Historical Arctic Rawinsonde Archive, Version 1

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

Serreze, M. C., J. D. Kahl, and S. Shiotani. 1997. *Historical Arctic Rawinsonde Archive, Version 1.* [Indicate subset used]. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. https://doi.org/10.5067/FQZA3330CVPO. [Date Accessed].

National Snow and Ice Data Center

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1 DETAILED DATA DESCRIPTION

This document describes the Historical Arctic Rawinsonde Archive, compiled by Principal Investigators J. Kahl, M. Serreze, and R. Schnell, under support from the National Oceanic and Atmospheric Administration's Climate and Global Change Program (Grant NA85RAHO5066), the Electric Power Research Institute (Grant RP2333-07), the National Science Foundation (Grant DPP-8822472), and the NSIDC Distributed Active Archive Center. The archive comprises millions of vertical soundings of temperature, pressure, humidity, and wind, representing all available rawinsonde ascents from Arctic land stations poleward of 65 degrees North, from the beginning of record through mid-1996. For most stations, the record begins in 1958, but a few begin as early as 1947 or 1948. The archive is presented in ASCII format that may be easily processed by most types of computers. Coverage is relatively uniform, except for the interior of Greenland. Typically, 20 to 40 levels are available in each sounding. HARA documentation is provided in the data archive as well as software (Fortran and C) for retrieval of sounding data subsets. The original soundings were obtained from the National Center for Atmospheric Research (NCAR), Boulder, Colorado and the National Climatic Data Center (NCDC) of NOAA in Asheville, North Carolina.

1.1 Objectives/Purpose

The archive is useful for meteorological and climatological research, applying to polar studies and investigations of global climate change. The archive is designed to facilitate climate analyses requiring sounding time series at multiple stations throughout the arctic.

1.2 Format

The data fields are in ASCII text format. Each sounding in the archive consists of a header record, followed by a number of data records. Typically 20 to 40 levels are available in each sounding. Appendix 2 includes an example of a sounding. The database is available via HTTPS at https://noaadata.apps.nsidc.org/nsidc-0008/.

We recognize that users usually desire a database of this type to be sorted in one of two ways:

1. Synoptic-ordered: One time period -- all stations; followed by the next time period -- all stations, etc.
2. Station-ordered: A complete time series for station #1; followed by a complete time series for station #2, etc.

As a compromise, the following file structure is used: One file contains a one-year time series of soundings for one station. Users requiring station-ordered data can simply append individual one-year files to obtain a station history of a length that is suitable to their needs. Users requiring synoptic-ordered data may extract files for several stations corresponding to a particular year, then extract from them the necessary dates and times.

The variables and formats of the individual soundings are as follows:

1.2.1   Header Record

1. STATION

World Meteorological Organization (WMO) station identification number. All stations are ascribed a WMO number, with the exception of "SHIP M" (Figure 1; Appendix 1). This was arbitrarily assigned a station code of 80000.

2. LATITUDE

Latitude of the station in degrees and hundredths of a degree (N).

3. LONGITUDE

Longitude from 0 to 360 degrees, in degrees and hundredths of a degree, measured counterclockwise from the Greenwich Meridian as viewed from the pole.

4. YEAR

Year of sounding.

5. MONTH

Month of sounding.

6. DAY

Day of sounding.

7. HOUR

Hour of sounding. This is usually 0000 GMT, 0600 GMT, 1200 GMT, or 1800 GMT. Prior to 1952, however, soundings reported at 0800 GMT and 1400 GMT.

8.-10. PROC1, PROC2, PROC3

Special processing codes. These are only available for sounding type ID=1. They provide information on special processing, and whether soundings were manually or automatically processed (see Appendix 4). For all other sounding types (ID=2, 3, 4 or 5), PROC1, PROC2, and PROC3 are assigned blanks. Pages 6 and 7 of Office Note 29 (Mulder (1977)), which describe these codes for the ID=1 data, are given in Appendix 5.

11. REP

Report type. This will always be assigned the value of 011 or 0. It denotes that the sounding was taken at a fixed land station.

12. ELEVATION

Station elevation in meters above mean sea level. Missing values are 99999.

13. INSTRUMENT

Instrument type used in sounding (e.g., Vaisala, Metox). This information is only available for ID=1 soundings. Page 9 of Office Note 29 (Mulder (1977)), describing the instruments for ID=1 soundings, is included in

Appendix 5. For all other sounding types, this variable is assigned a value of 0.

14. NLEVELS

The number of levels reported in the sounding; i.e., the number of data records following the header record.

15. ID

An identification code indicating the sounding's original source. Values correspond to the listing in the 3.1 Data Acquisition Methods section. These identification values are important because the quality codes vary with each sounding type (Appendix 4).

The FORTRAN format of the header record (15 variables) is as follows: FORMAT (A5, 2I5, 1X, 4I2, 1X, 3A1, I3, I5, I2, 1X, I3, 1X, I1).

1.2.2 Data Records

The variables are as follows:

1. PRESSURE

Pressure in tenths of millibars. Data from most stations are rounded to the nearest 1 mb. Missing values are 99999.

2. GEOPOTENTIAL HEIGHT

Geopotential height of the pressure level in whole meters. Missing values are 99999.

3. TEMPERATURE

Temperature in tenths of a degree (degrees C). Missing values are 9999.

4. DEWPOINT DEPRESSION

Dewpoint depression in tenths of a degree (degrees C). Missing values are 999.

5. WIND DIRECTION

Wind direction, 0 to 360 degrees, measured clockwise from north (e.g., 90 degrees is east). Missing values are 999.

6. WIND SPEED

Wind speed in whole meters per second. Missing values are 999.

7.-15. QG, QG1, QT, QT1, QD, QD1, QW, QW1, QP

Quality control flags for geopotential height (QG, QG1), temperature (QT, QT1), dewpoint depression (QD, QD1), winds (QW, QW1), and pressure (QP). The values of QG, QT, QD, QW, and QP depend on the sources of the sounding as identified by the value of ID (see Appendix 4). These vary considerably among the sources of the original soundings, and on whether the original

processing was accomplished automatically (via computer) or manually (designated by "auto" or "man" Appendix 4). QG1, QT1, QD1 and QW1 are additional quality code flags for geopotential height, temperature, dewpoint depression, and winds, based on our error-checking procedure, described earlier. Values are either 'P' (passed limits check) or 'F' (failed limits check). No limits check quality flag is given for pressure, as we used pressure as the test variable in the limits check. *(These additional codes are not available on Volume 5. Please see Revision below.)

16. LEVCK

A quality control flag set to 'P' if no errors were detected in the level for any variable, based on the limits check described above. If any errors were detected in the limits check, it is set to 'F'. *(This variable is not available on Volume 5. Please see Revision below.)

17. LTYPE

Code for level type (surface, significant, or mandatory). Only relevant for soundings of type ID=4 (see Appendix 4). For sounding types other than ID=4, the value is assigned a blank. This variable is not available on Volume 5. Please see Revision below.

18. LQUAL

Flag for quality of level. Only relevant for soundings of type ID=4 (see Appendix 4). This variable is not available on Volume 5. Please see Revision below.

The FORTRAN format of the data records (18 variables) are as follows: FORMAT (2(I5, 1X), I4, 1X, 3(I3, 1X), 2A1, 1X, 2A1, 1X, 2A1, 1X, 2A1, 1X, 4A1).

1.2.3   Revision

Experience has shown that the additional quality codes have limited value to the user. Starting with Volume 5, these codes are no longer provided. The columns corresponding to these codes simply appear as blanks. FORTRAN code that performs more comprehensive error-checking is available from M. Serreze.

