate changes to be first evident at higher latitudes.

A number of special Antarctic meteorological and climate data sets have been created with U.S. support. (See Appendix B.1.) NSF/DPP should support an effort to inventory these data sets and to prepare the data in a digital format suitable for archiving that is, to the extent feasible, compatible with the Antarctic data presently stored at NCDC. It is important to distinguish between data sets of lasting value and those of ephemeral value or of poor quality. Some data sets, of the "shoebox" type, are best left where they are, with publications from the data, if any exist, referenced in the inventory.

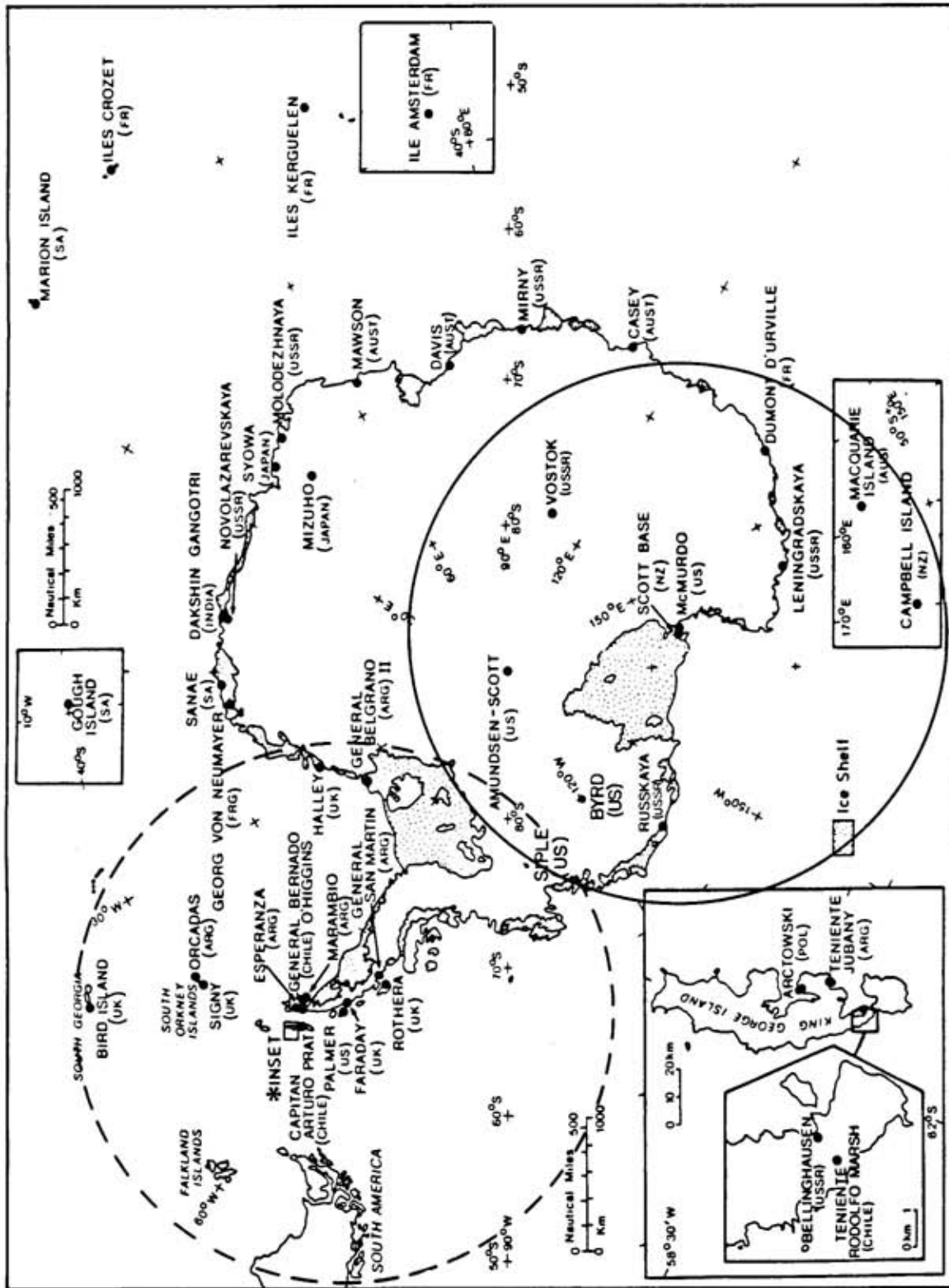


Figure 7. DMS direct readout coverage, Antarctic Research Center. Solid line shows existing McMurdo Station direct readout site, dashed line indicates coverage from planned site at Palmer Station. (Adapted from a British Antarctic Survey map.)

There is a need to identify and designate centers responsible for archiving the special, valuable, historical data sets. The centers considered might include the Byrd Polar Research Center at Ohio State University, the Desert Research Institute (DRI) at the University of Nevada, NCAR, NCDC, and NSIDC. The designated center(s) should provide data access for the user community as described in section XI, below.

**Recommendation:** Agencies should coordinate efforts to insure that valuable historical Antarctic meteorological data are permanently archived, and that funds are available for this purpose.

**Recommendation:** Recipients of Federal agency grants for Antarctic research should be required, at the end of the funded research, to prepare well-documented data sets suitable for permanent archival. The agencies should also ensure that funds are set aside for the preparation and maintenance of such data sets by the principal investigator in consultation with the selected data center(s).

#### XI. Data access for users.

NCDC-archived Antarctic meteorological data should be available in forms and formats that are portable to systems designed for interactive use. Data should be available at a reasonable cost and in a timely manner. Any systems used to make data access more efficient should be compatible with NOAA/NESDIS, NSF and NASA efforts already underway, by using existing systems as far as possible.

**Recommendation:** NSF/DPP should support development of a common computerized data catalog for U.S. Antarctic meteorological data. This system should include a well-advertised information referral function, either within NSF/DPP or at one of the existing data centers. The responsible organization should also provide identification of important user groups, assessment of their needs (data access, products, etc.), user training, and published brochures and catalogs. This system should be targeted for implementation by 1990.

Development of this common data catalog should take advantage of existing systems for data manipulation, report production and graphics display, systems that are suitable for managing modest-sized archives such as the Antarctic synoptic surface and upper air data. NSF/DPP should solicit proposals for a candidate system, such as NCDC's CLICOM, UCAR's NSF-funded UNIDATA or NASA's Pilot Climate Data System (PCDS/NCDS), to provide the necessary user services. When established, the existence of the service(s) should be made known throughout the research community.

**Recommendation:** "Language level" access to data sets should be provided, similar to the machine-independent Fortran 77 software (see Slutz, et al., 1985) available with the Comprehensive Ocean-Atmosphere Data Set (COADS), for users who prefer this method of interaction, for users who do not wish to acquire additional computer hardware or software packages, or for data sets too large for efficient interactive access.

XII. Follow up.

**Recommendation:** The Oversight Committee should meet at six-monthly intervals to monitor implementation of the workshop recommendations.

**Recommendation:** The Oversight Committee should continually monitor new technological developments and the cost of their implementation. New types of electronic scanners, laser optical disks, information systems and CD ROMs are now available, any of which might permit more accurate and more cost-effective data capture. NSF/DPP and the data centers should investigate new developments as they occur, to determine whether they can be used to provide appropriate and cost-effective solutions.

**Recommendation:** The Oversight Committee should consider using electronic mail for its internal communications, and the Omnet POLAR bulletin board, the NSF/DPP newsletter, and the *Antarctic Journal of the United States* to reach the community.

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- World Meteorological Organization. Executive Committee on Antarctic Meteorology. (1986) *Executive Council Working Group on Antarctic Meteorology, Fourth Session, Geneva, 1-5 September 1986. Final Report*. Geneva, WMO, 47p.

## Acronyms

APT	Automatic Picture Transmission
ATS-1	Applications Technology Satellite-1
AVHRR	Advanced Very High Resolution Radiometer
CD ROM	Compact Disk, Read-Only Memory
COADS	Comprehensive Ocean-Atmosphere Data Set
DMSP	Defense Meteorological Satellite Program
DRI	Desert Research Institute, University of Nevada
ECMWF	European Centre for Medium-Range Weather Forecasting
ERB	Earth Radiation Budget (Mission/Satellite)
ESMR	Electrically Scanning Microwave Radiometer
FGSE	First GARP (Global Atmospheric Research Program) Global Experiment
GAC	Global Area Coverage
GOES-East	Geostationary Operational Environmental Satellite-East
GTS	Global Telecommunication System, WMO/World Weather Watch
HF Radio	High Frequency Radio
HRPT	High Resolution Picture Transmission
IGY	International Geophysical Year (1957-58)
LAC	Local Area Coverage
LIMS	Limb Infrared Monitor of the Stratosphere
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NCDS	NASA Climate Data System
NDBD	National Data Buoy Center
NESDIS	National Environmental Satellite, Data and Information Service, NOAA
NMC	National Meteorological Center, NOAA/NWS
NOAA	National Oceanic and Atmospheric Administration
NPS	Naval Postgraduate School, Monterey
NSF/DPP/PCIS	National Science Foundation/Division of Polar Programs/Polar Coordination and Information Section
NSIDC	National Snow and Ice Data Center
NWS	National Weather Service, NOAA
OLS	Operational Linescan System
PCDS	Pilot Climate Data System
PI	Principal Investigator
SAMII	Stratospheric and Aerosol Measurement II
SAMS	Stratospheric and Mesospheric Sounder
SBUV/TOMS	Solar and Backscattered Ultraviolet and Total Ozone Mapping System
SDSD	Satellite Data Services Division, NOAA/NESDIS/NCDC
SMMR	Scanning Multichannel Microwave Radiometer
SSM/I	Special Sensor Microwave/Imager
SSM/T	Special Sensor Microwave/Temperature
THIR	Temperature-Humidity Infrared Radiometer
TOGA	Tropical Ocean Global Atmosphere



TOVS	TIROS Operational Vertical Sounder
UCAR	University Corporation for Atmospheric Research
USNSFA	U.S. Naval Support Force Antarctica
UTC	Universal Time Coordinated
VTPR	Vertical Temperature Profiling Radiometer
WMC	World Meteorological Center, NOAA/NWS/NMC, Washington

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## APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

### 1. List of data sets considered at the workshop.

#### A. Standard Data:

1. Surface and upper air data from McMurdo and Amundsen-Scott (South Pole), prepared at NCDC through 1986.
2. Surface data from Byrd Station, Palmer Station, Siple Station, prepared at NCDC through 1984-85.
3. Upper air data for the world, as received from the GTS. This includes raobs, aircraft, satellite cloud winds. These data include those collected by non-U.S. stations, and are archived at NCDC in "raw" GTS form. Available since approximately 1965.
4. Surface data for "all of Antarctica", as received from the GTS. These data include those collected by non-U.S. stations, and are archived at NCDC in "raw" GTS form. Available from 1976 to the present. The volume is large; an Antarctic subset may need to be extracted.
5. Automatic weather station (AWS) data. AWS data reports from the Department of Meteorology, University of Wisconsin at Madison (C.R. Stearns.)
6. Numerical analyses of twice-daily data. Held at NCAR, for the IGY and from 1972 to the present.

#### B. Satellite Imagery:

1. Defense Meteorological Satellite Program (DMSP): continuous global coverage from OLS (Operational Linescan System) in hard copy imagery format, visible and infrared, available from 1973 at NSIDC. Complete basic data available from late 1978. A data set with daily global infrared and visible coverage at 150-250 kilometer resolution is available from 1973 (only a few tapes.)

