

Amundsen-Scott South Pole Station CLIMAT Message Project

With support from the U.S. Global Climate Observing System program based at
NOAA's National Climatic Data Center

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This report is dedicated to all of those who have explored and been weather observers at South Pole over the last 100 years.

Table of Contents

Table of Contents	3
Introduction	4
Results of Historical Data Re-processing	5
CLIREP software acquisition and training.....	5
Corrections to original observations.....	5
Data reformatting	5
Processing	6
Data checking	7
Ongoing CLIMAT and CLIMAT TEMP Message Status in the USAP.....	8
Summary and Future Efforts.....	8
Acknowledgements.....	9
References.....	10
Appendix A: Supplemental Document	11
Appendix B: On-line Resources.....	12

Introduction

The inclusion of Antarctic meteorological data in climatic research efforts is imperative to understand worldwide climate interactions and possible effects of climate change (e.g. Turner et al. 2005). In support of global climate studies, and as a part of a larger effort to acquire these data from all U.S. and non-U.S. Antarctic stations, the Atmospheric Observation Panel for Climate (AOPC), which reports to the Global Climate Observing System (GCOS), has requested that monthly surface CLIMAT messages from Antarctica's Amundsen-Scott South Pole station (as well as other manned U.S. and non-U.S. Antarctic stations) be made available on a current and historical basis. These messages are a monthly climate summary in a coded message. The AOPC further requested that the real-time transmission of these messages be sent to the Global Telecommunications System (GTS). Surface CLIMAT messages as described in the World Meteorological Organization (WMO) 'Manual on Codes', No. 306, Volume 1.2 (WMO, 2001), and 'Guide to Climatological Practices' No. 100 (WMO, 1983), contain monthly averages and extremes of meteorological elements such as wind, temperature, and pressure and provide them in a coded message format. These coded messages, when transmitted via the GTS, facilitate the ingestion of meteorological data into various climate analysis databases, models and tools on a continuing basis.

Amundsen-Scott South Pole Station has provided meteorological data to the GTS for nearly 50 years, but surface CLIMAT messages have not been included in past disseminations. This project meets the requests for historical CLIMAT messages from the Amundsen-Scott South Pole Station and as a result of the primary effort, provided the start-up for real-time surface CLIMAT message disseminations from both South Pole Station as well as McMurdo Station. The effort completed the processing of the historical surface observations from South Pole Station to produce a more accurate overall climatology of the site for the generation of the historical CLIMAT messages as well as modifications to current systems to generate the information in requisite formats on a real-time basis. This report is a review of the work accomplished as a part of this project, including the distribution of the results. This effort was conducted in conjunction with Raytheon Polar Services Corporation (RPSC), the current Antarctic support contractor to the National Science Foundation (NSF). The NSF Office of Polar Program (OPP) is responsible for the management of the United States Antarctic Program (USAP) including the South Pole Meteorology Office (SPMO), a key partner in this effort. The NSF supported RPSC efforts related to this project (See Appendix A). Additional tertiary results due to the funding of this project are also outlined.

Results of Historical Data Re-processing

The final results of this project are a monthly CLIMAT message for each month South Pole Station has been in operation – February 1957 to January 2007 when the present real-time generation and GTS distribution of CLIMAT messages commenced from South Pole Station. To develop these basic messages, several pre-message creation activities required completion in advance of generating the final CLIMAT messages. After corrections were made to the original data, reformatting of the data sets and the development of a full climatology were completed before the final CLIMAT messages were created.

CLIREP software acquisition and training

The WMO CLIREP (CLIMAT Report) software, version 1.2 was employed to be the generator of the CLIMAT messages. This software was chosen as it provided both the opportunity to create historical messages and to be utilized in the operational environment. Hence lessons learned and testing done for this project benefited the routine operations at SPMO. Initial testing of CLIREP was conducted at the University of Wisconsin, in consultation with CLIREP developers at the WMO. A full climatology is required for the use of the CLIREP software and was generated jointly between AMRC and SPMO. With a working level understanding of the software and message generation process, CLIMAT message processing commenced at South Pole Station in real-time, while parallel efforts were initiated at the AMRC on the historical generation of South Pole CLIMAT messages.

Corrections to original observations

One of the two most significant portions of this effort was the correction to the digital records and original observations made by the South Pole Meteorology Office. A series of known minor errors were corrected before any CLIMAT messages were generated. An additional level of quality control was accomplished at the AMRC when the data was reformatted for the CLIREP software processing.