1.3 Sample Data Record

(THULE, GREENLAND: ID=4)

```
04202 765229125 59 1 1 0      11    63 0   23 4
10040     31 -329  94   90    3 9P 9P 9P 9P 9P00
10000     62 -308  95   90    3 9P 9P 9P 9P 9P10
 9500    430 -277  79   70    3 9P 9P 9P 9P 9P90
 9000    819 -283  66  105    4 9P 9P 9P 9P 9P90
 8500   1227 -287  83  142    5 9P 9P 9P 9P 9P10
 8000   1660 -301  93  182    5 9P 9P 9P 9P 9P90
 7500   2130 -323  94  225    7 9P 9P 9P 9P 9P90
 7000   2602 -346  97  250    7 9P 9P 9P 9P 9P10
 6500   3130 -370 101  260   11 9P 9P 9P 9P 9P90
 6000   3668 -396 101  260   12 9P 9P 9P 9P 9P90
 5500   4260 -416 999  260   16 9P 9P 8  9P 9P90
 5000   4903 -437 999  270   18 9P 9P 8  9P 9P10
 4500   5600 -488 999  270   20 9P 9P 8  9P 9P90
 4000   6371 -541 999  270   24 9P 9P 8  9P 9P10
 3500   7219 -589 999  270   21 9P 9P 8  9P 9P90
 3000   8180 -620 999  270   18 9P 9P 8  9P 9P10
 2500   9312 -603 999  270   14 9P 9P 8  9P 9P10
 2000  10712 -588 999  260   14 9P 9P 8  9P 9P10
 1750  11545 -620 999  260   15 9P 9P 8  9P 9P90
 1500  12499 -616 999  260   15 9P 9P 8  9P 9P10
 1250  13624 -631 999  260   14 9P 9P 8  9P 9P90
 1000  14984 -670 999  260   10 9P 9P 8  9P 9P10
  800  16321 -698 999  260   10 9P 9P 8  9P 9P90
```

1.4 Directory Structure

The directory structure design of the Historical Arctic Rawinsonde Archive (HARA) provides a logical path for locating the rawinsonde data. The data are stored in directories organized by year and World Meteorological Organization (WMO) station identification number. There is a separate DOCUMENT directory containing information about the HARA data and data formats, a SOFTWARE directory containing both C and FORTRAN source code that can be compiled and executed to retrieve a subset of the sounding data from a HARA directory, and a CATALOG directory containing a catalog of the HARA data available to date.

```
                          HARA_VOLUME_#
                               |
          ------------------------------------------------------------
                 |                   |              |             |
               DATA              DOCUMENT        SOFTWARE       CATALOG
                 |                   |              |             |
                 |               HARA.TOC                     HARA.CAT
        ---------------------...  INTRO.DOC
                 |           |    SOURCE.DOC
              1948        1949 (Years...) PROCESS.DOC
                 |           |    FORMATS.DOC
            70026.48    70026.49  BIBLIO.DOC
            71072.48    71072.49  APPENDIX.DOC
            71074.48    71074.49  SOFTWARE.DOC
                .           .     CD_ROM.DOC
                .           .     HARA.CAT
                .           .
                                         ------------------------------
                                              |                    |
                                             DOS                  UNIX
                                              |                    |
                                        ---------------      --------------
                                          |          |         |         |
                                       FORTRAN       C      FORTRAN       C
                                          |          |         |         |
                                       (FORTRAN    ( C      (FORTRAN    ( C
                                        source    source     source    source
                                        code)     code)      code)     code)
```
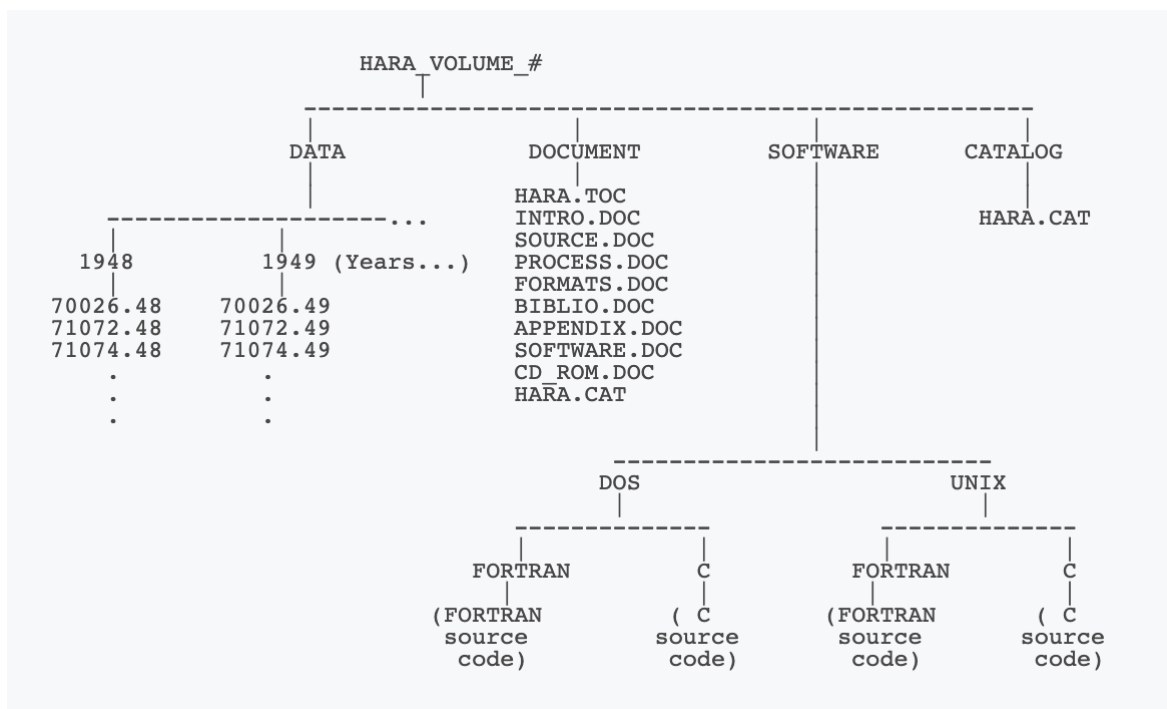
1.5 Spatial and Temporal Coverage

1.5.1 Spatial Coverage

North polar regions:

- Minimum latitude: 65N
- Maximum latitude: 90N
- Minimum longitude: 180W
- Maximum longitude: 180E

1.5.2   Spatial Coverage Map
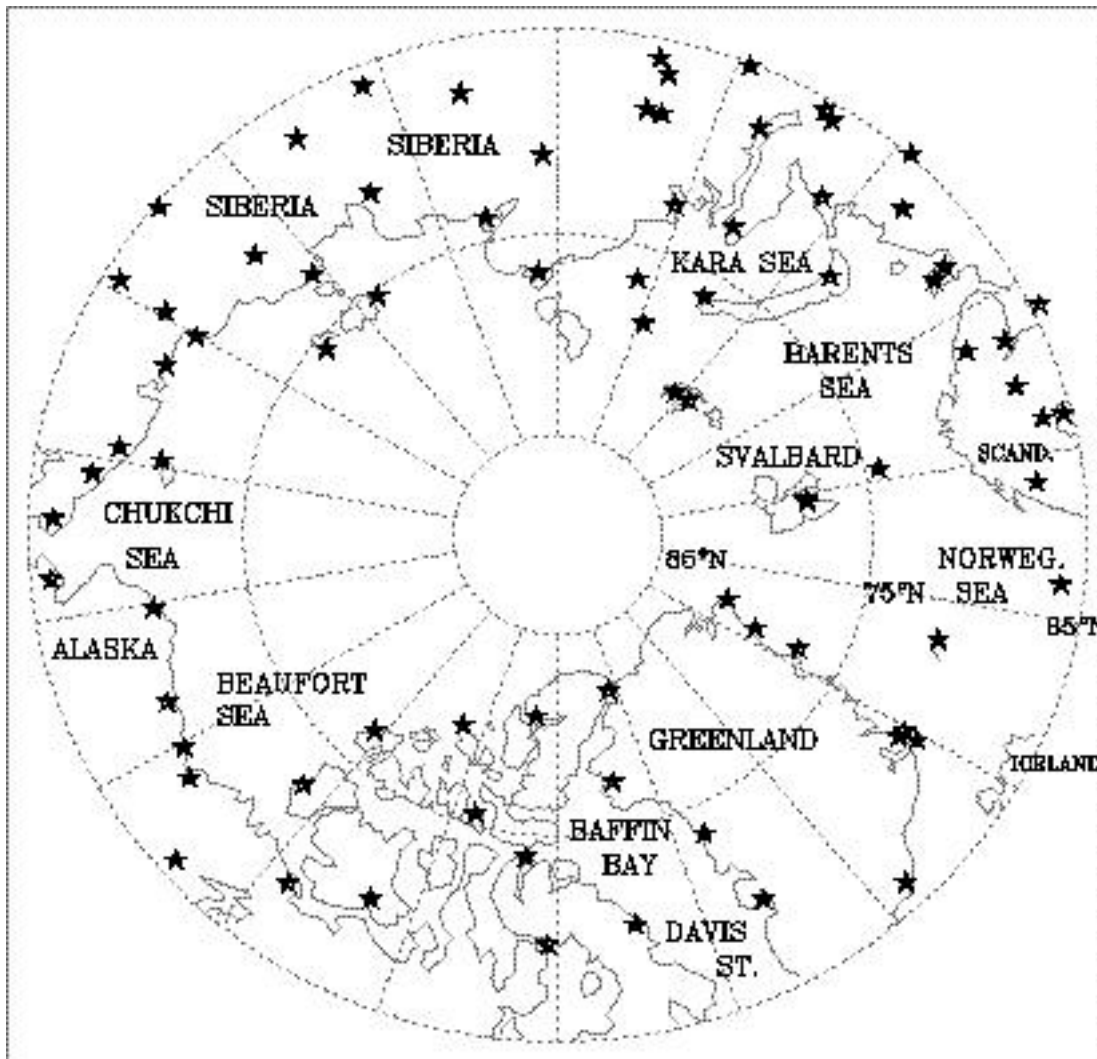
Figure 1. Station Locations

1.5.3   Temporal Coverage

The archive extends from the beginning of record through mid-1996. For most stations, the record begins in 1958; a few begin in 1947 or 1948.