The Antarctic Research Center (SeaSpace, Inc., and Scripps Institution of Oceanography joint venture, funded by NSF/DPP) receives and archives DMSP OLS, SSM/I, and SSM/T data, NOAA/TIROS AVHRR HRPT data, and Argos TOVS data at a receiving station at McMurdo Station in Antarctica, beginning with the 1987/88 field season. A second receiving station is planned at Palmer Station. Figure 7, p.23 indicates the receiving range of the present and planned stations.

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

1. List of data sets considered at the workshop, continued.

2. Satellite imagery archives:

DMSP direct readout (line of sight, McMurdo)	
DRO OLS (0.5-2.7 km SSM/T)	(archive = ARC/Scripps)
SSM/I (15-25 km)	(archive = ARC/Scripps)
DMSP tape delayed	
OLS (2.7-5.4 km, analog)	(archive = NSIDC)
SSM/I (15-25 km)	(archive = SDSD [orbital])
	(archive = NSIDC [gridded])
SSM/T	(archive = SDSD)
NOAA/TIROS direct readout (line of sight, McMurdo)	
HRPT AVHRR (1.1 km) TOVS ARGOS	(archive = ARC/Scripps)
BEACON TOVS ARGOS	(archive = N/A)
APT AVHRR (4 km)	(archive = N/A)
NOAA/TIROS tape delayed	
GAC AVHRR (4 km) TOVS ARGOS	(archive = SDSD)
LAC AVHRR (1.1 km) TOVS ARGOS	(archive = SDSD)
NIMBUS active systems, tape delayed	
ERB, SAMII, SBUV/TOMS	(archive = NSSDC)
NIMBUS non-active systems	
ESMR, SMMR	(archive = NSSDC [orbital])
	(archive = NSIDC [gridded])
LIMS, SAMS, THIR	(archive = NSSDC)
NOAA VTPR basic satellite sounder data 1972-March 1979	
	(archive = NCAR)
NOAA TOVS data, including visible and microwave channels, October 1978 to the present	
	(archive = NCAR)

Table B.1.1 shows meteorological satellites, sensors and associated geophysical measurements.

C. Non-standard Data Sets:

These include both historical and continuing data. Formats include microforms, research reports and other publications, maps, and digital tapes. For future archiving efforts, or in weeding materials already stored, it is important to include complete descriptions of station or ship history, notes from traverses, aircraft flight/navigation data, the instruments used, observers and their background, and an assessment of observation quality. This information is essential; without it potential users can make no intelligent assessment of the data quality.



Table B.1.1. Meteorological satellites, sensors and associated geophysical measurements. R.  
Weaver, September 1987.

GEOPHYSICAL MEASUREMENT	NOAA		DMSP		NIMBUS 7			GEOSAT		AEM NIM 5/6		ERB		
	AVHRR	TOVS	OLS	SSM/T	SSM/I	TOMS	SMMR	SBUV	SAMII	SAMS	THIR	LIMS	ERB	SAGEII
SURFACE TEMPERATURE	X		X											
TEMPERATURE SOUNDING		X		X										
MOISTURE SOUNDING				X										
PRECIPITABLE WATER					X		X							
CLOUD COVER	X		X							X				
SURFACE WINDS				X	X		X				X			
SEA ICE				X	X		X				X			
SURFACE RAD. BUDGET	X										X			X
TOTAL RAD. BUDGET											X			X
SURFACE REFLECTIVITY	X		X		X		X				X			
TOTAL OZONE					X									
OZONE PROFILE											X			X
AEROSOLS	X								X	X				X

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

1. List of data sets considered at the workshop, continued.

1. Expeditions:

- a. Byrd Antarctic Research Expedition I, 1928-1930. Byrd Antarctic Research Expedition II, 1933-1935. (See *Monthly Weather Review*, 1939, 1941 in Appendix B.8.)
- b. Antarctic Service Expedition, 1939-1941. West Base, East Base. Contact is the expedition meteorologist, Professor Arnold Court. Address: California State University, Northridge, CA 91324. Telephone (213) 885-3521 or 3508.
- c. Operation Highjump, large Naval operation in Antarctic waters following World War II. (See Weather Bureau, 1955a in Appendix B.8.)
- d. Operation Windmill, a follow-up summer operation. (See Weather Bureau, 1955b in Appendix B.8.)
- e. Ronne Antarctic Research Expedition, 1947-1948 (See U.S. Navy. Office of Naval Research, 1948a, 1948b in Appendix B.8) Stonington Island, Antarctic Peninsula. Peterson, expedition meteorologist, is still living; many contacts.

2. Micrometeorological data: Little America, Amundsen-Scott, Plateau Station; snow accumulation, bore hole temperatures. (See *Monthly Weather Review* 1949 in Appendix B.8, for Little America III data.)

3. Aircraft research flights: Katabatic wind studies from Airborne Research Data System (ARDS); ozone flights (some taken by ARDS). ARDS data for 1977/78, 1978/79 and 1980 are held by the World Data Center A for Glaciology/National Snow and Ice Data Center, CIRES, Campus Box 449, University of Colorado, Boulder, CO 80309. Telephone: (303) 492-5171. Telemail: [NSIDC/OMNET] MAIL/USA. Telex: 257673 WDCA UR. [ARDS' successor is called DADS.]

4. W. Schwerdtfeger's climatological records. Contact is Dr. Charles Stearns, Department of Meteorology, University of Wisconsin, Madison, WI 53706. Telephone (608) 262-0780. Telemail: [AWS.MADISON/OMNET] MAIL/USA.

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

1. List of data sets considered at the workshop, continued.

5. Shipboard data

- a. COADS (Comprehensive Ocean-Atmosphere Data Set): all available ocean ship data, 1854-1979. An update for 1980-86 will be available in Spring 1988. Appendix B.5 contains a description of COADS. Contact: Scott Woodruff, NOAA/ERL/Climate Research Division, R/E/AR6, 325 Broadway, Boulder, CO 80303. Telephone: (303) 497-6747. Telemail in care of: [H.DIAZ/OMNET] MAIL/USA. (See Slutz, *et al.*, 1985; Woodruff, 1986, and Woodruff, *et al.*, 1987 in Appendix B.8.)
- b. icebreaker data; [probably included in COADS];
- c. drifting buoy data, as from the Weddell Polynya Expedition;
- d. iceberg observations;
- e. instrumentation file for each ship needs to be archived, whenever possible.

6. Atmospheric turbidity data: astronomical observations taken at South Pole; are there other known sources?

7. Balloon data:

- a. Drifting balloon data from EOLE (8/71 - 12/72) and from TWERLE and FGGE projects are available at NCAR.
- b. High altitude (115-120,000 foot) balloon trajectories, January 1988, used to observe gamma radiation from the supernova. Contact: John Ground, AFGL/LCE, Hanscom Air Force Base, MA 01731. Telephone: (617) 377-2484.

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.  
2. Inventory of U.S. Antarctic station data archived at NCDC.

National Climatic Data Center  
NOAA/NESDIS  
Federal Building  
Asheville, NC 28801  
Telephone: 704-259-0682

A. Antarctic surface station data (digital and manuscript).

Amundsen-Scott	1/57 - 12/86
Beardmore	1-2/57, 10-12/59, 11/60 - 2/61, 10/61 - 2/62, 10/62 - 2/63, 10/63 - 2/64
Brockton	1-2/66, 10-12/67, 10/67 - 2/68, 10/68 - 2/69, 10-12/69, 10/70 - 2/71, 10/71 - 1/72
Byrd	1/57 - 12/85 [missing: 10-11/73, 10/74, 2/75 - 2/77, 2/79, 2-9/81, 3-12/82, 3-9/83, 2-10/84, 1-10/85]
Camp Ohio	12/60 - 2/61, 11/61 - 2/62
Darwin Glacier	10-12/78
Dome Charlie	11/77 - 1/78
Eights	11/61 - 2/62, 12/62 - 11/65
Ellsworth	2/57 - 12/62, 11/79 - 1/80 [missing: 1/59]
Hallett	2/57 - 3/64, 10/64 - 2/65, 10/65 - 2/66, 10/66 - 2/67, 10/67 - 2/68, 10/68 - 2/69, 10/69 - 2/70, 10/70 - 2/71, 10/71 - 2/72, 10/72 - 2/73
Ice Runway	10-12/77, 12/78
Little America V	2/56 - 12/58
Little Jenna	10/64 - 2/65, 10/65, 12/65 - 1/66
Little Rockford	10-12/59, 10/60-2/61, 10/61 - 2/62
Little Rockford 3	11/62 - 2/63, 10/63 - 2/64, 10/64 - 2/65
Marble Point	12/57 - 2/58, 11/58 - 1/59
Marie Byrd Land	10-12/57

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.  
 2. Inventory of U.S. Antarctic station data archived at NCDC, continued.

McMurdo	3/56 - 12/86
McMurdo Sound	3/56 - 1/83 [missing: 1/82]
Mile 60	1-2/66
Palmer	1/79 - 2/84
Plateau	12/65 - 12/68
Siple	1-10/73, 10/77 - 2/84
Wilkes	3/57 - 12/63
Wilkes Ice Cap	3-10/58
Williams/Hut Point	10-12/62, 10/68 - 2/69, 12/71 - 1/72, 2/76, 12/77 - 1/78, 10/78 - 2/79, 7/79 - 2/80, 7-8/80, 10/80 - 1/81

B. Antarctic upper air station data (digital and manuscript).

Amundsen-Scott	3/57 - 12/86 [missing: 10/75, 11/76, 2/80]
Byrd	3/57 - 1/75, 2/79, 12/79 - 1/80 [missing: 4-7/69, 10-11/72, 10-11/73, 10-11/74]
Ellsworth	3/57 - 11/62
Hallett	2/57 - 3/64, 10/64 - 2/73
Little America V	4/40 - 1/41, 4/56 - 12/58
Little Rockford	11-12/59, 11/60 - 2/61, 11/61 - 2/62
Little Rockford 3	10/62 - 2/63, 10/63 - 2/64, 11/64 - 2/65
McMurdo	4/56 - 12/86 [missing: 4/57 - 6/58, 11/59 - 12/60, 12/61, 10-12/62, 3/64, 10/71]
McMurdo Sound	4/56 - 1/83
Wilkes	3/57 - 12/63

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

3. Inventory<sup>1</sup> of Southern Hemisphere data available at NCAR.

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Data Support Section  
PO Box 3000  
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Telex: 989764  
Telemail: [R.JENNE/OMNET] MAIL/USA

1. National Meteorological Center (NMC) global analyses, 2.5 degrees. 1 July 1976 - 31 December 1986. SLP, sfc T, U, V, T, H 1000-50 mb; humidity in boundary layer and at levels 1000-300 mb. SLP starts 8 December 1977, sfc P starts 21 September 1978, SST starts 16 May 1979, boundary layer (U, V, RH, theta) starts 6 June 1980. Until April 1985, the boundary layer was 50 mb thick. Winds, etc., were valid at the midpoint, or about 200 meters elevation. Then, the MRF model started with 18 layers, not 12 layers. The boundary became 10 mb thick with winds, etc., valid at about 40 meters. 88 tapes, all 6250 bpi; approximately 45 days, 16,000 hemispheric grids per tape. A surface subset includes 1000 mb through June 1986; 12 tapes.
2. Navy Southern Hemisphere analyses, August 1974 - January 1983. 63x63 grids sfc to 100 mb, no winds. 20 tapes, 6250 bpi.
3. European Center for Medium-range Weather Forecasting (ECMWF) analyses, 2.5 degree global, twice daily, 1980 - 1985. 7 tapes for 0000Z and 7 for 1200Z, 6250 bpi. NCAR no. DS 110.
4. Australian analyses for entire Southern Hemisphere. Twice-daily 24 April 1972 - 9 June 1984. H, T, U, V 1000-100 mb; mixing ratio 1000-500 mb, 47x47 grid. 13 tapes, 6250 bpi.
5. South African analyses for entire Southern Hemisphere. Twice-daily August 1977 - March 1981. SST, sfc P, H, T 1000-50 mb, winds 925-100 mb. 29 tapes, 1600 bpi.
6. IGY Southern Hemisphere SLP and 500 mb analyses, June 1957 - December 1958. 72x16 points. NCAR no. DS 102.
7. Australian Southern Hemisphere year-month grids. H, T, U, V, R, 1000-100 mb May 1972 - May 1984. 1 tape, 1600 bpi.
8. Australian time series of daily grids, Southern Hemisphere. Twice-daily, April 1972 - July 1983. SLP; 1000, 850, 500, 300, 100 mb H and T. 6 tapes, 1600 bpi.
9. Australian rawinsondes and winds aloft. Data set spans 1943-August 1977. Seven tapes, 1600 bpi.

