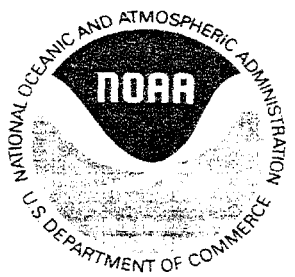

NOAA TECHNICAL MEMORANDUM
NWS WR-255

CREATION AND MAINTENANCE OF A COMPREHENSIVE CLIMATE DATABASE

Eugene Petrescu
National Weather Service Forecast Office
Seattle, WA

August 1998

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

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NOAA TECHNICAL MEMORANDUM
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Seattle, WA

August 1998

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CREATION AND MAINTENANCE OF A COMPREHENSIVE CLIMATE DATABASE

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ABSTRACT

Requests for climate information from the public and media are one of the more frequent inquiries that a National Weather Service field office receives. Climate data are also of importance for local research studies, determining long-term climate trends, and short-term forecasting problems; such as temperature and quantitative precipitation forecasts. This Technical Memorandum describes methods to create a comprehensive climate database, in the 'netcdf' format, that can be accessed by the UNIX X-Windows program Xmclimate. Xmclimate provides quick access to summary of day climate data from first order and cooperative stations; including a powerful search engine to quickly answer almost any climate question. In addition, methods to maintain and update the climate database with near real-time data are discussed.

I. INTRODUCTION

Until recently, a major drawback for using a climate software application, was the necessity to load hard copy climate data onto an electronic medium for access by the application. Typically, the only method for a National Weather Service office to create and update an electronic climate database was to manually enter the data. This is rather time consuming; limiting the creation of electronic climate databases to mainly first order stations.

In June of 1995, the National Climatic Data Center (NCDC), released the 21 Volume CD-ROM series: "Cooperative summary of the day". The CD-ROM series contains official summary of the day climate data for cooperative and first order stations in operation from the late 1940's to the present. Data for several stations, depending on the state, is available from the late 1800's and early 1900's. Using the CD-ROM series, it is now relatively easy to create a comprehensive climatic database that is accessible from any climate software application. With improvements in electronic communications and data transfer, the database can be updated on a near real-time basis using several means.

a. Xmclimate

Carl Dierking and Paul Shannon of NWSFO Juneau developed the powerful X-Windows application Xmclimate. This public domain software can be used to display daily climate data (Fig. 1), including: temperature (maximum, minimum, daily average, and heating and cooling degree days), precipitation, snowfall, and snow depth (Fig. 2). The program also

calculates and displays daily and monthly temperature extremes; monthly precipitation, snowfall, and snow depth extremes (Fig. 3); and daily and monthly 30 year normals (Fig. 4).

Xmclimate's most powerful feature is it's capability to perform searches on a database to extract an almost unlimited amount of climate information (Fig. 5). A few examples of possible searches include: a list of the longest dry spells, the warmest maximum temperature for a given period, the coldest average temperature for a given period, daily climatological POPs, and the first and last dates of temperatures at or below 32°F (Fig. 6-8). Using Xmclimate, climate questions can be answered quickly and accurately.

b. AKclimate Software Package

In addition to the methods described in this Technical Memorandum (TM), a software package AKclimate is available to aid in the creation and maintenance of the database, the interfacing of the database with an Internet web page, and the manipulation of the database for research purposes. A detailed description on the installation and implementation of the software package is described in the Programming Note "Software Package for the Creation and Maintenance of a Comprehensive Climate Database", expected submission Spring 1998. The use of the software package is not a requirement, but will provide a considerable time savings; particularly in the creation of the database. Throughout this TM, references will be made to software utilities and scripts. It will be noted whether a particular utility or script is included with the Xmclimate or the AKclimate software packages.