1.6 Application of the Data Set

Soundings are typically used in synoptic meteorology and for climatology.

2   SOFTWARE AND TOOLS

This document describes the access software that is in the directory for the Historical Arctic Rawinsonde Archive (HARA). The purpose of this software is to familiarize the user with the

structure of the data and to provide examples of software routines that can be used to subset and extract the data residing on the HARA directory. Two versions of the access software are being supplied in the HARA directory; one was written using the C programming language, the other using FORTRAN. Where appropriate, the differences between the two versions will be noted. This software can be compiled on either a UNIX or Microsoft Disk Operating System (MS-DOS) platform. The software was compiled and tested on an IBM PC using both Microsoft (MS) C and FORTRAN compilers. Please see the sections below for further details:

2.1.1   Compiling the Source Code

Copy Source and Ancillary Files to Working Directory

The first step in preparing to compile the HARA CD-ROM access software is to copy the source files from the CD-ROM to the directory where the executable is to be built. If the mount point for the HARA CD-ROM is "/CDROM" and the working directory is "/usr/people/mydir," then issue the following command replacing <PLATFORM> with UNIX or DOS and <language> with either C or FORTRAN.

TRANSFERRING FILES TO A UNIX ENVIRONMENT

cp /CDROM/software/<PLATFORM>/<language>/* /usr/people/mydir

Files required to compile and execute the C version of the software include:

- global.c
- access.c
- set0.c
- set1.c
- set2.c
- myheader.h
- makefileC
- stationwmo.dat
- infile.dat

Files required to compile and execute the FORTRAN version of the software include:

- access.f
- set0.f
- set1.f
- set2.f
- makefileFOR
- stationwmo.dat
- infile.dat

NOTE: Files copied from the CD-ROM to a local UNIX disk retain the 'read-only' attribute of the files residing on the CD-ROM. In order to modify or edit these files the attributes have to be changed to permit 'write' access. To change the file attributes, type in the following UNIX command:

#chmod u+w *

TRANSFERRING FILES TO AN MS-DOS ENVIRONMENT

copy l:\software\<PLATFORM>\<language>* d:\mydir*

Files required to compile and execute the C version of the software include:

- global.c
- access.c
- set0.c
- set1.c
- set2.c
- myheader.h
- stationwmo.dat
- infile.dat

Files required to compile and execute the FORTRAN version of the software include:

- access.f
- set0.f
- set1.f
- set2.f
- stationwmo.dat
- infile.dat

Verify Mount Point for CD-ROM

UNIX ENVIRONMENT

After the source code files have been copied to a working directory verify that the "fpath" variable is defined correctly in the source file set1.c (set1.f for FORTRAN). This variable defines the path to the rawinsonde data located on the CD-ROM. The "openr()" function located in the set1 module was coded with a default value for "fpath." If the mount point is defined other than "/CDROM" then the value of "fpath" must be changed in the set1 source file.

In the C source file set1.c, the line

        fpath[] = "/CDROM/data/19"

defines the value of the "fpath" variable.

In the FORTRAN source file, set1.f, the line

        fpath = '/CDROM/data/19'//ext//"/"//idst(icnt)//'.'//ext

defines the value of the "fpath" variable.

If for some reason the mount point for the HARA CD-ROM cannot be defined as "/CDROM," then the set1 source file must be edited, replacing the text string "/CDROM" on the line defining the "path" variable with the text string defining the mount point for the HARA CD-ROM.

MS-DOS ENVIRONMENT

After the source code files have been copied to a working directory verify that the "fpath" variable is defined correctly in the source file set1.c (set1.f for FORTRAN). This variable defines the path to the rawinsonde data located on the CD-ROM. The "openr()" function located in the set1 module was coded with a default value for "fpath." If the mount point is defined other than "I:\" then the value of "fpath" must be changed in the set1 source file.

In the C source file set1.c, the line

        fpath[] = "I:\\data\\19"

defines the value of the "fpath" variable.

In the FORTRAN source file, set1.f, the line

        fpath = 'I:\data\19'//ext//"\"//idst(icnt)//'.'//ext

defines the value of the "fpath" variable.

If for some reason the mount point for the HARA CD-ROM cannot be defined as "I:\", then the set1 source file must be edited, replacing the text string "I:\" on the line defining the "fpath" variable with the text string defining the mount point for the HARA CD-ROM.

Create the Executable File

UNIX ENVIRONMENT

A makefile is included with the source files that were copied into the working directory (refer to 1.1 above). Rename the appropriate makefile (MakefileC or MakefileFOR) to "makefile." By issuing the

command "make" at the shell prompt the source files will be compiled and linked into an executable file named "access."

MS-DOS ENVIRONMENT

There are multiple files containing subroutines that must be compiled and linked together. Refer to your compiler manual for exact instructions on how to accomplish this. The main program is named access.<c or for> with subroutines in files set0, set1, set2 ,(and global.c for C only).

The following command couples the required C-source modules using the MS C compiler and links the resulting object files creating the executable file, "ACCESS.EXE."

     D:\>CL ACCESS.C SET0.C SET1.C SET2.C GLOBAL.C

2.1.2   Running the Program

Once the executable file has been created and the CD-ROM path has been verified the program should be ready to execute. There are two different modes in which the access program can be implemented. One is the interactive mode which requires the user to respond to a series of questions that request attributes, such as spatial and temporal ranges, to define the subset of data to be extracted from the CD-ROM. The other mode requires the user to prepare a text file containing the attributes of the subset to be extracted from the CD-ROM. An example of a file containing parameters that define a subset of HARA data to be transferred from CD-ROM to a working directory is included with the distribution (Section 2.2).

Interactive Mode

The access program should be run interactively until the user becomes familiar with the structure of the data set and the format of the output the program generates. The user is required to type in the responses to each query made by the access program before the program begins transferring data from the CD-ROM. The following table describes the parameters required as input to the access program.

```
Parameter          Range
--------------- ----------
WMO Station ID     00000-99999
Latitude           0-90
Longitude          0-360
Year               48 - 69   (Volume 1)
                   70 - 79   (Volume 2)
                   80 - 87   (Volume 3)
Month              1-12
Hour               0-24   (GMT)
Pressure Level     0-1200 (mb)
```

Note that the latitude and longitude of a station can vary slightly due to irregular station location changes.

EXECUTING THE ACCESS PROGRAM IN THE INTERACTIVE MODE

To run either the C or FORTRAN version of the access program in the interactive mode simply type "access" at the shell prompt.

Example:

    #access

Non-interactive Mode

This mode provides quicker and easier execution of the access program. In order to use this mode the user must prepare a file with all of the parameters that define the subset of the data on CD-ROM that is to be extracted. Samples of the parameter file (infile.dat) are included with the distribution. One of the sample files for the non-interactive mode is to be used with the FORTRAN version of the access program, the other with the C version.

```
FORTRAN VERSION OF INFILE.DAT:

2              !interaction mode (1 for batch 2 for interactive)
1              !request specification (1 for WMO 2 for lat-long)
72948          !station name(1 value) or lat-long range(4 values)
48 69          !year range (2 values)
1 12           !month range(2 values)
0 24           !hour range(2 values)
2              !mandatory level flag (1 for mandatory pressure levels else 2)
0 1200         !pressure range (2 values)
1              !output file flag (1 for multiple files 0 for 1 file)


C VERSION OF INFILE.DAT:

2              !request specification (1 for WMO 2 for lat-long)
0 90 0 360     !station name(1 value) or lat-long range(4 values)
48 69          !year range (2 values)
1 12           !month range(2 values)
0 24           !hour range(2 values)
2              !mandatory level flag (1 for mandatory pressure levels else 2)
0 1200         !pressure range (2 values)
```

To execute the FORTRAN version of the access program in the non-interactive mode simply type "access" at the shell prompt. Observe that the parameter file must have the mode flag set to "1" for the access program to process the extraction request in the non-interactive mode.