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

3. Inventory of Southern Hemisphere data available at NCAR, continued.

10. United States raobs time series, includes significant levels. Several Antarctic stations are included, some from about 1956. 33 tapes through June 1970, 14 tapes July 1970 - December 1979, 9 tapes 1980 through 1985.
11. Observed data (mostly from GTS) and grid summaries:  
NMC, 1962-1972. All UA. 116 tapes, 1600 bpi.  
NMC, 1973-1984. UA. 106 tapes, 1600 bpi.  
NMC, 1976-1977. Surface ADP. 109 tapes, 1600 bpi.  
NMC, 1978 - September 1986. Surface ADP (8000 stations)  
Navy, May 1972 - September 1979. Surface and UA, no rainfall. 118 tapes, 1600 bpi.
12. U.S. Navy surface and upper air, October 1966 - January 1986. Surface is 2.5 tapes per year, upper air is 1 tape per year, approximately.
13. Daily world raobs from E. Kung, MIT, May 1958 - April 1963. 3 tapes, 6250 bpi.
14. Selected aircraft data:  
Southern Hemisphere Twerte balloon data, June 1975 - August 1976. NCAR no. DS 615.  
Southern Hemisphere EOLE balloon data (France). August 1971 - December 1972. NCAR no. DS 800.
15. Monthly World Surface Observations through 1985. Precip, pressure, temperature, sunshine. 1800 stations, long periods. Includes *World Weather Records* data. 3 tapes, 1600 bpi. NCAR no. DS 570.
16. COADS data. See Appendix B.5 for a description.
17. Ocean monthly temperature, seasonal temperature and salinity, annual long period grids of temperature, salinity, oxygen saturation, prepared by Levitus, NOAA/GFDL. 1 degree grids. NCAR no. DS 285.0.
18. Southern Hemisphere ocean grids, A. Gordon, Lamont Doherty Geological Observatory. 30 deg. S - 80 deg. S., 1 deg. lat/2 deg. lon., 47 levels, 0-9500 meters; T, salinity, oxygen, sigma-t, silicate, phosphate, nitrate. NCAR no. DS 285.1.
19. Global long-term mean ocean currents climatology, January, April, July, October. 5 degree lat-lon grid. Based on pilot charts from U.S. Naval Oceanographic Office. From J. Meehl. See *Journal of Physical Oceanography*, June 1982 and *NCAR Technical Note IA-159* for further details. 1 tape. NCAR no. DS 380.
20. Global surface U, V stress (72 x 46 grid) and heat budget (72 x 36 grid). Prepared by S. Esbenson, Oregon. NCAR no. DS 209.

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

3. Inventory of Southern Hemisphere data available at NCAR, continued.

21. Southern Hemisphere Climatology, surface - 100 mb, by Taljaard, van Loon, Crutcher, Jenne. Includes H, T, U, V, moisture at the surface and standard levels. 1 tape. NCAR no. DS 200.
22. NCAR also has several sets of satellite data, both basic radiances and summarized data. All are available online, some on tape. Inquire for details.
23. A complete inventory of rawinsonde data holdings for stations south of 51 degrees South is shown in Table B.3.1.

<sup>1</sup>This list compiled from "Data Availability at NCAR (Selected Data Sets)," R. Jenne, 12 March 1987.



Table B.3.1. Daily rawinsonde data holdings at NCAR, for stations south of 51 degrees South. Data from the decade of GTS data are also available in separate files. Updates for McMurdo and Amundsen-Scott are in progress. An asterisk (\*) indicates data are present for all months of a given year.

THIS SUMMARY OF TIME SERIES RA0B DATA PRINTS THE NUMBER OF MONTHS IN EACH YEAR FOR WHICH (DAYS OF SOUNDINGS) > 10,

BLANK = NONE, A = 10, B = 11, \* = 12

B SUFFIX ON THE STATION NUMBER INDICATES THE NUMBER IS WBAN

W SUFFIX ON THE STATION NUMBER INDICATES THE NUMBER IS WMO

NO SUFFIX ON THE STATION NUMBER INDICATES THE NUMBER IS UNKNOWN OR CREATED AT NCAR

NOTE. STATION NUMBERS ON DATA TAPES DO NOT HAVE UNITS DIGIT (NOW IS ZERO, BUT MAY BE USED FOR INVENTORY CONTROL)

STATION	1945	1946	1947	1948	1949	1950
557010B PUNTA ARENAS CH	55302	W	7051			
574010B ELLSWORTH IGY ANTARCTICA	89043	S7744	W	4107		
577010B EIGHTS ANTARCTICA	89073	S7514	W	7710		
674010B LITTLE ROCKFORD ANT	89153	S7915	W	14730		
674020B LITTLE ROCKFORD ANT		S7616	W	14730		
675010B LITTLE ROCKFORD ANT		S7935	W	15256		
676010B LITTLE AMERICA V ANT	89162	S7812	W	16215		
682010B BYRD STATION ANT	89125	S8001	W	11932		
861010B WILKES/CASEY ANTARCTICA	89611	S6616	E	11034		
876010B MCMURDO SOUND ANTARCTICA	89664	S7753	E	16644		
877010B HALLETT/ADARE ANTARCTICIA	89671	S7218	E	17013		
879260W RIO GALLEGOS E.N.	55139	W06912				
879380W USHUAIA ARGENTINA	55448	W06819				
888900W STANLEY	55142	W05752				
889520W ARGENTINE IS.	56515	W06416				
889680W ISLAS ORCADAS	56044	W04444				
890510W PETREL NAS	56328	W05617				
895710W DAVIS	56835	E07758				
896110W CASEY (SAME AS WILKES)	56615	E11035				
896710W HALLET	57219	E17019				
900010B AMUNDSON-SCOTT ANTARCTICA	89009	S9000	W	000		
939440W CAMPBELL ISLAND	55233	E16909				
949860W MAWSON	56736	E06253				
949970W HEARD IS.	55301	E07323				
949980W MACQUARIE ISL	55430	E15857				
1000110 CASEY (SAME AS WILKES)	89611	S6615	E	11032		
1000680 MAWSON	94986	S6736	E	06253		
1000710 DAVIS	89571	S6833	E	07756		
1000970 HEARD IS.	94997	S5301	E	07323		
1009870 MT CRESSWELL (ANT)	57244	E06423				
1009880 MOORE PYRAMID (ANT)	57018	E06506				
ALL SEQUENCES TOTAL SOUNDINGS	258115,	TOTAL SURFACE LEVELS	248502,	TOTAL LEVELS	5550427,	SOUNDINGS PRIOR TO 1935
LRECS/PRECS/WDS	208649	1487	1480722			

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

4. Historical Antarctic data held in hard copy form by the Department of Meteorology, Naval Postgraduate School, Monterey, California: A summary inventory.

1. Imagery (approximately eighteen boxes)

Meteosat imagery: September 1978 - February 1979.

TIROS and NOAA AVHRR imagery: June 1979 - December 1982, January 1983, October 1983 - January 1985, September and December 1985 (not a complete set for any date range.)

Christchurch satellite imagery: miscellaneous dates 1981-1984.

2. Miscellaneous Charts and Analyses

Amundsen-Scott Station, 1971-1975.

Siple Station 1973.

3. Surface Weather Observations

McMurdo: March - October 1970, February 1971 - January 1972, August - December 1972, February - December 1973, broken runs 1974-75, February 1976 - November 1977, October 1978 - August 1979, November - December 1980, August - December 1982, July - December 1983.

Byrd Station: December 1973 - February 1974, December 1978, January 1979.

Amundsen-Scott Station: January 1978.

Williams Field: February 1977, August - December 1977, January 1978, November - December 1980.

Siple Station: October 1977 - January 1978.

Outlying stations: November 1977 - February 1978.

4. Miscellaneous Charts and Analyses

McMurdo rawinsonde data: (WBAN 31A-C) broken runs 1971-75, March 1976, January 1977.

McMurdo continuity graphs: January - December 1983.

Pole to Christchurch continuity charts: February 1973 - December 1980.

Flight following: Christchurch and McMurdo - broken runs 1976 - 1980, October 1983 - January 1984 (DD175/1), October 1983 - February 1984 (NSFA 3144/3).

Miscellaneous flight briefs, AIREPS, PLATFS: 1978, 1979, 1980.

Williams Field observations from Souders, 1984.



APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

4. Historical Antarctic data held in hard copy form by the Department of Meteorology, Naval Postgraduate School, Monterey, California: A summary inventory, continued.

1977: January - surface, 400, 700 mb, nephanalyses  
February - surface, 300, 400, 500, 700 mb, nephanalyses  
March - July - surface, 400 mb, nephanalyses  
August - surface, 400 mb  
September - surface, 200, 400, 500, 700 mb, nephanalyses  
October - surface, 200, 400, 700 mb, nephanalyses  
November - December - surface, 200, 300, 400, 700 mb,  
nephanalyses

1978: January - February - surface, 400, 700 mb  
March - April - surface, 400 mb  
May - August - surface, 500 mb  
September - surface  
October - surface, 200, 700 mb, nephanalyses, skew T  
November - December - surface, 200, 300, 700 mb,  
nephanalyses, skew T

1979: January - surface, 400, 700 mb, nephanalyses, skew T  
February - surface, 400 mb, nephanalyses  
March - September - surface, 400 mb  
October - surface, 200, 400 mb, nephanalyses  
November - December - surface, 200, 300, 400 mb,  
nephanalyses

1980: January - surface, 400 mb, nephanalyses, skew T  
February - surface, 400 mb, nephanalyses  
March - surface, 400 mb, skew T  
April - July - surface, 400 mb, skew T  
August - surface, 400 mb, nephanalyses, skew T  
September - surface, 400 mb  
October - December - surface, 400 mb, skew T

1981: January - surface, 400 mb  
February - surface, 400 mb, skew T  
March - June - none  
July - surface  
August - September - none  
October - November - surface, skew T  
December - surface, 400 mb, skew T

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

4. Historical Antarctic data held in hard copy form by the Department of Meteorology, Naval Postgraduate School, Monterey, California: A summary inventory, continued.