II. OBTAINING AND INSTALLING XMCLIMATE

As of January 1998, the Xmclimate software package can be obtain by FTP from the following site: **inetsrv.alaska.net**

i. **Login: anonymous**
ii. **Password: your e-mail address**
iii. Compressed 'tar' files for the source code and executable files are located in the directory: **/pub/hpapps/xmclimate**

The filename of the executable code has the format: **xmclimate[date].hpux.exe.tar.Z**

[date] - date of latest revision

This file contains Xmclimate, several utilities for use with Xmclimate, man pages, and on-line help files.

The filename of the source code has the format: **xmclimate[date].hpux.src.tar.Z**

Only the executable code is required. The executable code is pre-compiled to run on the HP-UX operating system version 9.0 or greater.

To create a web page interface, download the files: **climRead***. Interfacing the web page with the database is covered in the Programming Note. Note - The character '*' represents a wildcard.

iv. Create a directory for placement of the xmclimate files and climate data files. (Ex. /usr/public/climate; /usr/climate, etc.) The amount of disk space required for the climate files is approximately 6 MB. Allow approximately 100 MB of disk space for every 100 climate stations. (Number of stations in the following databases: Montana - 430, Washington - 260, and Oregon - 350). It is not required that the data files be located on the same hard drive as the executable files, however the program will operate more efficiently if they are collocated. It is strongly suggested to maintain a complete backup copy of the data files on a separate hard drive or backup tape.

v. Downloaded the appropriate files to the climate directory.

vi. Type: **uncompress xmclimate[date].hpux.exe.tar.Z**

vii. Type: **tar xvf xmclimate[date].hpux.exe.tar**

viii. Create a script to start "xmclimate" with the appropriate command line arguments.

Example:

/usr/public/climate/xmclimate -ddir /usr/public/climate/storage -udir '\' /usr/public/climate/DIR.utl -hdir /usr/public/climate -bdir /usr1/climate/backup -stn SEA__

****NOTE**** - Throughout this TM, a '\' is used to indicate the command is continued on the next line. To execute the command the entire command must be on one line.

Command line arguments:

-ddir - location of data files
-udir - location of Xmclimate utilities
-hdir - location of help files
-bdir - location of backup directories (not required)
-stn - default station on startup

For further assistance or detailed instructions on the installation and use of the program consult the README and 'man' files included with the software. The application also contains on-line help files. Xmclimate is not officially supported, however revisions are released on occasion.

III. OBTAINING THE CD-ROM

The "Cooperative summary of the day" CD-ROM series from NCDC contains 21 volumes. Typically two or more states are included on a single volume. The series contains period of record data through 1993 for over 23,000 stations in the United States, Puerto Rico, the U.S. Virgin Islands, and selected Pacific Islands under U.S. protection. An additional single CD-ROM, "Cooperative summary of the day: Combined update", released in May 1997, contains climate data for the period 1994 to 1996. The combined update CD-ROM is expected to be re-released with new climate data on a yearly basis. To obtain climate data for 1997 or later see section 6e.

These CD-ROMs are generally free of charge to National Weather Service field offices. Otherwise the current fee (as of January 1998) for each CD-ROM is $70.00. To obtain CD-ROMs, contact the NCDC through the following means.

Mail: National Climatic Data Center
151 Patton Avenue, Room 151
Asheville, NC 28801-5001

E-mail: orders@ncdc.noaa.gov

Phone: 704-271-4800
Fax: 704-271-4876

Internet: http://www.ncdc.noaa.gov

The data on the CD-ROM are in the TD3200 format. For additional information on the TD3200 format see the file "3200DAT.DOC" on the CD-ROM or the NCDC Documentation Manual: "Daily Summary Obs - Cooperative U.S. & Possessions, TD3200".

The database, although quality controlled, contains known errors. For a brief description of known errors and quality control measures, see "3200DAT.DOC" on the CD-ROM. For an in-depth description of known errors, contact NCDC. Particular caution should be used when interpreting snowfall and snow depth data, especially in regions where snowfall is relatively infrequent. If errors are discovered in the data on the CD-ROM, contact NCDC. If necessary, it is easy to edit data in the database using Xmclimate.

If older data for a particular station are available in hard copy format or on an electronic medium, these data can be entered into the database at a later time by hand or through other means. See section 5a, under **-byr**, for a brief discussion of entering data older than the current beginning date of a data file.