To process the extraction request in the non-interactive mode using the C version of the access program enter "access" followed by the "-i" option followed by the name of the parameter filename at the shell prompt.

Example:

    #access -i infile.dat

2.1.3 Format Description of the Data Extracted from the HARA CD-ROM

The data extracted from the HARA CD-ROM retains the same format as the data residing on the CD-ROM. The information for each sounding is comprised of a header and a series of measurements, each measurement taken at a particular pressure level. The format for each sounding can be described by the following FORTRAN format statements.

The format for the header record is:

FORMAT(A5,2I5,1X,4I2,1X,A3,I3,I5,I2,1X,I3,1X,I1)

while the format for each measurement in the sounding is:

FORMAT(2(a5,1X),14,1X,3(13,1X),4(A1,A1,1X),2A1).

A sample of the structure of a sounding follows:

```
Header:
      72948 702023530 69 5 2 0        0     5 0     9 5

Sounding:
      99999 99999 9999 999 999 999 9   9   9   9   9P
       8500  1387     4    4 160    12 AP AP AP DP AP
       7000  2929   -55    3 225     6 DP AP AP DP AP
       5000  5489  -213   40 185    13 DP AP AP DP AP
        500 99999  -549  999 999 999 9   AP 9   9   9P
        440 99999  -507  999 999 999 9   9P 9   9   9P
        320 99999  -531  999 999 999 9   9P 9   9   9P
        300 99999  -523  999 999 999 9   CP 9   9   OP
        230 99999  -503  999 999 999 9   9P 9   9   9P
```

For a complete description of the variables that correspond to HARA data formats see the 1.2 Format section.

2.1.4 Description of Files Produced Using the HARA CD-ROM Access Software

The HARA CD-ROM access program produces the file "my_list.dat" each time the program executes. The file contains a list of the stations for which data are being extracted from the CDROM. This file is overwritten each time the access program is executed.

The default for presenting the data extracted from the HARA CD-ROM is to transfer the data into the file "outfile.dat" in the working directory. This file is overwritten each time the FORTRAN version

of the access program is executed, whereas data are appended to this file each time the C version is executed. It is recommended that the file "outfile.dat" be renamed prior to or after each extraction process.

Besides the default for presenting the data extracted from the HARA CD-ROM, the user can specify the data be stored in multiple files. The access program partitions the extracted data into files containing only those soundings recorded for a single year that are associated with an individual station. For example, suppose the request was for an area that included five stations and the user is interested in retrieving only those soundings occurring between January and March for the years 1970 through 1974. Using the option to create multiple files, the results would be stored in 25 separate files (5 stations times 5 years = 25). The naming convention for files created using the multiple file option is to concatenate the WMO station identification number with the last two digits of the year and to append ".dat" as the file extension (e.g., 7002687.dat would contain sounding data recorded during 1987 at the station with the WMO identifier 70026).

To produce multiple files using the C version of the access program specify the "-o" option:

    #access -i infile.dat -o

To produce multiple files using the FORTRAN version of the access program in the non-interactive mode set the parameter on the last line in the parameter file to 1 (section 2.3).

Care should be taken to ensure that there is sufficient disk space to accommodate the data extracted from the HARA CD-ROM.

2.1.5   Listing of Arctic WMO Stations

A listing of the stations can be found in the stationwmo.dat file. An example of the contents of stationwmo.dat is listed below.

```
   # WMO     LAT   LONG   YR ID STATION NAME

 1 71072   7623 24068 48   3 MOULD BAY, NT          CANADA
 2 71074   7868 25647 48   3 ISACHSEN, NT           CANADA
 3 71917   8000 27407 48   3 EUREKA, NT             CANADA
 4 71918   7303 27485 48   3 ARCTIC BAY, NT         CANADA
 5 71924   7472 26504 48   3 RESOLUTE BAY, NT       CANADA
 6 71938   6782 24487 48   3 COPPERMINE, NT         CANADA
 7 70026   7130 20322 48   4 BARROW, AK             ALASKA

 1 71072   7623 24068 49   3 MOULD BAY, NT          CANADA
 2 71074   7868 25647 49   3 ISACHSEN, NT           CANADA
 3 71917   8000 27407 49   3 EUREKA, NT             CANADA
 4 71924   7472 26504 49   3 RESOLUTE BAY, NT       CANADA
 5 71938   6782 24487 49   3 COPPERMINE, NT         CANADA
 6 70026   7130 20322 49   4 BARROW, AK             ALASKA
```

The column labeled # represents the number of the file associated with a single year and is used as a counter to track the number of stations contributing sounding data for a particular year. For example, the HARA disk contains rawinsondes measured from seven (7) stations during 1948.

3   DATA ACQUISITION AND PROCESSING

3.1 Data Acquisition Methods

Data represent one-dimensional vertical soundings taken at land stations north of 65 degrees latitude, each including measurements of pressure, temperature, winds, and humidity at various atmospheric levels. The archive consists of all available Arctic rawinsonde data from fixed-position (mostly land) stations north of 65 degrees N. Data from drifting ice islands, ships, and aircraft dropsondes have been assembled as a separate archive.

Soundings data were obtained from the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, and the National Climatic Data Center (NCDC) in Asheville, North Carolina. Five original archives were used to compile the database. These sources are assigned identification codes (ID) 1 through 5.

- (ID=1) Asian Arctic, 1976-87; all stations subsequent to 1987: The original data, obtained from NCAR, is described by Mulder (1977). For the period 1976-87, ID=1 soundings represent a subset of the NCAR archive for Soviet and Scandinavian stations and "Ship M", a moored ship in the Norwegian Sea.
- (ID=2) Victor Starr, 1958-63: This was the original archive compiled by Professor Victor Starr of the Massachusetts Institute of Technology in the late 1960s. It contains soundings from 75 stations throughout the Arctic. Up to 27 fixed pressure levels (including the surface) are reported. These data were obtained from NCAR.

- (ID=3) Canadian Stations: This set contains soundings from Canadian Arctic stations. The record for some stations begins as early as 1948, but most stations started reporting regularly in the early to mid 1950s. These data were obtained from NCAR.
- (ID=4) Alaska and Thule, Greenland: The record begins in 1947 for Barrow, Alaska; in 1952 for Barter Island, Alaska; and in 1952 for Thule, Greenland. These data were obtained from NCDC.
- (ID=5) Asian Arctic, 1962-75: Similar to ID=1 but in a slightly different original format and containing fewer stations. The original data, obtained from NCAR, is described by Nielon (1964).

A considerable amount of overlap exists between original data sources. We have made an effort to choose the best available data from each original archive, based on error analyses and completeness of the soundings.

Appendix 1 lists all stations for which soundings are available. In the appendix, the year column indicates that sounding data are available for at least part of a given year. Millions of soundings are available, covering at least a 30-year period for most stations.

The station locations are shown in Figure 1. Note that the coverage is relatively uniform, with the exception of the interior of Greenland. Depending on the station, soundings are available from one to four times daily at 0000 GMT, 0600 GMT, 1200 GMT and 1800 GMT. Most often, reports are available at 0000 GMT and 1200 GMT. Prior to 1952, reporting times were 0800 GMT and 1400 GMT.

3.2 Instrument Description

The instrumentation used to collect these data were Rawinsondes. Rawinsondes are balloon-borne instruments. The balloons are made of natural or synthetic rubber, which expand as they ascend, and eventually burst. For more information, please see the Historical Arctic Rawinsonde Archive (HARA) Radiosonde Systems Technical Reference document. See also Elliot and Gaffen (1991) and Garand et al. (1992).

Note: The instrument type used in sounding (whether Vaisala, Metox, etc.) is only available for ID=1 soundings. See Appendix 5: Additional Quality Codes for special processing procedures.

3.3 Sort/Merge Routines

All original data except those corresponding to ID=1 and ID=5 (Asian data through 1987 and all data from 1988, onward) were received already sorted by decreasing pressure. ID=1 and ID=5, however, were not sorted by decreasing pressure and, therefore, required some special processing. Each original sounding was sorted into five categories:

1. temperature, dewpoint depression, geopotential height and winds at mandatory pressure levels;
2. temperature, dewpoint depression and winds at variable pressure levels;
3. winds at variable pressure levels;
4. winds at variable geopotential heights (this category was generally reported infrequently); and
5. tropopause data.