1982:      January - surface, 400, 500 mb, skew T  
            February - surface, 400 mb  
            March - surface, 400 mb  
            April - June - surface  
            July - surface, 200, 400 mb, skew T  
            August - surface, 300, 400, 500 mb, skew T  
            September - surface, 250, 300, 400 mb, skew T  
            October - December - surface, 250, 300, 400, 500 mb,  
                    skew T

1983:      January - February - surface, 400 mb  
            March - surface  
            April - May - surface, 400 mb  
            June - surface, 250, 400 mb  
            July - surface  
            August - October - surface, 400 mb  
            November - surface  
            December - surface, 250 mb, 500 mb

1984:      January - February - 400 mb  
            March - surface  
            April - surface, 400 mb  
            May - none  
            June - July - surface, 400 mb  
            August - 400 mb  
            September - 200 mb  
            October - 400, 500 mb  
            November - surface, 200, 300, 400 mb  
            December - surface, 300, 400 mb

1985:      January - 400 mb  
            February - 400, 500 mb  
            March - July - none  
            August - 300, 400 mb  
            September - 200, 300 mb  
            October - 200, 300, 400, 500 mb  
            November - 300, 400, 500 mb  
            December - surface, 300, 400, 500 mb

1986:      January - 400, 500 mb  
            February - 400 mb  
            March - October - none  
            November - surface, 300 mb  
            December - none

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

4. Historical Antarctic data held in hard copy form by the Department of Meteorology, Naval Postgraduate School, Monterey, California: A summary inventory, continued.

Reference:

Souders, C.G. (1984) *Visibility climatology of McMurdo Sound/Williams Field, Antarctica*. Monterey, Naval Postgraduate School, 149 pp., NTIS order number AD-A 148 108.

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.  
5. Comprehensive Ocean-Atmosphere Data Set.\*

Global marine data observed during 1854-1979, primarily by ships-of-opportunity, have been collected, edited, and summarized statistically for each month of each year of the period, using two-degree latitude by two-degree longitude boxes. Table B.5.1 indicates the broad base of input sources. Products available in the first release include fully quality-controlled (trimmed) reports and summaries. Each of the seventy million unique reports contains twenty-eight elements of weather, position, etc., as well as flags indicating which observations were statistically trimmed. The summaries give fourteen statistics, such as the median and mean, for each of eight observed variables of air and sea surface temperatures, wind, pressure, humidity, and cloudiness, plus eleven derived variables. Relatively noisy (untrimmed) individual reports and summaries (giving fourteen statistics for each of the eight observed variables) are available for investigators who prefer their own quality control. Two other report forms, inventories, and decade-month summaries are among the other data products available. Fortran 77 software is also available to help read the "packed binary" data products. An interim update to COADS covering the period 1980-1986 was released in October 1987; this update is scheduled for revision and completion in 1988. Figures B.5.1 and B.5.2 indicate the change in number of observations south of 60 degrees South over the length of the data set, as well as the difference between summer and winter seasons.

See Slutz, *et al.* (1985), Woodruff (1986), and Woodruff, *et al.* (1987) in Appendix B.8 for complete information on COADS, or contact Scott D. Woodruff, NOAA/ERL/Climate Research Division, R/E/AR6, 325 Broadway, Boulder, CO 80303. Telephone (303)497-6747. Telemail in care of [H.DIAZ/OMNET] MAIL/USA.

\*From Slutz, *et al.*, 1985, p. 1.

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.  
 5. Comprehensive Ocean-Atmosphere Data Set, continued.

Table B.5.1 Input sources of the Comprehensive Ocean-Atmosphere Data Set (COADS).<sup>1</sup>

	Million reports (approx.)	Source
Atlas	38.6	NCDC
HSST (Historical Sea Surface Temperature Data Project)	25.2	NCDC, Germany
Old TDF-11 Supplements B and C	7.0	NCDC
Monterey Telecommunication	4.0	NCDC
Ocean Station Vessels, and Supplement	0.9	NCDC
Marsden Square 486 Pre-1940	0.07	NCDC
Marsden Square 105 Post-1928	0.1	NCDC
National Oceanographic Data Center (NODC) Surface, and Supplement	2.0	NCDC
Australian Ship Data (file 1)	0.2	Australia
Japanese Ship Data	0.13	M.I.T.
IMMPC (International Exchange)	3.0	NCDC
South African Whaling	0.1	NCAR
<i>Eltanin</i>	0.001	NCDC
'70s Decade	18.0	NCDC
IMMPC (International Exchange)*	0.9	NCDC
Ocean Station Vessel Z*	0.004	NCDC
Australian Ship Data (file 2)*	0.2	Australia
Buoy Data*	0.3	NCDC
'70s Decade Mislocated Data*	0.003	NCDC
	100**	

<sup>1</sup>From Slutz, R.J., *et al.* (1985) *COADS: Comprehensive Ocean-Atmosphere Data Set, Release 1*. University of Colorado at Boulder/CIRES, NOAA/Environmental Research Laboratories, National Center for Atmospheric Research, NOAA/National Climatic Data Center, p.5.

\*Additions solely to 1970-1979 decade.

\*\*The approximate total includes 26.58 million relatively certain duplicates, and some seriously defective or mis-sorted reports, which were removed by initial processing steps.



Annual and Cumulative Number of COADS  
 Observations of Scalar Wind South of 60°S  
 for  
 Months December–February

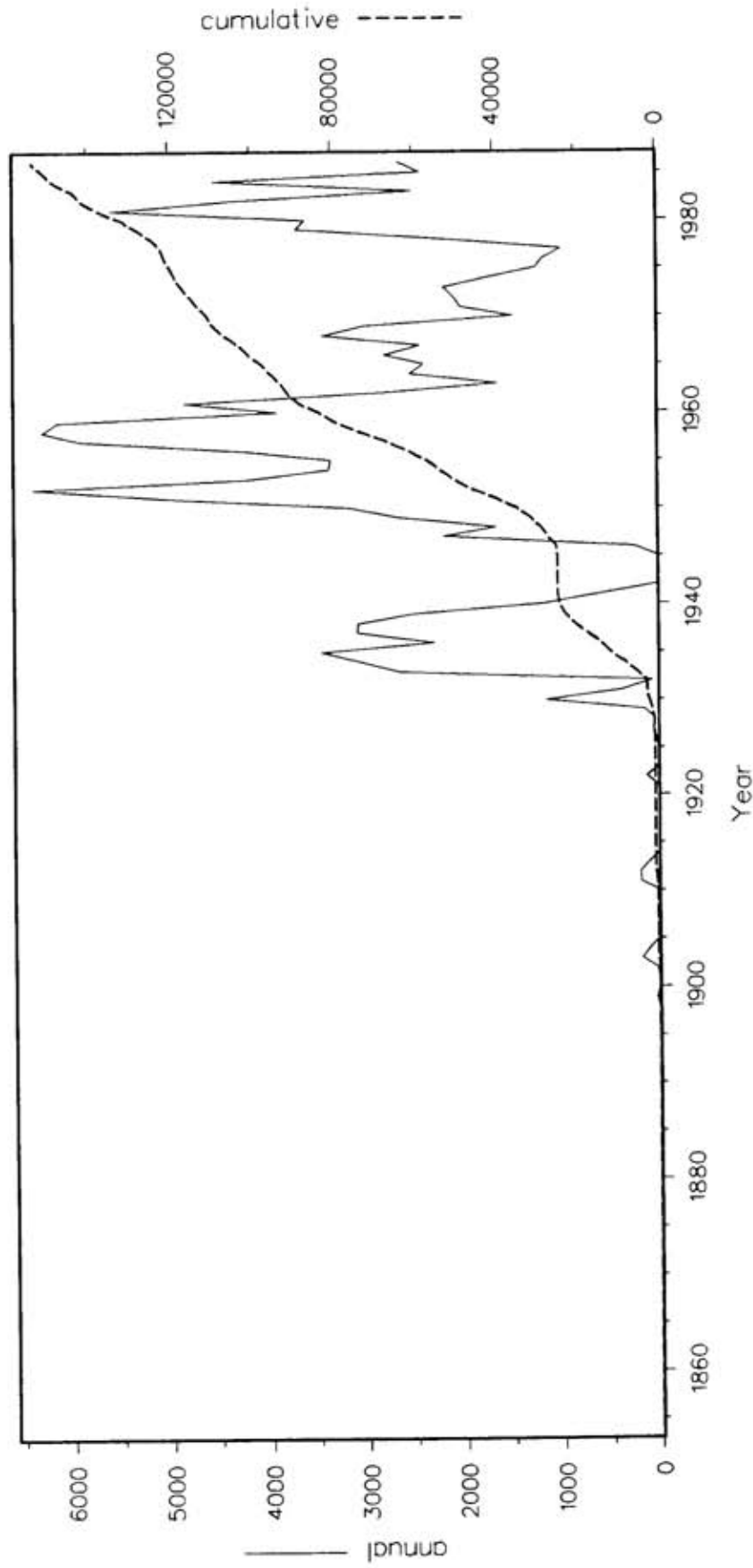


Figure B.5.1. COADS scalar wind observations south of 60 degrees South, summer months. COADS plot provided by S.D. Woodruff.

Annual and Cumulative Number of COADS  
 Observations of Scalar Wind South of 60°S  
 for  
 Months March–November

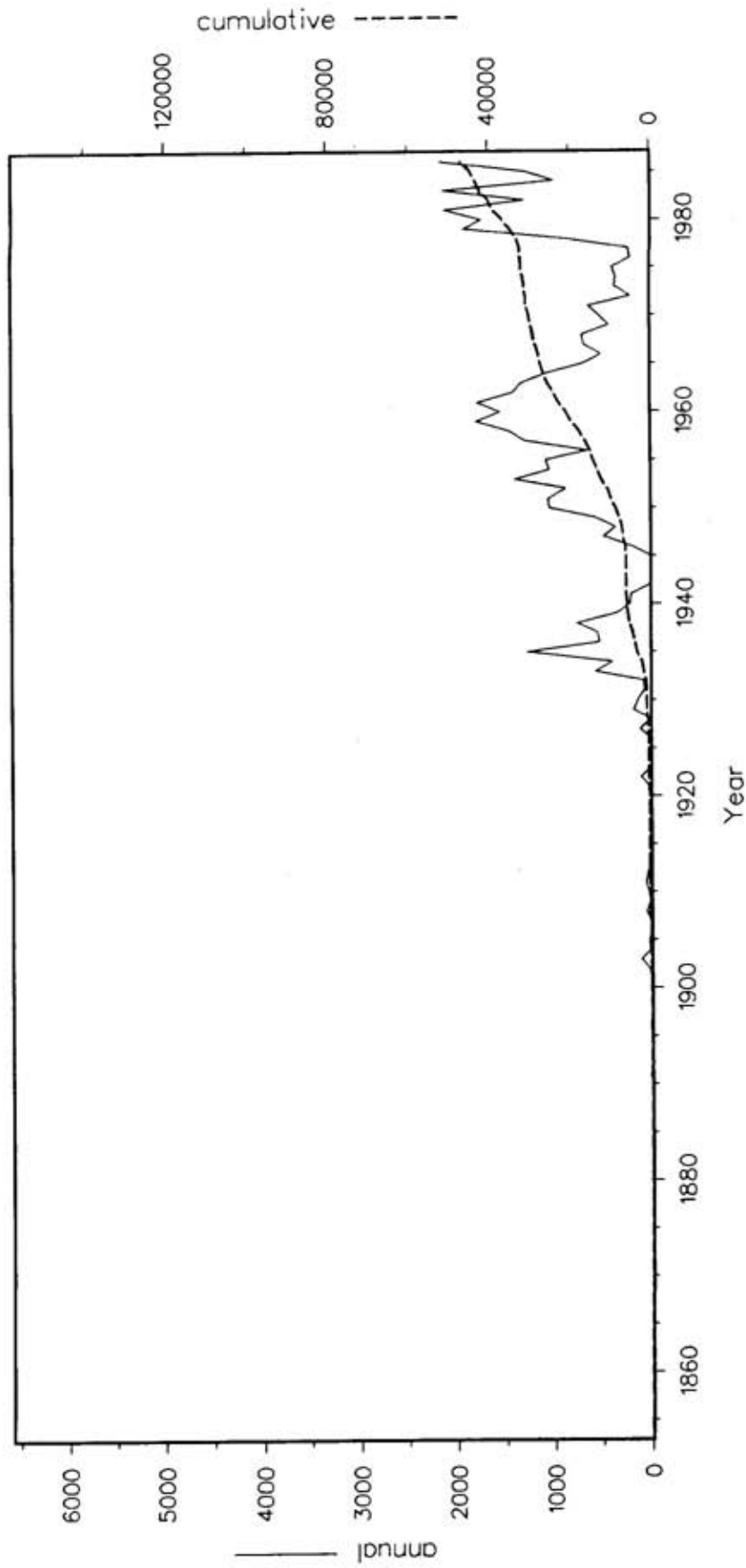


Figure B.5.2. COADS scalar wind observations south of 60 degrees South, winter months. COADS plot provided by S.D. Woodruff.