IV. THE STATION SELECTION PROCESS

a. The Basics

Station selection is the most important and difficult step in the database creation process. There are three questions that need to be answered before beginning the process. The answers are site specific and will guide the creation process. Once a set of guidelines is created, follow the guidelines for consistency, as it will be difficult to perform significant changes to the database at a later time. It is also important to maintain good records while creating the database. Good record-keeping will facilitate trouble-shooting if problems arise in the creation process, and will aid in the maintenance of the database.

On the CD-ROM, there are three files for each state. The files are located in the /DATA directory. The *.DAT file contains the TD3200 data. The *.HIS file contains station histories for all stations in a given state. The *.INV file provides the inventory of data on the CD-ROM for each station. For every station listed in the *.INV file, the number of days with missing values and the data types available (precipitation and/or temperature) are listed for each month in the station's period of record (POR). Data are not available for all the stations listed in the station history. Use the *.INV file as the main guide to selecting stations. **Note** - when accessing the files on the CD-ROM it is necessary to bracket the full file name, including the ';1' in single or double quotes.

Question 1: What criteria will be used to determine which stations to add to the database?

It is not necessary to use hard and fast rules, but only a general guideline that can be adapted to the particular situation.

Suggested guidelines:

1. Include any active stations, regardless of the station's POR. The office Cooperative Program Manager (CPM) will have a list of active stations, or consult the state's Annual Climate Directory.

2. Include any single station or combination of stations that are not currently active and have a combined POR of at least 20 to 30 years. Include stations that have been inactive for several decades. If the station is located in a data sparse region, or of unique interest (a ski resort), a lower POR cut-off is suggested. If the station contains a large number of missing values, use a higher POR cut-off.

Question 2: What criteria will be used to determine if stations, in close proximity with different periods of record, should be combined?

As in question 1, any guidelines should be flexible; taking into account the particular situation.

It is common for climate stations to open, close, and move on a regular basis. It is possible to combine data records from stations, that are in close proximity to each other, using caution. Even under the best of circumstances, stations that are relatively close may be affected by local micro-climates that could result in significant differences in the climate records of the stations (particularly with temperature).

In general, when a station is closed, attempts are made to open a new station nearby. This will be evident in the POR of both stations. In most cases the new station will have a similar name, however in some cases this is not true. It is very useful to plot station locations, on a topographical map, to determine station proximity and variations in topography. In certain circumstances, three or four stations could be combined into one data file.

Relocation information of every station with a unique WBAN ID (six digit numeric identification number) is listed in the *.HIS file. Data for each station with a unique ID has already been combined on the CD-ROM. The following guidelines are used to determine whether stations in close proximity, with different ID numbers, should be combined.

Suggested guidelines for combining stations:

1. Do not combine data from any stations that are more than 7 to 10 miles apart in flat terrain with a homogenous land cover.

2. Do not combine data from any stations that are more than 3 to 4 miles apart in hilly or mountainous terrain, in terrain with varying land cover (e.g., a station near a body of water was moved to an inland site), or from a valley station that was moved to a ridge or bluff.

3. When combining stations be cautious of using a station that has a short POR, or an abundance of missing data. Example 1: Station A has a POR from 1957 to 1986. Station B has a POR from 1956 to 1957. Is this worth combining? Probably not, but this depends on the particular situation (e.g., stations in a data-sparse region). Example 2: Station B has a POR from 1948 to 1957, but 70 percent of the data are missing. Is this worth combining? Again probably not, but it depends on the particular situation.

4. Several first order stations on the CD-ROM are listed with two or more unique WBAN IDs, but are located at the same location with the identical name. This is particularly true of stations that opened before 1948. Data stored under one of the unique IDs may only include one day to one month of data. It is suggested not to combine data for these locations unless the short POR station has at least one month of data.