Pressure levels are often repeated in this format. For example, while the first level in categories 2, 3, and 4 is always the surface, each category contains different information. At other times, what was reported as a mandatory level was also repeated as a significant level. Typically, two to four repeat levels were found for each sounding. To make these data compatible with the soundings from other sources, each sounding was passed through a sort/merge program.

The sort/merge program worked as follows: Each sounding was first sorted by decreasing pressure, then by increasing geopotential height. Repeat levels were flagged, based on identical values of pressure or geopotential height. The most complete record possible for each repeat level was then assembled. The first occurrence of any repeat value and its associated quality flag was retained (see Appendix 4). A drawback of the technique is that although two levels may be identified as repeats, temperature or wind values associated with repeat levels are sometimes slightly different. Retaining only the first occurrence will occasionally result in retaining a bad value. While in theory, this problem could have been eliminated by also inspecting each quality flag, the large volume of processing made this impractical. Spot checks indicate that this is only a minor problem. An artifact of the technique, however, is that since some of the quality flags indicate whether or not there is agreement between values at repeat levels (but do not indicate which level is correct), any flags retained relevant to between-category checks should be ignored (see Appendix 4).

3.4 Error Checking

Data through 1991 were subjected to additional rudimentary error-checking routines. The design of the error-checking procedure was guided by three considerations:

1. a desire to produce the highest-quality database possible;
2. recognition that the large amount of raw data (106 soundings) prohibit exhaustive error-checking procedures, such as manually inspecting each sounding; and
3. a desire to retain all data values present in the original soundings, thus allowing users to make their own determination of data quality.

The first step involved flagging obvious errors, such as negative wind speeds, negative geopotential heights, etc. All soundings were then passed through a seasonally adjustable limits check to screen additional errors. No guarantee is made that this routine identifies all errors and it

is recognized that, on occasion, what is flagged as errors may in fact be valid data. As such, all obvious and probable errors are simply flagged, but the original data is retained.

The seasonally adjustable limits check worked as follows: All data from all stations for 1987 were stratified by season into 15 atmospheric layers bounded by pressure levels. Seasons are defined as December through February (winter), March through May (spring), June through August (summer) and September through November (autumn). Since all checks are based on pressure, no check on the pressure values, themselves, have been performed.

Initial frequency histograms of geopotential height, temperature, wind direction and wind speed were compiled for each layer and for each season in 1987. Extreme outliers were eliminated by discarding values more than four standard deviations from the respective means. Since wind speed does not follow a normal distribution, these values were first converted into log wind speed. Means and standard deviations for the remaining data were then recomputed. Using these data as representative sample means and standard deviations of the complete data set, we then flagged any value that was greater than plus or minus four standard deviations from the sample mean for the respective season and layer. The means and standard deviations used in the limits check are given in Appendix 3.

An implicit assumption in the error-checking routine is that the layer mean is representative of the mean for any level within that layer. Since a large number of atmospheric levels are used in the check, this is a tolerable assumption for testing temperature, wind direction and wind speed. It was found to be inappropriate for geopotential height; however, due to the logarithmic decay of pressure with increasing elevation.

To check the geopotential heights, we made use of this logarithmic relationship: Taking the log of pressure at the bottom (P1) and top (P2) of the layer in which the observed pressure (P) fell, a weight W was calculated:

$$W = [LOG(P)-LOG(P2)]/[LOG(P1)-LOG(P2)]. \quad (1)$$

Next, ZL1 and ZH1, respectively, are defined as the lowest and highest allowable geopotential height at the base of the layer, and similarly, ZL2 and ZH2 as the lowest and highest allowed limits of the top of the layer (with limits taken as +/- 4 standard deviations from the mean). We then calculate ZL and ZH, which, by incorporating the weight W, define the limits of allowable geopotential height for the value of P:

$$ZL = W*[ZL1-ZH1] + ZH1 \quad (2)$$

$$ZH = W*[ZL2-ZH2] + ZH2 \quad (3)$$

The allowable value of Z at pressure level P in the sounding is, thus

$$ZL <= Z <= ZH$$

As part of the error-checking routine, the 1000-millibar (mb) mandatory level was deleted if the corresponding geopotential height was less than the reported station elevation. Frequently situations were encountered in which a level was reported (i.e., pressure or geopotential height data were given), but all other variables had missing value codes. These levels were deleted.

Since atmospheric moisture can be highly variable, with considerable uncertainties in cold arctic conditions, the dewpoint depression data were simply screened to flag negative values and any values exceeding an arbitrary high threshold of 35 degrees C. Those wishing to use these data are referred to Elliot and Gaffen (1991), who provide an overview of problems in rawinsonde moisture data.

*Experience has shown that these error checks are of limited value to the user. They have, hence, been dropped for 1992, onward. FORTRAN code providing more comprehensive error checks is available from M. Serreze.

3.5 Notes and Problems

Since each original database was in a different format, some adjustments and changes were required to make all soundings consistent. A number of problems were also noted during processing and as a result of manual spot checks. These are summarized below. Users encountering additional problems are urged to contact the authors of this document. All soundings subsequent to 1987 were obtained from NCAR tapes, which are in the ID=1 format.

Through a processing oversight on the part of M. Serreze, the pressure quality codes (QP) in Volumes 1 through 4 are missing and set to '9'. This problem has been corrected in Volume 5. Soundings in earlier volumes also appear to have some remaining problems related to the sort/merge routines. Again, these have been corrected in Volume 5.

ID=1: (Asian Arctic for 1976-1987; All stations for 1988, onward)

1. Winds were originally in knots and were changed to meters per second.
2. Longitudes were originally reported 0 to 360 degrees clockwise from the Greenwich Meridian. They were converted to 0 to 360 degrees counterclockwise as viewed from the North Pole.
3. If categories 2, 3, and 4 were missing (the data categories for soundings of type ID=1 were discussed in the 3.1 section Data Acquisition Methods section above), the surface report was padded with missing values.

4. The geopotential height of the surface level is not given in categories 2 through 4. The value has been set equal to the station elevation. However, reported station elevations do not always match those listed by WMO.
5. Geopotential heights are usually available only for mandatory levels.
6. If the indicated surface pressure is < 930 mb, the surface report is assumed to be missing.
7. As noted previously, the requirement to merge duplicate levels means that any quality codes referring to agreement/disagreement between duplicate levels reported in different categories should be ignored.

ID=2: (Victor Starr, 1958-63)

Of all the original data, the Victor Starr soundings contained the most frequent errors. As such, we tried to use soundings from other sources whenever possible (i.e., during periods of overlap).

1. Occasional surface reports with a value of 1000 mb should be present in any large sounding archive. Very few are noted in the original data, however. It is suspected that, at some point in time, 1000-mb surface reports were lost due to a processing error.
2. Numerous reported surface pressures from 950 to 960 mb were encountered. In most cases, these must be errors. While such levels will often be flagged as errors on the basis of the geopotential height limits check, many were observed to pass this check.
3. Temperature values were frequently flagged by the limits check algorithm. Surface temperature values in these situations were sometimes above 20 degrees C, with suspiciously high values throughout the profiles.
4. Winds were originally reported in U and V components. They were converted to speed (meters per second) and direction (0-360 degrees).
5. At times, the highest reported level had a geopotential height of 0 m. Temperatures also appear bogus in these cases. These are flagged as errors. The problem seems to only occur when 27 levels (the maximum possible) are reported. This appears to be a problem with the original data, and may have resulted from a bad array size.
6. Errors are particularly common at 1200 GMT. The presence of a systematic error in the original processing is suspected. These soundings should be viewed with caution.

ID=3: (Canadian)

1. The geopotential height of the surface report and the station elevation were supplied in the original sounding. Situations were frequently encountered in which the geopotential height at the surface was lower than the station elevation. Also observed were cases in which the surface geopotential height was greater than the station elevation.
2. Surface pressure reports are sometimes shown as higher than the adjacent level by approximately 0.1 mb. (Only with ID=3 data are surface pressures commonly given to nearest 0.1mb.) However, the adjacent level shows geopotential height lower by 1 to 2 m.
3. In the original tapes, the five-digit code for the Canadian stations had a '2' or '4' as the second byte (variable STATION in the header record). The second byte was changed to '1' to match WMO codes.
4. Wind speed was originally in knots, and was converted to meters per second.