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.  
6. U.S. Interim Climate Data Inventory. Archives of Antarctic Data.<sup>1</sup>

**TITLE:** Temperature and wind speed profile data, surface to 8 meters, Little America V, Antarctica (1957-1958)  
**PARAMETERS:** Temperature, wind speed  
**PERIOD OF OBSERVATION:** 2 years  
**Start:** Jan. 1957  
**End:** Dec. 1958  
**GEOGRAPHICAL AREA:** Little America V, Antarctica 78-12S, 162-11W  
**DATA TYPE:** Observed data  
**Organization:** Point  
**MEDIA:** Publication, magnetic tape, digital standard 1/2 inch  
**VOLUME:** Unknown  
**REMARKS:** Temp at SFC, 3, 6, 12, 25, 50, 100, 200, 400, 800cm, wind speed at top 6 levels.  
**HOLDING CENTER:**  
U.S. Army Engineers Topographic Labs,  
Ft. Belvoir, VA 22060

**TITLE:** Analysis of the spatial and temporal variations of the ice in Antarctica (1972 to 1975).  
**PARAMETERS:** Brightness, satellite imagery  
**PERIOD OF OBSERVATION:** 3 years  
**Start:** Dec. 1972  
**End:** Jun. 1975  
**GEOGRAPHICAL AREA:** Antarctica and surrounding seas  
**DATA TYPE:** Derived data  
**Organization:** Grid  
**MEDIA:** Charts/maps, magnetic tape, digital standard 1/2 inch  
**VOLUME:** Unknown  
**REMARKS:** Chief data source: NIMBUS-5, 15.5 mm band radiometer.  
**HOLDING CENTER:**  
National Space Science Data Center,  
U.S. National Aeronautics and Space Administration

**TITLE:** Analysis of spatial and temporal variations of the ice in the Antarctic (December 1972 to June 1975).

**PARAMETERS:** Ice cover, satellite imagery  
**PERIOD OF OBSERVATION:** 3 years  
**Start:** Dec. 1972  
**End:** Jun. 1975  
**GEOGRAPHICAL AREA:** Antarctica and surrounding sea  
**DATA TYPE:** Derived data  
**Organization:** Grid  
**MEDIA:** Charts/maps, magnetic tape, digital standard 1/2 inch  
**VOLUME:** 2 volumes  
**REMARKS:** Chief data source: NIMBUS-5, 15.5 mm band radiation brightness temperature.  
**HOLDING CENTER:**  
National Space Science Data Center, U.S. National Aeronautics and Space Administration

**TITLE:** Snow cover analysis, Northern and Southern Hemisphere grids (1975-present)  
**PARAMETERS:** Snow depth, snow cover, snow age  
**PERIOD OF OBSERVATION:** 13 years  
**Start:** Jan. 1975  
**End:** Continuous  
**GEOGRAPHICAL AREA:** Northern and Southern Hemisphere  
**DATA TYPE:** Derived data  
**Organization:** Grid  
**MEDIA:** Charts/maps, magnetic tape, digital standard 1/2 inch, machine printed hard copy  
**VOLUME:** 1 map per day  
**REMARKS:** Grid is from digitized hand analysis of synoptic observations, grid length 46.3 km at 60N.  
**HOLDING CENTER:**  
National Climatic Data Center,  
National Environmental Satellite, Data, and Information Service,  
NOAA

**TITLE:** Weekly northern ice limit, Antarctic (1973 to present)  
**PARAMETERS:** Ice cover

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.  
6. U.S. Interim Climate Data Inventory. Archives of Antarctic Data, continued.

**PERIOD OF OBSERVATION:** 15 years  
**Start:** Jan 1973  
**End:** Continuous  
**GEOGRAPHICAL AREA:** Antarctic  
**DATA TYPE:** Observed Data  
**Organization:** Field  
**MEDIA:** Charts/maps  
**VOLUME:** Unknown  
**REMARKS:** Satellite data supplemented by ship, aircraft and surface observations.  
**HOLDING CENTER:**  
National Technical Information Service, U.S. Department of Commerce. See also Appendix B.7 for 1973 to present digital data set available from NSIDC.

**TITLE:** 3-day average maps of satellite microwave brightness temperatures, Antarctic region (1973 to 1977).  
**PARAMETERS:** Brightness, ice cover, satellite imagery  
**PERIOD OF OBSERVATION:** 4 years  
**Start:** Jan. 1973  
**End:** Jun. 1977  
**GEOGRAPHICAL AREA:** Antarctic region, 50S to South Pole  
**DATA TYPE:** Derived data  
**Organization:** Grid  
**MEDIA:** Photographic prints or copies, magnetic tape, digital standard 1/2 inch, film-slides  
**VOLUME:** Unknown  
**REMARKS:** Data processed on 293 x 293 grid, 30 km resolution, some gaps in record, numerous references.  
**HOLDING CENTER:**  
World Data Center A: Rockets & Satellites, Goddard Space Flight Center.  
See also Appendix B.7 for 3-day and monthly data sets available at NSIDC.

**TITLE:** Global solar radiation data in 5 spectral bands at the Geophysical Monitoring for Climatic Change (GMCC) South Pole Observatory (1976 to 1977).  
**PARAMETERS:** Incident radiation, global radiation  
**PERIOD OF OBSERVATION:** 2 years  
**Start:** Jan. 1976  
**End:** Dec. 1977  
**GEOGRAPHICAL AREA:** South Pole, 90S, 2847m.  
**DATA TYPE:** Observed data  
**Organization:** Point  
**MEDIA:** Magnetic tape, digital standard 1/2 inch  
**VOLUME:** 1 tape  
**REMARKS:** None  
**HOLDING CENTER:**  
National Climatic Data Center, National Environmental Satellite, Data, and Information Service, NOAA

**TITLE:** Tower temperature and wind profile data and radiation at Plateau Station, Antarctica (1966-1968)  
**PARAMETERS:** Ice temperature, atmosphere temperature, wind speed, wind direction, standard surface meteorology, global solar radiation, global IR radiation, direct solar radiation, reflected solar radiation, emitted radiation, solar radiation, UV radiation.  
**PERIOD OF OBSERVATION:** 3 years  
**Start:** Jan. 1966  
**End:** Dec. 1968  
**GEOGRAPHICAL AREA:** Plateau Station, Antarctica, 79-15S, 40-30E, 3625m.  
**DATA TYPE:** Observed data  
**Organization:** Point  
**MEDIA:** Publication, magnetic tape, digital standard 1/2 inch  
**VOLUME:** Unknown

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.  
6. *U.S. Interim Climate Data Inventory*. Archives of Antarctic Data, continued.

REMARKS: Temp at -10, -2, -1, -.5, -.25, -.125, 0, .25, .5, 1, 2, 4, 8, 12, 16, 20, 24, and 32m. Data analysis published in *Antarctic Research Series, Vol.25, Meteorological studies at Plateau Station, Antarctica*, American Geophysical Union, Washington, DC, 1977.

**HOLDING CENTER:**

U.S. Army Engineers Topographic Labs,  
Ft. Belvoir, VA 22060

<sup>1</sup>From: Ropelewski, C.F., Predoelh, M.C., Platto, M. (1980) *Interim Climate Data Inventory: A Quick Reference to Selected Climate Data*. Washington, DC, National Oceanic and Atmospheric Administration. Center for Environmental Assessment Services, 167p.

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

7. Catalog of Antarctic data available at NSIDC.

National Snow and Ice Data Center  
World Data Center A for Glaciology [Snow and Ice]  
CIRES, Campus Box 449  
University of Colorado  
Boulder, CO 80309  
Telephone: 303-492-5171  
Telex: 257673 WDCA UR  
Telemail: [NSIDC/OMNET] MAIL/USA  
Vax mail via SPAN: KRYOS::NSIDC

Data are available at cost; please inquire for volume and cost estimates.

1. Special Sensor Microwave/Imager (SSM/I) Cryospheric Data, from the SSM/I sensor on the Defense Meteorological Satellite Program (DMSP) F9 satellite, beginning July 1987. Gridded sea ice concentration and ice edge data produced from brightness temperatures. Data access via online catalog and inventory on Vax 11/750 running VMS (Cryospheric Data Management System.)
2. Defense Meteorological Satellite Program visible and infrared imagery, photographic products. Global coverage up to four times daily, 1973 to the present. Custom searches, custom photographic products or on-site use available.
3. NASA/Goddard Space Flight Center Southern Hemisphere Scanning Multi-channel Microwave Radiometer (SMMR) Sea Ice Data, 1978-1985. Sea ice concentration and multi-year ice fraction calculated from polarized antenna temperatures. South of 50 degrees South (and north of 30 degrees North), data are available in SSM/I gridded format. Original orbital data are available from the National Space Sciences Data Center (NSSDC), Code 601, Goddard Space Flight Center, Greenbelt, MD 20771.
4. U.S. Navy - NOAA Joint Ice Center (JIC) Digital Sea Ice Data, 1973 to the present. Digitized in the World Meteorological Organization's SIGRID (sea ice grid) format from the weekly JIC ice charts. 2 tapes, 1600 bpi. Also available for Northern Hemisphere.
5. NASA/Goddard Space Flight Center Antarctic Microwave Sea Ice Data from the Nimbus-5 ESMR (Electrically Scanning Microwave Radiometer), 1973-1976. Monthly and 3-day data, 3 reels, 6250 bpi.
6. Byrd Polar Research Center Ice Core Microparticle Analyses, Byrd Station 2164 meter core, (also Quelccaya Ice Cap in Peru, Lewis Glacier on Mount Kenya, Camp Century in Greenland.) Data include particle counts in each of 15 size ranges. 1 tape, 1600 bpi.

APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

7. Catalog of Antarctic data available at NSIDC, continued.

7. National Meteorological Center/Climate Analysis Center Antarctic (and Arctic) Sea Ice, 1973-1982. Digitized from U.S. Navy Fleet Weather Facility and Navy - NOAA Joint Ice Center sea ice charts (the last chart of each month), with sea ice area computed for 10-degree longitude "slices." 1 tape, 1600 bpi.
8. Max-Planck Institut fur Meteorologie Southern Hemisphere Ice Limits, 1973 - 1978. Digitized from U.S. Navy Fleet Weather Facility (now JIC) weekly ice charts, data are gridded at 5 degree longitude intervals. 1 tape, 1600 bpi.
9. Rand Corporation's Monthly Mean Global Snow Depth Data. All available mean-monthly snow depth climatologies combined into a 4 degree latitude x 5 degree longitude grid. 1 360k floppy disk.
10. Lamont-Doherty Geological Observatory Antarctic (and Arctic) Ice Concentrations, 1972-1980. Weekly indices of snow and ice cover from U.S. Navy and NOAA ice charts. 1 tape, 1600 bpi.
11. Airborne Polar Ice Sounding and Geomagnetism Data Sets, 1977-1979. Collected by the Airborne Research Data System (ARDS) on NSF-funded missions by U.S. Navy aircraft, these data include radio echo soundings over portions of the Antarctic ice sheet, as well as navigation and basic meteorological parameters. Some flights included ozone monitoring. 1980 data include meteorological and atmospheric chemistry, rather than glaciological, experiments. Data are both analog (soundings) and digital. Data are raw and uncorrected and quite voluminous. Please inquire for further details. 1977- 1979 data were used to produce a detailed atlas: Drewry, D.J., ed. (1983) *Antarctica: Glaciological and Geophysical Folio*. Cambridge, UK: Scott Polar Research Institute.

## APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

### 8. Preliminary Bibliography of Antarctic Data Sources.

This list of references containing Antarctic data intentionally limits non-U.S. sources. It is intended as a starting point for future efforts to locate as much of the published Antarctic meteorological data as possible. Additions to the list may be forwarded to the WDC/NSIDC for inclusion. The references were compiled at WDC/NSIDC with the help of R.L. Jenne, National Center for Atmospheric Research.

Some of the materials listed may be difficult to obtain. Notations are included for items actually located. Items held at WDC/NSIDC are marked "WDC." Those items found at the U.S. Department of Commerce, Mountain Administrative Support Center Library, RL-3 Branch in Boulder, are marked "MASC/Branch". Items with no coding are commonly available, or were not actually located.

#### Selected Bibliography of Antarctic Data Sources January 1988

- Fleming, R.J., Kaneshige, T.M., McGovern, W.E., Bryan, T.E. (1979) Global weather experiment II. Second special observing period. *Bulletin of the American Meteorological Society*, 60(11), p.1316-1322.
- GARP Joint Planning Staff. (1981) The Global Weather Experiment. *First GARP Global Experiment (FGGE) Operations Report Series: Volume 4, Summary of Data Collected 7 March - 4 July 1979*. Prepared in cooperation with International Council of Scientific Unions. Geneva, World Meteorological Organization, 344p. [NTIS microfiche order no. N83-12807. Hard copy from WMO.]
- Jones, P.D., Limbert, D.W.S. (1987?) *Data Bank of Antarctic Temperature and Surface Pressure Data*. Climatic Research Unit, University of East Anglia, 23p. (Draft.)
- Loon, H. van, Taljaard, J.J., Sasamori, T., London, J., Hoyt, D.V., Labitzke, K., Newton, C.W. (1972) *Meteorology of the Southern Hemisphere*. Boston, American Meteorological Society. Meteorological Monographs, 13(35), 263p. [MASC/Branch.]
- Monthly Climatic Data for the World*, volume 1, 1948--. U.S. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC.
- Monthly Weather Review* (1939) Supplement no. 41. *Meteorological Results of the Byrd Antarctic Expeditions, 1928-1930, 1933-1935: Tables* [by George Grimminger and William C. Haines], 377p.
- Monthly Weather Review* (1941) Supplement no. 42. *Meteorological Results of the Byrd Antarctic Expeditions, 1928-1930, 1933-1935: Summaries of Data*. 106p., 122 figs.



APPENDIX B. PRELIMINARY INVENTORY OF U.S. ANTARCTIC METEOROLOGICAL DATA.

8. Preliminary Bibliography of Antarctic Data Sources, continued.

- Monthly Weather Review* (1949) Supplement no. 48. *Meteorological Data for Little America III*. 150p. [Government Document Collection, University of Colorado at Boulder.]
- Raper, S.C.B., Wigley, T.M.L., Mayes, P.R., Jones, P.D., Salinger, M.J. (1984) *Variations in Surface Air Temperatures: Part 3. The Antarctic, 1956-1981*. *Monthly Weather Review*, 112(7), p.1341-1353.
- Rooy, M.P. van, ed. (1957) *Meteorology of the Antarctic*. Pretoria, Department of Transport, Weather Bureau, 240p. [MASC/Branch.]
- Ropelewski, C.F., Predoel, M.C., Platto, M. (1980) *Interim Climate Data Inventory: A Quick Reference to Selected Climate Data*. Washington, DC, National Oceanic and Atmospheric Administration. Center for Environmental Assessment Services, 176p. [WDC]
- Savage, M.L., Stearns, C.R., Fleming, D. (1985a) *Antarctic Automatic Weather Station Data for the Calendar Year 1982*. University of Wisconsin at Madison, Department of Meteorology, 185p. [WDC]
- Savage, M.L., Stearns, C.R., Fleming, D. (1985b) *Antarctic Automatic Weather Station Data for the Calendar Year 1981*. University of Wisconsin at Madison, Department of Meteorology, 149p. [WDC]
- Savage, M.L., Stearns, C.R., Fleming, D. (1985c) *Antarctic Automatic Weather Station Data for the Calendar Year 1980*. University of Wisconsin at Madison, Department of Meteorology, 72p. [WDC]
- Savage, M.L., Stearns, C.R., Weidner, G., Fleming, D. (1985a) *Antarctic Automatic Weather Station Data for the Calendar Year 1984*. University of Wisconsin at Madison, Department of Meteorology, 244p. [WDC]
- Savage, M.L., Stearns, C.R., Weidner, G., Fleming, D. (1985b) *Antarctic Automatic Weather Station Data for the Calendar Year 1983*. University of Wisconsin at Madison, Department of Meteorology, 192p. [WDC]
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- Sievers, M.F., Weidner, G.A., Stearns, C.R. (1986a) *Antarctic Automatic Weather Station Data for the Calendar Year 1986*. University of Wisconsin at Madison, Department of Meteorology, 268 p. [WDC]

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## APPENDIX C. SUPPLEMENTARY COMMENTS FROM PARTICIPANTS.

### 1. Comments from Paul C. Dalrymple

The following are post-game comments by an attendee at the recent Workshop on the U.S. Antarctic Meteorological Data Delivery System held in Boulder on September 10-11, 1987. They are unsolicited. The writer was somewhat unique among the attendees, as his background included a considerable amount of time as a weather observer in the old Weather Bureau, two years on the ice conducting micrometeorological programs, and working as a climatologist to analyze data from the various Antarctic International Geophysical Year (IGY) stations. He had more hands-on experience than other attendees, and probably had the greatest concern for proper instrumentation and quality control of the data. He had no personal axes to grind, nor any interest in future organizational changes, as he is happily retired, which also set him apart from other attendees. The comments that follow probably represent a minority opinion, but he feels they are important nonetheless.

#### The Bad:

Climate in Antarctica supposedly came of age when it was noticed that thirty years had elapsed since the IGY and several stations had thirty-year data records. However, over a continent comprising five and one-half million square miles, there are fewer than ten stations with thirty years of data (Amundsen-Scott, McMurdo, Belgrano, Halley, Mawson, Dumont d'Urville, Mirny, Wilkes/Casey, and Faraday) and only one, Amundsen-Scott, is a non-coastal station. So there are a half dozen coastal stations, a couple of island stations, and one continental station, each of which has climate determined by its unique topography and relationship with the sea and with sea ice. One station, Vostok, has close to a thirty-year record; one other interior station, Filchner, has a very short record as it is a relatively new station. So, when it comes to climate, Antarctica short-changes relative to the number and location of stations, as well as length of record. Also, there has been considerable construction at all of these stations, so the observation sites have been changed and the addition of new buildings has created new microclimates. The nine stations with thirty-year records represent six different nations, so instrumentation may not be comparable. Antarctica is, climatologically, very much of a mixed bag, with very little good, long-term data of any great consequence, particularly for the vast interior that is, essentially, a climatic desert. The only grace is that weather improves as one approaches the Pole; where weather is at its worst, there is at least a scattering of coastal stations.

#### The Good:

Antarctica is well-known, as it has been a scientific laboratory with researchers from around the world studying the continent from below, from the surface, and from above. So there are all kinds of supporting geophysical data that will materially aid any climatologist trying to piece together a clear picture of Antarctica. Some of these data are:

## APPENDIX C. SUPPLEMENTARY COMMENTS FROM PARTICIPANTS.

### 1. Comments from Paul C. Dalrymple, continued.

1. Hundreds of firn temperatures taken at ten-meter depths, permitting a close approximation of the mean annual temperature for a specific site.
2. Several deep ice cores, yielding probably the best paleoclimatic data that have been obtained to date.
3. Satellite imagery of the coastal area, resulting in an excellent sea ice climatology for Antarctica.
4. Micrometeorological studies from two coastal stations (Maudheim and Little America V) and two interior stations (Amundsen-Scott and Plateau) that have helped to determine the mass budget of Antarctica.
5. Polar-orbiting satellites that are yielding radiation data, thus establishing an excellent energy-exchange climatology for the continent.
6. A large network of unmanned automatic weather stations in important unoccupied areas of Antarctica, that has helped to fill some of the climatic data gaps.
7. A tremendous national effort, involving tens of scientists, studying springtime ozone depletion, a phenomenon that could have catastrophic climatic consequences.
8. Continued study of the role of climatic change in ablating part of the snow and ice in Antarctica, yielding much supporting data that could be of use to climatologists.

### Antarctic Climatic Records:

#### A. Stations with records of thirty continuous years:

Station Name	Country	WMO number
*Amundsen-Scott (South Pole)	U.S.A.	89009
*Belgrano	Belgium	89034
*Dumont d'Urville	France	89642
Faraday (Argentine Island)	U.K.	89063
*Halley	U.K.	89022
*Mawson	Australia	89594
*McMurdo	U.S.A.	89664
*Mirny	U.S.S.R.	89592
*Wilkes/Casey	Australia	89611

APPENDIX C. SUPPLEMENTARY COMMENTS FROM PARTICIPANTS.

1. Comments from Paul C. Dalrymple, continued.

B. Stations with records in excess of twenty years:

*Molodezhnaya	U.S.S.R.	89542
*Novolazarevskaya	U.S.S.R.	89512
SANAE	South Africa	89001
*Syowa	Japan	89532
*Vostok	U.S.S.R.	89606

C. Stations with 3-hourly surface observations and an upper air program:

Bellingshausen	U.S.S.R.	89050
*Davis	Australia	89571
*Georg von Neumayer	West Germany	89002
Vicecomodoro Marambio	Argentina	89055

D. Stations with 3-hourly surface observations:

Base Arturo Prat	Chile	89057
*Dakshin Gangtori	India	89510
Dinamet	Uruguay	89054
Great Wall	P.R. China	89058
Jubany	Argentina	89053
Pdte. Eduardo Frei	Chile	89056
Rothera	U.K.	89062
*Russkaya	U.S.S.R.	89132
San Martin	Argentina	89066

Stations marked with an asterisk (\*) in the list above are the only truly Antarctic stations, the rest lying on the Antarctic Peninsula. Of these sixteen Antarctic stations, those of West Germany and India are only recently established, leaving a set of fourteen stations. Upon further examination of their location, only two (Amundsen-Scott and Vostok) are in the interior. This leads to the conclusion that the climate network for Antarctica is inadequate.