5. Check the *.INV file closely to determine any extended periods that a station was inactive. Occasionally a station may have been active for only one month up to a few years, at the beginning of the station's POR, followed by a period of inactivity lasting several decades. It is suggested to discount the data at the beginning of the POR unless there is more than one year of data.

6. During the 1940s, many first order stations located in the center of urban regions were moved to airport sites outside the city. It is possible to create three climate files for stations in this category. One station for the old urban site, one for the new airport site, and a combined station that includes data from both locations.

7. It is not uncommon for a station to close for a time, while another station opens nearby in the interim. Example: Station A has a POR of 1932 to present, but was inactive from 1954 to 1970. Station B located three miles away has a POR of 1954 to 1970. These stations should be combined. This will be referred to as an "included" station.

8. PORs of combined stations may overlap. In this case, for the period in question, choose data from the station with the fewest missing data, or choose from the station with the most recent POR.

Question 3: What scheme should I use to select an ID for the data files?

The data files must have alphanumeric ID's of 5 characters. Be consistent, as this will make station recognition simpler.

ID suggestions:

1. Use the common FAA 3-letter identifier for climate stations located at airports. Append two underlines to the identifier. Example: SEA ==> SEA__.

2. For active or inactive stations with a 5-letter SID code, use the official code. Example: Paradise, Mount Rainier R.S. ==> ASFW1.

3. For inactive stations without a FAA identifier or SID code, create any 5-letter ID that resembles the station name as closely as possible. Example: Garden City ==> GARCY.

b. The Process

After determining the basic guidelines discussed in 4a, the next step is to determine all potential stations by scanning the *.INV and *.HIS files. The utility inv_create, included in the AKclimate software package, greatly reduces the time required for this step.

Reading the *.INV file: For a complete description of the *.INV file refer to 3200INV.DOC located on the CD-ROM.

Reading the *.HIS file: For a complete description of the *.HIS file refer to 3200HIS.DOC located on the CD-ROM.

1. Scan through the *.INV file. Make a list of all stations included on the CD-ROM, noting: the station's POR, the quality of the data (number of missing values, type of data available), and any gaps in the data record. Each station in the *.INV file and *.HIS will

have a unique WBAN ID. Consider each station with a unique WBAN as an individual station, regardless of whether two stations share the same name. Obtain the station's location, elevation, and official ID from the *.HIS file. Official IDs for every station are not listed in the *.HIS file. Check your station's cooperative station roster for the appropriate SID code. If an ID is not listed and a SID code does not exist, create a station ID. Plot each unique station on a topographical map. It is suggested to refer to each station plotted by a sequential numbering scheme, so that each station plotted on the map can be easily cross-referenced to the station list in future steps.

2. Scan the *.INV and *.HIS files from the "combined update" CD-ROM, and the state's Annual Climate Directories, for 1993 to the present available year. Note if a station opened, closed, or moved after 1993. In addition, note the stations that were active in 1993 and the stations are presently active.

3. Carefully scan the station list created in steps 1 and 2. Using the predetermined guidelines select the stations to include in the database.

ix. Check each station's location, previously plotted on the topographical map, to determine if there are any other stations located within 10 miles of the station.
x. If there are no stations located nearby, select the station for inclusion if the station has an adequate POR.
xi. If there are nearby stations, determine if the stations should be combined. If the POR of the combined station is adequate, include the station in the database.
xii. For combined stations, the station ID, WBAN ID, name, location, and elevation should be taken from the active station or the station with the latest POR.

4. Create the final station list, including: the station name, ID, WBAN ID, location, elevation, POR information, county, and climate division code. For each combined station, list the above information for each station included in the combination.