ID=4: (Alaska and Thule, Greenland)

1. As discussed earlier, these soundings have two additional quality codes LTYPE (type of level, e.g., significant, mandatory, surface, etc.) and LQUAL (overall quality code for each level). LQUAL should not be confused with LEVCK, which is the overall quality code for the level based on our limits check used through 1987.
2. Wind speed was originally in knots, and was converted to meters per second.
3. Original moisture data were reported as relative humidity, and were converted to dewpoint depression.
4. In some early soundings, a 1000-mb level is reported as a mandatory level even when the surface pressure is < 1000 mb.

ID=5: (Soviet, 1962-75)

1. If categories 2, 3, or 4 were missing (the data categories for soundings of type ID=5 are discussed in Section 3a above), the surface report was padded with missing values.
2. If categories 2, 3 ,or 4 were available, but the indicated surface pressure was < 930 mb, the surface report was assumed to be missing, and was padded with missing values.
3. As for ID=4, longitude values were converted to 0 to 360 degrees counterclockwise as viewed from the pole.
4. Wind speed was originally in knots, and was converted to meters per second.
5. Station elevation was not included in the sounding reports until 12/16/63. All station elevations were set to missing for years before 1964.

See 3.4 section Error Checking.

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5   CONTACTS AND ACKNOWLEDGMENTS

6   DOCUMENT INFORMATION

6.1 Document Authors

NSIDC Technical Writers

6.2 Document Creation Date

August 1997

6.3 Date Last Updated

December 2020

APPENDIX

Appendix 1. Summary of the Soundings Contained in the Historical Arctic Rawinsonde Archive, 1948-1990

East longitudes are positive; west longitudes are negative.

```
STATION ID                              LAT      LON      # OF
   NAME                   COUNTRY       DEG N    DEG E    SOUNDINGS      YEARS

1001   JAN MAYEN          NORWAY        70.93     -8.67    15561      58-57
1005   ISFJORD RADIO      NORWAY        78.07     13.63      983      58-62, 64, 66-68
1010   ANDOYA             NORWAY        69.30     16.12       22      66-68
1020                                    80.05    -18.29     1237      58-63
1028   BJORNOVA           NORWAY        74.52     19.02    16972      58-87
1030                                    69.69    -19.02     2424      58-63
1152   BODO               NORWAY        67.28     14.42    17005      58-87
2057   16LULEA/KALLAX     SWEDEN        65.60     22.10     5881      63-77
2185                                    66.55     22.13    10000      77-87
2836    SODANKYLA          FINLAN       67.37     26.65    25290       58-87
4202   THULE AFB          GREENL        76.53    -68.75    42617      52-87
4210   UPERNAVIK          GREENL        72.78    -56.17      221      62-64, 71-72
4220   EGEDESMINDE        GREENL        68.70    -52.75    16727      58-87
4230   HOLSTEINBORG       GREENL        66.92    -53.67       12      63, 68-69, 71
4231   SDR. STROMFJORD    GREENL        67.00    -50.80        4      62, 85
4310   NORD               GREENL        81.60    -16.67     5512      58-73, 75, 77-79, 81, 84-
85, 87
4320   DANMARKSHAVN       GREENL        76.77    -18.77    15450      58-87
4330   DANEBORG           GREENL        74.30    -20.22        7      68-70
4339   SCORESBYSUND       GREENL        70.48    -21.97     4819      80-87
4340   KAP TOBIN          GREENL        70.42    -21.97    11819      58-80
4360   ANGMAGSSALIK       GREENL        65.60    -37.63    16452      58-87
20046  GMO IM ET KRENKELYA SOVIET       80.62     58.05    20826      58-87
20047                                   80.44     52.80     1649      58-63
20069  OSTROV VIZE        SOVIET        79.50     76.98    18358      58-87
20107  BARENTSBURG        SOVIET        78.07     14.22    20289      58-87
20274  OSTROV UEDINENIA   SOVIET        77.50     82.23    17337      58-87
20292  GMO IM EK FEDEROVA SOVIET        77.72    104.28    19396      58-87
20353  MYS ZHELANIA       SOVIET        76.95     68.58    18207      58-87
20406                                   80.62     58.05        2      79
20667  IM POPOVA          SOVIET        73.33     70.03     8709      58-87
20674  OSTROV DIKSON      SOVIET        73.50     80.23    17487      58-87
20744  MALYE KARMAKULY    SOVIET        72.38     52.73    13088      58-63, 67-74, 76-87
20891  KHATANGA           SOVIET        71.98    102.27    16753      58-80, 83-87
```

```
21358 OSTROV ZOHOVA           SOVIET        76.15        152.83       15375              58-87


STATION ID                                   LAT         LON          # OF
   NAME                        COUNTRY       DEG N       DEG E        SOUNDINGS          YEARS

21432 OSTROV KOTELNY           SOVIET        76.00        137.90       18983              58-87
21504 OSTROV PREOBRAZHENIA     SOVIET        74.67        112.93       20447              58-87
21647 MYS SHALAUROVA           SOVIET        73.18        143.93       18181              58-87
21824 BUKHTA TIKSI             SOVIET        71.58        128.92       19476              58-87
21825 OSTROV MOSTAKH           SOVIET        71.53        129.92           2              87
21908 DZHALINDA                SOVIET        70.13        113.97           4              81, 87
21946 COKURDAH                 SOVIET        70.62        147.88       11238              58-87
21965 OSTROV CHETYREKHSTOLBO   SOVIET        70.63        162.40       17650              58-87
21982 OSTROV VRANGELYA         SOVIET        70.97       -178.55       16430              58-87
22113 MURMANSK                 SOVIET        68.97         33.05       23186              58-87
22165 KANIN NOS                SOVIET        68.65         43.30        1803              58-62
22205 ENA                      SOVIET        67.60         31.17           4              86-87
22217 KANDALASKSA              SOVIET        67.13         32.43       21051              58-87
22271 SOJNA                    SOVIET        67.88         44.13       20852              63-87
22408 KALEVALA                 SOVIET        65.20         31.17           2              62
22522 KEM-PORT                 SOVIET        64.98         34.78        5660              58-73
23022 AMDERMA                  SOVIET        69.77         61.68       18284              58-87
23074 DUDINKA                  SOVIET        69.40         86.17        2231              58-64, 66-67
23078 NORILSK                  SOVIET        69.32         88.22        8777              80-87
23130                                         0.           0.             6              61, 65
23146 MYS KAMENNY              SOVIET        68.47         73.60       18944              58-87
23162                                         0.           0.            10              60, 65
23205 NARJAN MAR               SOVIET        67.65         53.02       24628              58-87
23274 IGARKA                   SOVIET        67.47         86.57        5356              58-74
23330 SALE-KHARD (OBDORSK)     SOVIET        66.53         66.53       20461              58-87
23339 POLUY                    SOVIET        66.27         67.87          96              76-87
23383 AGATA                    SOVIET        66.93         93.47           2              62
23418 PECHORA                  SOVIET        65.12         57.10       23793              58-87
23472 TURUKHANSK               SOVIET        65.78         87.95       21946              58-87
23552 TARKO-SALE               SOVIET        64.92         77.82        1478              58-65
24125 OLENEK                   SOVIET        68.50        112.43       15175              58-87
24266 VERKHOYANSK              SOVIET        67.55        133.38       19425              58-87
```

```
24343 ZHIGANSK              SOVIET    66.77      123.40   21842      58-87
25042 AYON                  SOVIET    69.93      167.97    6272      58-63, 66-86
25123 CHERSKIY              SOVIET    68.80      161.28   18090      58-63, 68-87
```