The data sets from the fourteen stations may look fairly complete, but it is likely they are microclimate data representative of the particular site where the stations were built. If one has seen pictures of the non-U.S. stations in Antarctica, one remembers that nearly all of them are built on snow-free promontories right on the coast, sites that certainly are atypical of the Antarctic continent. To further limit the utility of the data sets, stations like McMurdo have been drastically changed in configuration by thirty years of construction, so both the observation sites and the environment have changed.

There was an Antarctica before the IGY, and meteorological measurements were taken. There were three major U.S. expeditions: Byrd Antarctic Expedition, 1928-30 (BAE I), the Second Byrd Antarctic Expedition, 1933-35 (BAE II), and the U.S. Antarctic Service Expedition, 1939-41. In addition, there was

## APPENDIX C. SUPPLEMENTARY COMMENTS FROM PARTICIPANTS.

### 1. Comments from Paul C. Dalrymple, continued.

the Ronne Antarctic Research Expedition, 1947-48, and two military operations, the giant Operation Highjump in 1946-47 and Operation Windmill in 1947-48. Climate data from both BAE I and BAE II, as well as from the U.S. Antarctic Service Expedition, have been published. (See *Monthly Weather Review*, 1939, 1941 in Appendix B.8.) The Office of Naval Research has published weather statistics from the Ronne Expedition. I think it is sufficient to cite these publications (see Appendix B.8), so that anyone who wants to use the data will know that they are available. Archiving the data in a central archive is probably not worthwhile.

The U.S. operated two stations during the IGY for a two-year period: Little America V and Ellsworth. They also operated Wilkes during 1957-58, and their data should be incorporated with data from Casey, as the Australians took over the operation of Wilkes under an assumed name! In addition, the U.S. has operated other stations: Byrd Station was in operation from January 1957 to February 1980; Plateau Station was maintained from December 1965 to December 1968; Eights Station was open from November 1961 to November 1965; and Siple Station has a ten-year interrupted record dating from October 1977.

There are all kinds of "shoebox" sets of meteorological data from research sites such as Beardmore Glacier, Darwin Glacier, Brockton, Little Rockford and the like; these data should probably stay right where they are, as they are too restricted to have any great utility for the future. One has to call a halt somewhere, and a rule of thumb might be that a station with only austral summer data is not worth expending time or money to archive.

#### Recommended Priorities:

- A. Amundsen-Scott Station: These data are absolutely necessary.
- B. Murdo Station: These data are necessary because McMurdo is a primary logistical center, although for long-term climatic analyses the data sets have limitations.
- C. Byrd, Plateau, Eights and Siple Stations: Data should be preserved and digitized as these stations are the best of the rest, and in the case of Plateau, representative of severely cold, dry climate.
- D. Little America I (1928-30), Little America II (1933-35), Little America III (1939-41), Little America V (1957-59), Ellsworth (1957-59) and Ronne Antarctic Research Expedition: Maintain a record of the location of these data, but don't waste time or funding on any further processing.
- E. All field data from austral summer expeditions should be the responsibility of the principal investigators, not of any data center.

## APPENDIX C. SUPPLEMENTARY COMMENTS FROM PARTICIPANTS.

### 1. Comments from Paul C. Dalrymple, continued.

#### Other Personal Observations:

All climate data from Antarctica should go directly to the National Climatic Data Center (NCDC) in Asheville, and should be quality controlled before they are released to users. No one ought to use data right off the GTS before the data have been checked for errors.

It is essential for the analyst to know as much as possible about how measurements were taken. If you look in the *World Weather Records*, you will find that they are excruciatingly attentive to the measurement sites, changes in sites, instrumentation used, etc. Inasmuch as is possible, all data sets should have an historical paragraph added about instrumentation, sites, observers, etc. For example, aerovanes were used and are probably still being used at most stations, but if you are there in the winter, you will note that they can and do get stalled in place at low wind speeds (when lightweight micrometeorological cups are recording winds of 2 m/s). Temperatures once were taken by thermometers in large aspirated shelters that occasionally got clogged with snow. This might not be detected for several days. If an analyst knew the instrumentation being used, he could make an assessment whether he would want to use those sets. The climatologist cannot be given too much information.

Because of the very limited amount of Antarctic climate data available, my recommendation would be not to waste any money creating another bureaucratic structure. I recommend working within the National Climate Program Office (NCPO), which has a charter to monitor climate. There is nothing wrong in having a small working group (not to exceed five members) that might meet every other year to discuss the status of climate in Antarctica, but the coordination should be left to the NCPO which would have no personal interests of its own. Because the NCPO presumably talks with the WMO's World Climate Research Programme (WCRP) staff, the NCPO could serve as the U.S. international spokesman. This would limit empire-building activities by groups having a personal stake in Antarctic climate data.

Mentioned above were other studies, primarily geophysical, whose data might be of use to climatologists. It would seem very foolish to this innocent if any of these data were to be transferred to any climate center. What should be done is to establish points of contact for each effort, and disseminate information about these points of contact via some mechanism such as the "Dear Colleague" letters from Dr. Peter Wilkness, Director, Division of Polar Programs, National Science Foundation. Don't create any more empires to manage these data.

As far as a system to manage the Antarctic climate data, time will take care of this quite nicely as one system gains favor over all others by virtue of its inherent qualities. It would seem ill-founded at this time to do anything that is not congruous with efforts of the National Weather Service. As there is so relatively little Antarctic data, it is not worth worrying. The data exist and are available, it just requires an investment of time and money

APPENDIX C. SUPPLEMENTARY COMMENTS FROM PARTICIPANTS.

1. Comments from Paul C. Dalrymple, continued.

to acquire them. There is some doubt that there are long lines waiting to analyze the data in question, as the cream has already been skimmed.

If a center must be designated, it should be at an existing polar center where an institutional commitment can be guaranteed, rather than where a newly-involved institution wants to develop such a center.

Overall advice at this time would be to tread lightly, work within the framework of NCDC, avoid creating more bureaucratic structure, and above all, strive for better observations being taken in Antarctica.



## APPENDIX C. SUPPLEMENTARY COMMENTS FROM PARTICIPANTS.

### 2. Comments from David H. Bromwich, Byrd Polar Research Center.

#### A. General comments

- 1) There has been a tendency in Antarctic meteorology to equate routine data collection with research. The U.S. program does not suffer from this shortcoming, but it could be enhanced by making greater use of recent research results.
- 2) Data collection activities need quite a lot of attention. Especially in the coastal areas where there are very marked topographic variations, there are strong mesoscale influences. Thus, the relationship of observing sites to their environment needs to be understood to appreciate the significance of acquired observations. The climate of McMurdo Station, for example, is radically different from that of the nearby Ross Ice Shelf (Savage and Stearns, 1985). In addition there are very large data gaps in the Antarctic; the technology is at hand to eliminate this basic observational deficiency.
- 3) Any technological approach adopted to enhance data accessibility should be within the financial reach of the individual investigator. An optimum solution would be a personal computer-based system with moderate storage requirements. Alternatively, if an advanced data handling capability, such as that employed by the Antarctic Research Center at Scripps Institution of Oceanography, is to be used, then funds should be provided by the National Science Foundation/Division of Polar Programs so that small groups as well as large organizations can access this new capability. Interactive data access should be an add-on to existing procedures (e.g., magnetic tape acquisitions from the National Climatic Data Center) and not a replacement for them.

#### B. Data collection

- 1) Upper air soundings: There is a pronounced bias in coastal Antarctic rawinsonde records in that observations tend to be missed when surface wind speeds are high (Bromwich, 1978). Even so, a relatively high percentage of scheduled soundings is normally acquired. At Casey Station during the 1972 winter, for example, the success rate was 87% (Bromwich, 1979); at other locations the success rate approached 100%. Examination of winter 0000 GMT soundings at McMurdo (the only station examined) for 1980-1985 revealed a 75% acquisition of scheduled ascents. This result suggests that the rawinsonde program at McMurdo can be improved; perhaps launch priorities need to be re-examined. Acquisition of as complete an upper air record as possible is vital given the small number of observing sites.
- 2) Synoptic network: There are two huge data gaps: the coast of West Antarctica and the continental interior. A systematic program needs to be formulated to deploy automatic weather stations (AWS) at well

## APPENDIX C. SUPPLEMENTARY COMMENTS FROM PARTICIPANTS.

### 2. Comments from David H. Bromwich, Byrd Polar Research Center, continued.

chosen sites; this probably should be international in scope with a strong U.S. component. In the interior, AWS sites on ice crests monitor the synoptic scale circulation because there the downslope buoyancy force is approximately zero, for example, at Dome C in East Antarctica (Wendler and Kodama, 1984).

- 3) Aircraft data: Aircraft missions are needed so that the full three-dimensional time-dependent atmospheric structure can be sampled. Aircraft time should be available on a regular basis, perhaps each field season. A dedicated aircraft suitable for operations in complex terrain may be required. It is highly desirable that computer equipment at McMurdo and perhaps Amundsen-Scott Stations be available to process aircraft data sets shortly after acquisition.
- 4) New types of data: With the new meteorological satellite reception capability online at McMurdo, it is important to emphasize the effort required to understand how to use this capability in the most effective fashion. Particular attention needs to be given to the optimal combination of AWS and satellite observations. For example, what spatial and temporal resolutions are needed from the two data sources to resolve the marked mesoscale gradients alluded to above? Clearly, the operational and research portions of the National Science Foundation need to give joint attention to such questions.

### C. Data transmission

- 1) A way should be found to transmit U.S. AWS data over the GTS. However, consideration should also be given to the need for limited access to data from platforms established for specific research projects. Perhaps only data from selected platforms should be put onto the GTS.
- 2) Data sets obtained from the GTS are likely to be completely inadequate for archival. Research-quality data sets (manned observations) should be assembled when all records are physically returned from the Antarctic.

### D. Data archiving

- 1) An Antarctic Meteorological Data Center is needed somewhere in the U.S. Convenient, moderately priced data access should be a key criterion for its operation.
- 2) Data now stored by the National Climatic Data Center (NCDC): an example. A magnetic tape containing all surface and upper air observations collected at McMurdo between 1956 and 1985 was provided by NCDC during 1987 in response to a request. This demonstrates that data are available shortly after they are returned from the

APPENDIX C. SUPPLEMENTARY COMMENTS FROM PARTICIPANTS.

2. Comments from David H. Bromwich, Byrd Polar Research Center, continued.

Antarctic. This timeliness is important given the availability of AWS data within a few months of real time.

Examination of records on this tape produced conflicting findings. All surface observations over this 30-year period appeared to be present. However, there were unexplained large gaps in the upper air records. In 1984, for example, there were no soundings given for April to June, despite a daily release schedule. Were the records not collected? If not, why was this? If the records were collected, did they go astray between McMurdo and NCDC? As the May 1984 500 millibar hemispheric maps prepared by the Australian Bureau of Meteorology show observations for McMurdo, the upper air records for April-June 1984 were probably lost between McMurdo and NCDC.