Example of a final station list:

1 ADEO3 Adel 350036 42.11 119.54 1397 01/1956 * * 07Lake
2 ALBO3 Albany 350078 44.39 123.06 64 01/1928 +01/1963
Albany/2 350082 44.37 123.07 67 02/1963 * * 07 Linn
3 LOPO3 Lowell 355072 43.55 122.46 226 01/1948 +05/1950 (nt)
Lowell/1 E 355074 43.55 122.47 308 06/1950 +09/1955
Lookout Point/ Dam 355050 43.55 122.46 217 10/1955 * * 02 Lane
4 TDLO3 The Dalles/2 358410 45.36 121.11 85 06/1967 !01/1975
The Dalles 358407 45.36 121.12 31 01/1948 * * 06
Wasco '\' g06/1967-01/1975

Format:

[File number] [Station ID] [Station name] [WBAN ID] [Latitude] [Longitude] '\' [Elevation] [Beginning year of POR (month/year)] '\'
[* indicates station was active in 1993] [* indicates station is currently active] '\'
[Climate division number] [County] [Ending date of POR if station is closed '\'
(+month/year), (!month/year) indicates the ending date of POR for inclusive '\' data]
[Other remarks]

Station 1 - A single uncombined station.

Station 2 - Two stations combined into one file. The stations are listed in chronological order. The combined station ID is ALBO3. The combined station name is Albany/2. The combined station WBAN is 350082.

Station 3 - Three stations combined into one file. The combined station ID is LOPO3. The combined station name is Lookout Point/ Dam. The combined station WBAN is 355050. In remarks, (nt) indicates no temperature data are available for the station.

Station 4 - Two stations are combined into one file. Data from the first station in the list are "included" into the second station as indicated by the "!". The POR of The Dalles/2 is 06/1967 to 01/1975. The POR of The Dalles is 01/1948 to 12/1997 with a gap from 06/1967 to 01/1975.

V. THE DATABASE CREATION SCRIPTS

After finalizing the station list, the next step is to write the scripts required to create and maintain the data files. A script consists of a series of commands to be executed by the computer. Executing these scripts is much more efficient than typing in each command one at a time. There may be several hundred data files in a database and each command consists of several lengthy command line arguments. The utility script_create, included in the AKclimate software package, will automatically create all the scripts required.

A list of the scripts, their purpose, the corresponding Xmclimate utility, and format are listed below. The Xmclimate utilities referenced are located in the ~/climate/DIR.utl directory. For more detailed information regarding the utilities discussed below, refer to the appropriate 'man' file in the DIR.utl directory. In the examples, the scripts will be referenced by specific names, however the scripts can have any name.

a. climCreateFile.scr

A netcdf climate data file must be created for each station before loading data from the CD-ROM. The netcdf files are created using the Xmclimate utility climCreateFile. The script climCreateFile.scr will execute commands to create a file for each station in the list.

Only one command is required for each climate station, including a combined station.

'climCreateFile' is executed from the command line using the following format:

/usr/public/climate/DIR.utl/climCreateFile -ddir /usr/public/climate/storage '\'
-stn SQLW1 -byr 1932 -emon 12 -eyr 1982 -l 'Snoqualamie Pass -t COOP

Command line arguments:

-ddir = location of data files
-stn = 5-letter station ID
-byr = beginning year of period of record (important) - this cannot be changed once the file has been created. To add older data to a file a new file must be created. Data from the old file can be loaded into the new file using the climDataCopy utility included with Xmclimate.
-bmon = not shown. The default is 01 for January. It is best to use the default.
-emon = ending month of period of record (01-12).
-eyr = ending year of period of record.
-emon and -eyr do not need to be included for active stations. New data added after the ending dates will result in the automatic updating of the ending dates in the data file. Specifying ending dates for closed stations is important for saving disk space. If ending dates are not specified, the ending dates will default to the month and year the data file is created.

-l = Station name. For consistency it is best to use the official station name. Some abbreviation may be required for certain stations, as there is a 17-character limit.
-t = Station type. FAA, COOP, WSO, WFO, etc. There is a 9-character limit.

b. clim3200convert.scr

The Xmclimate utility clim3200convert loads data from the CD-ROM into the individual climate station files. The script clim3200convert.scr is used to load data for the period ending 1993 into the station files.

One command line is required for each station, including each station that is part of a combined station.