Data reformatting

The most significant effort at the AMRC was the reformatting of data to meet the input standards of the CLIREP software. Throughout South Pole Station's observing history, a variety of observing time steps were discovered in the data (e.g. 1 hourly, 3 hourly, 6 hourly, etc.). This required constant vigilance to monitor

the changes in the time spacing between observations throughout a month of data that was being processed. Choices had to be made to use the lowest common number of observing time periods that would allow the CLIREP software to generate a successful CLIMAT message, and provide the best available data. Some choices also had to be made to offer the most meteorological variables toward the CLIMAT message, as some variables were measured at different time steps (such as visibility in some cases would be measured every 6 hours, while temperature and wind would be measured every 3 hours). The maximum time step used was 6 hours.

In addition, the data were not standardized as far as units or observation time. Some observation times were based on Local Standard Time, and corrections were made to standardize the time to UTC. Units for temperature were in both Fahrenheit and Celsius, and wind speed was given in both knots and miles per hour. These data were converted to Celsius for temperature and knots for wind speed. The visibility was given in miles for many of the years. These data were converted to kilometers to correspond to the coding table in the WMO Manual on Codes. A joint decision by South Pole and AMRC led to the use of only three visibility designations – 97 for visibilities greater than or equal to 1000 meters, 93 for visibilities less than 1000 meters and greater or equal to 100 meters, and 91 for visibilities less than 100 meters.

Processing

One critical issue addressed as a part of this project was the use of as much observational data as possible. This allows for average temperatures to be based off of 6 hourly, 3 hourly or even 1 hourly observational datasets, rather than the historic practice of using only the minimum and maximum temperature to find the average. This practice has been carried over to the local climate data (LCD) summaries as well.

A sample result of the processing in the CLIREP software is shown in figure 1. As CLIMAT messages have been generated as a part of this project, two partial collections were provided on CD-ROM to Dr. Thomas Peterson, National Climatic Data Center (NCDC)/National Oceanic and Atmospheric Administration (NOAA); Dr. Howard Diamond, World Data Center for Meteorology; and Dr. Phil Jones, and Climate Research Unit – University of East Anglia. The final South Pole Station CLIMAT collection has been provided to the above parties and has been made available via AMRC file transfer protocol (FTP) site (See Appendix B) and soon via the web.

```
CSAA01 KWBC 262114  
CLIMAT 01990 89009  
111 16899 31276039 412591291 8010100 9313131  
333 23131 63131 73131 8020000 9001031  
444 0119905 1135029 2118004 3135829 5422054 =  
NNNN
```

Figure 1. Sample CLIMAT message from South Pole for January 1990.

Data checking

Once the CLIMAT messages are created, the messages were checked for errors by comparing the generated maximum, minimum and mean values with the original monthly data.

Tertiary results

Two important tertiary results have taken place that can be attributed to the funding of this effort: The initiation of McMurdo CLIMAT message generation in real-time and the correction of South Pole Local Climate Data (LCD) summaries. Prior to this study, errors in the South Pole record were known but had not yet been corrected. This project afforded the opportunity to have these errors corrected. The routine generation of CLIMAT messages from South Pole and McMurdo Station are a recent development, and are now standard operating procedures for both stations.

An additional tertiary result was a first ever effort for the South Pole, and perhaps a first for any station in the Antarctic – a detailed comparison study of the new meteorological instrument suite compared to a prior instrumentation suite. This effort aims to begin a tradition of having studies undertaken with any instrument suite change to characterize the differences between the old and new systems.

One important tertiary result is the recognition and collection of metadata regarding South Pole meteorological observations. Although already a goal in AMRC existing efforts, thanks to the support of the SPMO, a collection of metadata was created regarding changes that were made during the CLIMAT message processing effort. Developments and issues in observations made at both the surface and with the upper air systems are included. While the results of this effort are perhaps not at a level of detail as desired by data centers and data users, it offers what critical information is available. This information is available via the AMRC web and FTP sites, and has been provided to NCDC. Efforts to continue this documentation will be encouraged.