- 3) Whatever system is devised to maintain Antarctic meteorological data, a station history file should be maintained as an integral part of the system for each observing station. Rather than referring to published documents, all instruments and observing practices should be specified. There is probably much variability in observing procedures that must be documented in the data files.
- 4) Invaluable historical meteorological observations are scattered around the world. At the very least, a catalog of these data should be compiled, and preferably a collection assembled.
- 5) Numerous short records are available from summer field parties. A vigorous effort is needed to locate all these data. It would help if a fixed data format was established. The Byrd Polar Research Center at Ohio State University has records from three recent Antarctic field seasons as well as weather data collected during over-snow traverses just after the International Geophysical Year (IGY).
- 6) Aircraft data sets recorded by the NSF-funded Airborne Research Data System (ARDS) and now being recorded by the Data Acquisition and Display System (DADS) should be preserved.
- 7) The automatic weather station data reports published by the University of Wisconsin at Madison/Department of Meteorology are very useful. They could be enhanced if a cut-off of data collection from a particular sensor could be agreed upon by all parties concerned. For example, wind speeds are published for Manuela station (8922) from February through August 1985. These records are probably unreliable after May 9, 1985. It would be useful to have these three-hourly data sets also available in a computer-compatible form. The tapes containing all satellite-received AWS transmissions should be preserved for future consultation.

## APPENDIX C. SUPPLEMENTARY COMMENTS FROM PARTICIPANTS.

### 2. Comments from David H. Bromwich, Byrd Polar Research Center, continued.

- 8) The extensive climatological records maintained by the late Professor W. Schwerdtfeger are an invaluable resource that should be made available to the community.
- 9) The synoptic charts produced by the U.S. Navy at McMurdo should be archived.

### E. Data access

- 1) Development of an Antarctic data set from all available sources is strongly supported. This should include extractions of Antarctic grid point data from numerical analyses such as the FGGE data sets.
- 2) The establishment of an interactive system to access the Antarctic data stream seems like a good idea. I have found that real-time access to Antarctic AWS data via Service ARGOS is an invaluable management tool. Whatever technological approach is adopted should be simple to use and moderately priced. If economical, retrospective data delivery on optical laser disk would be an acceptable alternative because interactive access is not mandatory. Distribution of data on floppy disks is preferred because it is a known technology.

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**APPENDIX C. SUPPLEMENTARY COMMENTS FROM PARTICIPANTS.**

3. Proposal for future meteorological data transmission within Antarctica. William Smythe, UCLA/Institute of Geophysics and Planetary Physics, September 1987.

Utilizing meteor burst technology, outlying camps and remote field parties conducting surface weather observations could transmit observations directly to the Vax communications computer at McMurdo Station. The Vax would receive the data, check for accuracy using a subroutine, and transmit the data onward to the GTS, to NMC, or hold the data for local use. Weather office personnel would become users in the sense that continental data would flow from the communications office to the weather office. Current HF radio transmissions would be used as a backup procedure only.

**Advantages:**

McMurdo weather observers would no longer be tasked with receiving and transmitting observations from as many as five Antarctic stations at the same time, on a routine basis. Errors resulting from poor voice (HF) communication would be reduced.

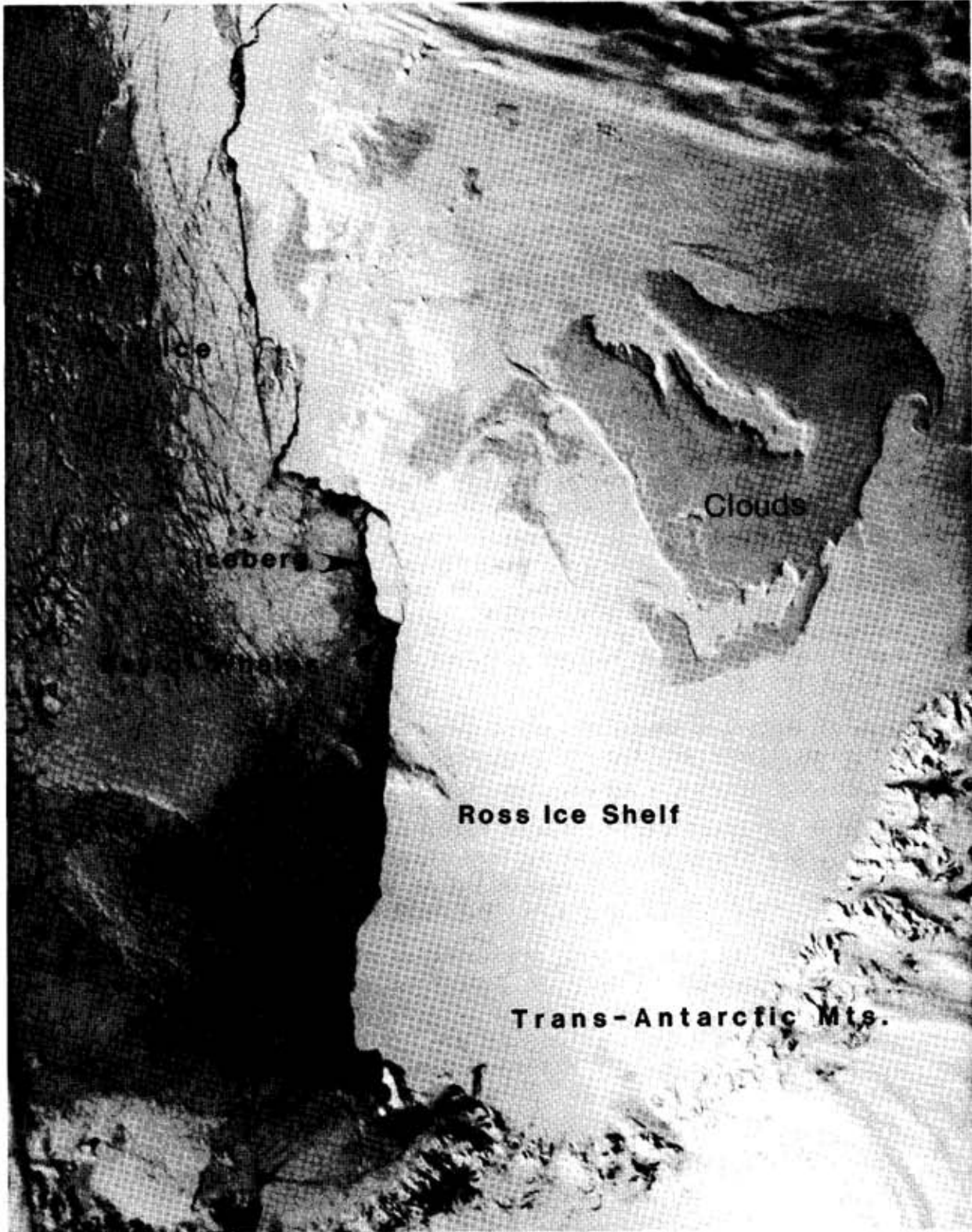
**Disadvantages:**

Accuracy of weather observations would be checked by computer instead of Navy weather personnel, so the only errors flagged would be those recognized by the filtering software.

McMurdo observers would be tasked to examine data flagged by the software before transmission, reducing the time-saving benefit of direct data transmission.

Training of field party members in surface observation procedures would need to be increased. Many observations currently consist of statements such as "It's cloudy and windy, but visibility is good." The loss of direct human communication could result in significant data loss.

**Recommendation:** Include direct transmission of observations from outlying camps in the feasibility study of improving data communication within Antarctica.



U.S. Air Force Defense Meteorological Satellite Program (DMSP) 2.7 kilometer resolution visible band image showing Bay of Whales iceberg on 14 October 1987.

## NOTE

### Antarctic Iceberg Observed From DMSP Satellite Imagery

Greg Scharfen

National Snow and Ice Data Center

This visible-band image (facing page) from the U.S. Air Force Defense Meteorological Satellite Program (DMSP), received at NSIDC as part of its archive for DMSP data, shows a huge tabular iceberg in Antarctica. The iceberg, twice the size of Rhode Island, broke off from the Ross Ice Shelf in October 1987, permanently changing the local geography of the area. Before calving, that part of the ice shelf formed one edge of the Bay of Whales, an area marked on most maps of the Antarctic. The Bay of Whales is where Norwegian explorer Roald Amundsen and his party of five began their trek to become the first humans to reach the South Pole in December 1911, and was the base for Admiral Richard E. Byrd's five expeditions between 1929 and 1956.

The Bay of Whales berg ranks as one of the largest icebergs to be observed from space and airborne platforms. Icebergs are formed as snowfall on the high Antarctic Plateau, accumulating year after year until it reaches the density of ice, eventually becoming part of the Antarctic Ice Sheet. Over the course of several hundred millenia, the glacial ice near the pole flows out towards the edges of the continent to become floating ice shelves that cover expansive areas of ocean. The largest of these is the Ross Ice Shelf, an area some 1000 kilometers across and 200 meters thick. Eventually the ice calves off as bergs, tabular in shape, that float out into the open sea where they will break up or melt.

Tabular icebergs of this kind have several times been considered as a potential supply of fresh water for distant parts of the world. During the 1970's, engineers studied the possibility of towing the larger bergs to parts of the world with chronic water shortages such as Saudi Arabia and southern California. Various schemes involving nuclear-powered tug boats and plastic coating, to prevent melting during the long journey across the tropical oceans, were considered. Apart from these problems, environmental studies pointed to the ecological consequences of harboring such a large volume of fresh water ice off the coast of an area like southern California. Changes in water temperature and salinity (as well as possible increased frequency of low stratus clouds at the beaches caused by the presence of this additional cold water) would have disastrous consequences for the local fishing and tourism industries. Needless to say, none of these schemes was ever carried out.

The DMSP image archive at NSIDC contains over 1.25 million pieces of visible and thermal infrared hard-copy transparencies, with global coverage up to four times per day since 1973. It is now the longest-running satellite collection of its kind. Many areas of the world are covered with a spatial resolution of 600 meters, making this the most detailed daily satellite imagery available. A unique feature of the DMSP satellites is their ability to view the earth at night in the visible band. These data are useful for studying the distribution of city lights, lightning, and various kinds of fires.

The data are used extensively by the national and international user communities in a wide range of fields including meteorology, climatology, snow and ice studies, oceanography, astronomy, demography, economics, ecology and litigation. Recently, DMSP data were used in support of the NOAA/NASA/NCAR Antarctic Ozone Hole Experiment. The archive receives about twenty to thirty requests for data and information per month. The data can be used on-site by visitors to the collection or copied to a variety of photographic formats.

The archive is operated by NSIDC with funding from NOAA's National Environmental Satellite, Data, and Information Service.



## GLACIOLOGICAL DATA SERIES

Glaciological Data, which supercedes Glaciological Notes, is published by the World Data Center-A for Glaciology (Snow and Ice) several times per year. It contains bibliographies, inventories, and survey reports relating to snow and ice data, specially prepared by the Center, as well as invited articles and brief, unsolicited statements on data sets, data collection and storage, methodology, and terminology in glaciology. Contributions are edited, but not refereed or copyrighted. There is a \$5 shelf stock charge for back copies.

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- GD-15 Workshop on Antarctic Climate Data, 1984
- GD-16 Soviet Avalanche Research; Avalanche Bibliography Update; 1977-1983, November 1984
- GD-17, Marginal Ice Zone Bibliography, July 1985, Out of Print (Microfiche available)
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