STATION ID NAME	COUNTRY	LAT DEG N	LON DEG E	# OF SOUNDINGS	YEARS
25173 MYS SCHMIDT	SOVIET	68.92	-179.48	18478	58-87
25248 ILIRNEYJ	SOVIET	67.33	168.23	3	71
25282 VANKAREM	SOVIET	67.85	-175.83	73	80-87
25399 MYS UELEN	SOVIET	66.17	-169.83	7373	58-75
25400 ZYRIANKA	SOVIET	65.73	150.90	13294	63-87
25428 OMOLON	SOVIET	65.23	160.50	13838	58-87
70026 BARROW, AK	ALASKA	71.30	-156.78	27713	48-87
70086 BARTER IS., AK	ALASKA	70.13	-143.63	24613	53-87
70133 KOTZEBUE, AK	ALASKA	66.87	-162.63	4869	62-75
70192 145UNIVERSITY EXP STA	USA	64.90	-147.90	2	73
71043 NORMAN WELLS, NT	CANADA	65.28	-126.80	23631	55-87
71051 SACHS HARBOUR, NT	CANADA	72.00	-125.27	22302	55-86
71072 MOULD BAY, NT	CANADA	76.23	-119.32	28243	48-87
71074 ISACHSEN, NT	CANADA	78.68	-103.53	21518	48-78
71081 HALL BEACH, NT	CANADA	68.78	-81.25	22020	64-87
71082 ALERT, NT	CANADA	82.50	-62.33	26745	50-87
71090 CLYDE, NT	CANADA	70.47	-68.62	13867	50-70, 72
71914 NANISIVIK, NT	CANADA	72.97	-84.53	2	62
71917 EUREKA, NT	CANADA	80.00	-85.93	28437	48-87
71918 ARCTIC BAY, NT	CANADA	73.03	-85.15	5697	48, 50-57, 62-64, 66
71924 RESOLUTE BAY, NT	CANADA	74.72	-94.95	29933	48-87
71925 CAMBRIDGE BAY, NT	CANADA	69.10	-105.13	13122	62-63, 68, 70-87
71938 COPPERMINE, NT	CANADA	67.82	-115.13	14132	48-70
71957 INUVIK, NT	CANADA	68.30	-133.48	19942	60-87
71968 SHINGLE POINT, YT	CANADA	68.93	-137.23	7056	50-60
80000 Ship "M"		66.00	2.00	15521	62, 68, 73-87

```
TOTAL                                          1,220,713
```

Appendix 2. Example of a Sounding (THULE GREENLAND, ID=4)

```
04202 765229125 59 1 1 0      11    63 0   23 4
10040    31 -329   94   90    3 9P 9P 9P 9P 9P00
10000    62 -308   95   90    3 9P 9P 9P 9P 9P10
 9500   430 -277   79   70    3 9P 9P 9P 9P 9P90
 9000   819 -283   66  105    4 9P 9P 9P 9P 9P90
 8500  1227 -287   83  142    5 9P 9P 9P 9P 9P10
 8000  1660 -301   93  182    5 9P 9P 9P 9P 9P90
 7500  2130 -323   94  225    7 9P 9P 9P 9P 9P90
 7000  2602 -346   97  250    7 9P 9P 9P 9P 9P10
 6500  3130 -370  101  260   11 9P 9P 9P 9P 9P90
 6000  3668 -396  101  260   12 9P 9P 9P 9P 9P90
 5500  4260 -416  999  260   16 9P 9P 8  9P 9P90
 5000  4903 -437  999  270   18 9P 9P 8  9P 9P10
 4500  5600 -488  999  270   20 9P 9P 8  9P 9P90
 4000  6371 -541  999  270   24 9P 9P 8  9P 9P10
 3500  7219 -589  999  270   21 9P 9P 8  9P 9P90
 3000  8180 -620  999  270   18 9P 9P 8  9P 9P10
 2500  9312 -603  999  270   14 9P 9P 8  9P 9P10
 2000 10712 -588  999  260   14 9P 9P 8  9P 9P10
 1750 11545 -620  999  260   15 9P 9P 8  9P 9P90
 1500 12499 -616  999  260   15 9P 9P 8  9P 9P10
 1250 13624 -631  999  260   14 9P 9P 8  9P 9P90
 1000 14984 -670  999  260   10 9P 9P 8  9P 9P10
  800 16321 -698  999  260   10 9P 9P 8  9P 9P90
```

Appendix 3. Data for Seasonally-Adjustable Limits Check

```
Temperature (øC)
Pressure (mb)
at layer              Winter            Spring            Summer            Autumn

  Bottom    Top     Mean     SD      Mean     SD      Mean     SD      Mean     SD

  1200      951     -21.3   12.1     -4.9    10.1      5.0     6.6     -15.7   12.7
  950       901     -19.1    8.9     -6.0     8.6      3.1     6.8     -14.2    9.6
  900       851     -18.6    7.8     -7.4     7.6      0.5     6.2     -14.0    8.7
  850       801     -19.1    7.3     -8.6     7.1     -1.1     5.9     -14.6    8.0
  800       701     -22.3    6.9    -12.1     6.9     -5.5     5.8     -17.9    7.8
  700       601     -25.7    6.5    -15.8     6.7    -10.2     5.5     -21.1    7.4
  600       501     -35.1    6.7    -25.6     6.9    -19.5     6.0     -31.1    8.0
  500       401     -44.7    6.2    -36.0     7.0    -30.3     6.5     -41.2    7.8
  400       301     -54.1    4.8    -47.8     5.2    -44.7     6.2     -52.9    5.7
  300       201     -57.4    6.7    -50.6     5.9    -51.2     5.7     -55.6    5.3
  200       151     -56.3    8.4    -47.7     4.6    -47.1     4.3     -54.1    5.0
  150       101     -56.1    8.5    -48.3     4.1    -46.6     3.1     -55.2    4.7
  100       51      -56.5    9.4    -48.9     4.5    -47.0     3.6     -58.2    6.3
  50        21      -55.1    9.4    -47.4     5.9    -45.4     7.5     -59.6   10.2
  20         0      -50.8   10.1    -38.7    12.9    -38.3    13.0     -54.7   15.1


Geopotential height (m)

                Winter            Spring            Summer            Autumn

  P (mb)     Mean      SD       Mean      SD      Mean      SD       Mean      SD

  1200          0       0          0       0         0       0          0       0
  1000        121     102        111      74        99      64         95      94
  850        1333     105       1386      79      1417      71       1330      97
  700        2769     123       2882     104      2954      91       2789     121
  500        5159     164       5368     155      5504     135       5217     177
  400        6668     191       6933     189      7108     167       6745     215
```

```
  300        8536       209      8859      217     9066     201      8629      251
  250        9695       207     10051      218    10261     206      9795      257
  200       11115       227     11517      216    11720     201     11225      256
  150       12949       218     13420      227    13628     202     13074      256
  100       15537       278     16099      251    16321     217     15667      274
   70       17809       330     18445      278    18685     231     17929      288
   50       19961       381     20659      314    20916     258     20046      316
   30       23236       454     24023      419    24293     473     23282      544
   20       25842       533     26687      592    26998     459     25776      594
   10       30313       573     31333      629    31607     629     30238      555
    1       40000       573     40000      573    40000     573     40000      573


Ln wind speed (with wind speed in ms-1)
Pressure (mb)

at layer              Winter            Spring            Summer            Autumn

  Bottom    Top      Mean     SD      Mean     SD      Mean     SD      Mean     SD

  1200      926     1.933    0.631   1.844   0.588    1.737   0.677   1.914    0.725
   925      776     2.246    0.564   2.049   0.549    2.023   0.555   2.218    0.592
   775      601     2.405    0.557   2.207   0.559    2.143   0.560   2.340    0.585
   600      451     2.692    0.581   2.528   0.597    2.412   0.573   2.605    0.596
   450      351     2.823    0.608   2.717   0.621    2.592   0.600   2.751    0.621
   350      276     2.830    0.636   2.783   0.649    2.748   0.633   2.792    0.667
   275      226     2.736    0.642   2.640   0.648    2.695   0.628   2.737    0.669
   225      176     2.586    0.618   2.357   0.612    2.401   0.580   2.590    0.619
   175      126     2.499    0.595   2.101   0.570    2.123   0.541   2.502    0.549
   125       86     2.519    0.621   1.888   0.534    1.853   0.522   2.523    0.499
    85       66     2.554    0.687   1.730   0.501    1.684   0.518   2.557    0.480
    65       46     2.617    0.744   1.694   0.463    1.622   0.528   2.626    0.502
    45       26     2.743    0.758   1.787   0.431    1.679   0.531   2.763    0.545
    25       16     2.840    0.747   1.912   0.433    1.753   0.559   2.891    0.575
    15        0     3.000    0.727   2.222   0.557    2.031   0.708   3.142    0.568
```