Ongoing CLIMAT and CLIMAT TEMP Message Status in the USAP

One of the outcomes seeded from this effort was the initiation of routine CLIMAT message generation by South Pole Station, and more recently by McMurdo Station. Both stations, prior to this effort did not routinely create or file CLIMAT messages on the GTS. On a related note, Palmer Station, the third and remaining permanent US station in the Antarctic does have surface CLIMAT messages created on its behalf by the British Antarctic Survey. This effort began approximately Feb 2008 and continues today.

The installation of new radiosonde systems at South Pole and McMurdo have enabled both stations to return to the submission of CLIMAT TEMP messages to the GTS in real-time, starting in approximately 2005 to the present.

Summary and Future Efforts

This effort has resulted in meeting the key goals identified. CLIMAT messages for Amundsen-Scott South Pole Station have been created from 1957 to present. The local climate data (LCD) have been corrected and recomputed using the average of temperatures values from the observations and not using the minimum and maximum temperatures. The resulting CLIMAT messages have been made available to World Data Center for Meteorology, NCDC, The University of East Anglia Climate Research Unit, as well as via AMRC data servers (See Appendix B).

This effort does define other areas that should be worked on as well, including the historical generation of CLIMAT messages from both McMurdo Station and Palmer Station. These efforts are currently not tasked to anyone, nor is there funding at this time. This effort could be extended to other historic locations where the USAP has had manned stations, including Byrd Station, Siple Station, Ellsworth Station, Cape Hallett, etc. In addition, efforts of this nature could be extended to other surface observing systems in the Antarctic, including automatic weather stations (AWS). While some efforts are underway for real-time CLIMAT message generation from a portion of the network, historical CLIMAT message generation, and a more complete real-time CLIMAT message generation are beyond the scope of the currently funded US Antarctic Automatic Weather Station program.

The historical generation of CLIMAT TEMP messages from the current and historic USAP stations in the Antarctic, which is an unfunded activity, appears to be a low priority, or perhaps even a no longer desired ambition, as the WMO is currently considering the elimination of the CLIMAT TEMP message. Discussion of this topic depends on the future of CLIMAT TEMP messages within the WMO.

Acknowledgements

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Appendix A: Supplemental Document

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ARLINGTON, VIRGINIA 22230



OFFICE OF POLAR PROGRAMS

August 12, 2005

Mr. Howard Diamond
U.S. GCOS Program Manager
National Oceanic and Atmospheric Administration
National Climate Data Center
1335 East-West HWY, Room 7214
Silver Spring, MD 20910-3283

Dear Mr. Diamond:

This letter is in response to your letter of May 16, 2005 to Mr. Al Sutherland of my staff regarding the potential for having South Pole Station, McMurdo Station and Palmer Station begin to submit CLIMAT format monthly climate summary messages to the Global Telecommunications System (GTS) on a routine basis. I support the initiatives that you propose.

The phase in of each station will be staged over the next two to three years, as there are some preparations that are needed to be completed in advance before routine submission of the CLIMAT messages are possible. In addition, since Palmer Station has no on-site meteorologist the message submission will have to be submitted automatically and this may cause some unforeseen difficulties that could preclude that one station from submitting the messages.

South Pole will be first at creating and submitting the CLIMAT messages to the GTS. That submittal is expected to be initiated next year. CLIMAT messages at McMurdo Station are expected in the following year. The viability of automating Palmer Station messages will then be reviewed and, if feasible, implemented.

I believe that the proposed climatological datasets will be of value to researchers and forecasters and am looking forward to this cooperative effort between the United States Antarctic Program and the U.S. Global Climate Observing System.

Sincerely,

A handwritten signature in black ink, appearing to read "Karl A. Erb".

Karl A. Erb
Director

Appendix B: On-line Resources

South Pole CLIMAT messages (1957 to Present):

<http://amrc.ssec.wisc.edu/pub/southpole/climat/surface/>

South Pole CLIMAT TEMP messages (2005 to Present):

http://amrc.ssec.wisc.edu/pub/southpole/climat/upper_air/

McMurdo CLIMAT messages (2009 to Present):

<http://amrc.ssec.wisc.edu/pub/mcmurdo/climat/surface/>

McMurdo CLIMAT TEMP messages (April 2005 to Present):

http://amrc.ssec.wisc.edu/pub/mcmurdo/climat/upper_air/

Palmer Station CLIMAT messages (2008 to Present):

<http://amrc.ssec.wisc.edu/pub/palmer/climat/surface/>