Appendix 4. Quality Codes

```
QG (Geopotential height)

ID=1: (Soviet, 1976-87)

Auto.   Man.
A        I   Passed vertical consistency check with tight limits.
B        J   Failed vertical consistency check and has not been recomputed.
C        K   Failed vertical consistency check and recomputed.
D        L   Failed vertical consistency check with tight limits and passed with loose
limits.
E        M   Not assigned
F        N   Checked but did not pass vertical consistency checks with loose limits
G        O   Not assigned
Blank    $    Not specified
9        9   Corresponding data value missing

ID=2: (Victor Starr Data)
0        Not checked
1        Checked, reported values (presumably good data).
2        Interpolated value (presumably failed check or was missing and value was
              interpolated from next higher and lower value)
9            Corresponding data value missing

ID=3: (Canadian Data)
Original quality codes were extremely confusing.  They were adjusted to correspond
as closely as
possible to those given in ID=1:
A           Passed vertical consistency check with tight limits
B           Failed vertical consistency check with loose limits
C           Failed vertical consistency check and recomputed
9           Corresponding data value missing

ID=4: (Alaskan and Thule, Greenland)
0           Value is correct
1           Value is doubtful
2           Value is in error
3           Replacement value
4           Assumed or estimated value
9           Value not checked
8           Corresponding data value missing

Auto.   Man.
A        I   Passed vertical consistency check with tight limits
B        J   Failed vertical consistency check and has not been recomputed
C        K   Failed vertical consistency check and was recomputed
D        L   Failed vertical consistency check with tight limits, passed with loose
limits
E        M   Not assigned
F        N   Checked but did not pass vertical consistency check with loose limits
G        O   Not assigned
Blank    Not specified
8        8   Corresponding data value missing
Additional Codes:
P           Undefined
$           Undefined
```

```
ID=5: (Soviet, 1962-75)
Original quality codes in NCAR documentation changed to be as close as possible to
those for ID=1.
Values are as follows:
Auto.   Man.

A       I  Passed vertical consistency check with tight limits
B       J  Failed vertical consistency check and has not been recomputed
C       K  Failed vertical consistency check and recomputed
D       L  Failed vertical consistency check with tight limits and passed with
loose limits
O       O  No hydrostatic check done
9       9  Corresponding data value is missing

QT (Temperature)

ID=1: (Soviet, 1976-87)
         Same as for QG

ID=2: (Victor Starr)
         Same as for QG

ID=3: (Canadian Data)
         Same as for QG

ID=4: (Alaska and Thule, Greenland)
         Same as for QG

ID=5: (Soviet, 1962-75)
         Same as for QG
```

QD (Dewpoint Depression)
```
ID=1: (Soviet, 1976-87)

Auto.    Man.
Blank    $  Not Specified

ID=2: (Victor Starr)
         Same as for QG

ID=3: (Canadian Data)
         Same as for QG with following addition:
S        "Statistical".  Original NCAR tapes contained values of relative
humidity less than 0.  The
         original documentation stated that the minus sign indicated that the
absolute value is
         "statistical", which we assume means that it is obtained from
climatology.  We
         converted the absolute value of the relative humidity to dewpoint
depression.
         Generally, values depart considerably from values at adjacent levels.

ID=4: (Alaska and Thule Greenland)
         Same as for QG

ID=5: (Soviet, 1962-75)
         Same as for QG
```

QW (Wind Direction and Speed)
```
ID=1: (Soviet, 1976-87)
            Same as for QG


ID=2: (Victor Starr)
            Same as for QG


ID=3: (Canadian Data)
            Same as for QG


ID=4: (Alaska and Thule, Greenland)
            Same as for QG


ID=5: (Soviet, 1962-75)
            Same as for QG


QP (Pressure)


ID=1: (Soviet, 1976-87)
Auto     Man
Q        Y  Base of stratum with missing data
R        Z  Top of stratum with missing data
T        1  Reported tropopause level
U        2  Not applicable (ignore)
V        3  Not applicable (ignore)
W        4  Maximum reported wind level is not at the terminating level
X        5  Maximum reported wind level is at the terminating level
Blank    $  Not Specified
9        9  Corresponding value is missing.


Note: For mandatory levels, all pressure quality flags are blank (not specified).


ID=2: (Victor Starr)
            Same as for QG


ID=3: (Canadian Data)
            No relevant values, all set to '9'


ID=4: (Alaska and Thule, Greenland)
            Same as for QG


ID=5: (Soviet, 1962-75)
            Same as for QG


LQUAL (Level Quality Code)


ID=1: (Soviet, 1976-87)
            All blanks (flag not applicable)


ID=2: (Victor Starr, 1958-64)
            All blanks (flag not applicable)


ID=3: (Canadian, 1948-87)
            All blanks (flag not applicable)


ID=4: (Alaska and Thule, Greenland)
0           Original values correct
```

```
1            Original values missing
2            Original value doubtful, a corrected level follows
3            Original values doubtful, uncorrected
4            Original values in error, a corrected level follows
5            Original values in error, uncorrected
6            Corrected level
9            Level not checked


Auto    Man.
A         I   Passed vertical consistency check with tight limits
B         J   Failed vertical consistency check and has not been recomputed
C         K   Failed vertical consistency check and has been recomputed
D         L   Failed vertical consistency check with tight limits and passed with
loose limits
E         M   Not Assigned
F         N   Has been checked but did not pass vertical consistency checks with loose
limits
G         O   Not assigned
blank         Not specified


Additional Flags:
H            Not relevant (ignore)
P            Not relevant (ignore)

ID=5: (Soviet, 1962-75)
             All Blanks (flag not applicable)

LTYPE (Level Type)
ID=1: (Soviet, 1976-87)
             All Blanks (flag not applicable)

ID=2: (Victor Starr, 1958-64)
             All blanks (flag not applicable)

ID=3: (Canadian, 1948-87)
             All blanks (flag not applicable)

ID=4: (Alaska and Thule, Greenland)
0            Surface
1            Mandatory
2            Significant
3            Generated
4            Tropopause
5            Maximum wind
9            Other/unspecified

ID=5: (Soviet, 1962-75)
         All blanks (flag not applicable)
```

Appendix 5. Additional Quality Codes

PROC1, PROC2, PROC3 and INSTRUMENT. Taken from pages 6, 7 and 9 of Mulder (1977).

PROC1

Assigned to indicate special processing procedures.

```
      PROC1

Value                   Meaning

   0            Report has been adjusted to map time by an NMC updating
                procedure.  Heights are referenced to some forecast level

   1            Report has been adjusted to map time by an NMC updating
                procedure.  Heights are referenced to 1000 mb level at sea level.

   8            Reported heights are referenced to 1000 mb level at sea level.

   9*           Reported heights are referenced to some forecast level.

                *Except for report type 061 (SIRS), this value means "missing" or
not applicable
```

PROC2

Assigned to indicate the information specifying that the standard isobaric surfaces were located by use of pressure equipment, or that pressure equipment was not available and the wind data were reported at altitudes approximating the standard isobaric surfaces.

```
      PROC2
Value          Equipment

   0           Pressure instrument associated with wind-measuring
equipment.
   1 or 5      Optical theodolite.
   0 or 2      Radio theodolite.
   3 or 7      Radar.
   4           Pressure instrument associated with wind-measuring
equipment but
               pressure element failed during ascent.
   6           Not assigned.
   8           Not assigned.
   9           Not specified.
```

PROC 3

Assigned to indicate results of processing.

```
Value          Meaning

   0           All parameters in the report have been processed
automatically
               (no manual intervention).

   1           All parameters in the report have been obtained by
manual
               intervention (no automatic processing).

   2           All parameters in the report have been obtained by
manual
               intervention and all parameters agree with
automatically
               processed values.

   3           All parameters in the report have been obtained by
manual
               intervention and all parameters disagree with
automatically
               processed values.

   4           All parameters in the report have been obtained by
manual
               intervention and one or more parameters disagree
with
               automatically processed values.

   5           One or more, but not all, parameters in the report
have been
               obtained by manual intervention and all of these
parameters
               agree with automatically processed values.
```

```
   6          One or more, but not all, parameters in the report
have been
              obtained by manual intervention and all of these
parameters
              disagree with the automatically processed values.

   7          Two or more, but not all, parameters in the report
have been
              obtained by manual intervention and one or more
parameters
              agree and one or more parameters disagree with the
              automatically processed values.

   8          Not assigned.

   9          Not specified.
```

Instrument Assigned to Indicate Instrument Type

```
Instrument
   Value              Description

    01 U.S. - ESSA External thermistor
    02 U.S. - ESSA External thermistor (Plateau
stations)
    03 U.S. - An/AMT-4 Military external thermistor
    04 Finland - Vaissla
    05 France - Metox
    06 Portugal - Canada Model IV
    07 W. Germany - Graw H.50 (Corrected)
    08 U.S. - ESSA 403 MhZ Duct-type (WBAN
       corrections applied at station)
    09 Japan - Code sending
    10 E. Germany - Freiberg
    11 Britain - Kaw Mark IIB
    12 USSR - A-22-III (IV)
    13 U.S. - ESSA 403 MhZ Duct-type (WBAN correction
not
       applied at station)
    98 NOAA-II (SIRS-B) Instrument 1
    97 NOAA-II (SIRS-B) Instrument 2
```