This program is executed from the command line using the following format:

For a single station:

/usr/public/climate/DIR.utl/clim3200convert -f '/cdrom/DATA/OR35STN.DAT;1' '\'
-n 351067 -ddir /usr/public/climate/storage -stn BTHO3

For a combined station:

/usr/public/climate/DIR.utl/clim3200convert -f '/cdrom/DATA/OR35STN.DAT;1' '\'
-n 351332 -ddir /usr/public/climate/storage -stn CANO3 -emon 04 -eyr 1966
/usr/public/climate/DIR.utl/clim3200convert -f '/cdrom/DATA/OR35STN.DAT;1' '\'
-n 351329 -ddir /usr/public/climate/storage -stn CANO3 -bmon 05 -byr 1966 '\'
-emon 11 -eyr 1979

* note these are two separate commands.

For a combined station with inclusive data:

/usr/public/climate/DIR.utl/clim3200convert -f '/cdrom/DATA/OR35STN.DAT;1' '\'
-n 358410 -ddir /usr/public/climate/storage -stn TDLO3 -bmon 01 -byr 1967 '\'
-emon 01 -eyr 1975
/usr/public/climate/DIR.utl/clim3200convert -f '/cdrom/DATA/OR35STN.DAT;1' '\'
-n 358407 -ddir /usr/public/climate/storage -stn TDLO3 -bmon 01 -byr 1948 '\'
-emon 12 -eyr 1997

* note these are two separate commands.

Command line arguments:

-f = path to *.DAT file
-n = WBAN 6 digit number
-ddir = location of data files
-stn = 5 letter station ID

The following arguments are not required, but should be used when combining stations for clarity. 'clim3200convert' will only overwrite data in a climate file if data for that day or element exist in the *.DAT file. However, if the POR's from two combined stations overlap, it will be necessary to define the data to include in the data file by choosing the correct beginning and ending dates.
-bmon = beginning month of data to be loaded (01-12).
-byr = beginning year of data to be loaded.
-emon = ending month of data to be loaded (01-12).
-eyr = ending year of data to be loaded.

c. clim3200convert_96.scr

The script clim3200convert_96.scr is used to load data from the "Combined update" CD-ROM.

Only stations that are active at any time during the POR on the combined update CD-ROM need to be included in the script.

The command line format is identical to that used for clim3200convert.scr, see 5b.

d. clim_update.scr

The script clim_update.scr is used to load newly released data from a TD3200 monthly climate file issued by NCDC. NCDC releases preliminary monthly climate files for each state approximately 2 to 3 months after the fact, and final monthly data for each state about 6 to 7 months after the fact.

Only active stations need to be included in the script. If in doubt about a station's status, include the station, so as not to miss any new data.

This program is executed from the command line using the following format:

/usr/public/climate/DIR.utl/clim3200convert -f $1 -n 351067 '\'
-ddir /usr/public/climate/storage -stn BTHO3 -bmon $2 -byr $3 -emon $2 -eyr $3

Command line arguments are the same as for clim3200convert.scr.

$1 = Filename of the NCDC TD3200 monthly climate data file.
$2 = Valid month of data (01-12).
$3 = Valid year of data.

Example command: **clim_update.scr /usr/public/climate/newdata/marfin-or. 04 1998**

e. clim_update_bak.scr (optional)

The script clim_update_bak.scr is identical to clim_update.scr, except the data directory path points to the backup data directory. This script is used to update backup copies of the data files.

Example:

/usr/public/climate/DIR.utl/clim3200convert -f $1 -n 351067 '\'
-ddir /usr1/climate/backup -stn BTHO3 -bmon $2 -byr $3 -emon $2 -eyr $3

f. extrm_update.scr

The Xmclimate utility climExtremeUpdate automatically calculates daily and monthly temperature extremes, and monthly precipitation, snowfall, and snow depth extremes for a given station.

Only one command is required for each station, including a combined station.

This program is executed from the command line using the following format:

/usr/public/climate/DIR.utl/climExtremeUpdate /usr/public/climate/storage SEA__

Command line format:

[executable path] [date file path] [station ID]

g. extrm_update_bak.scr (optional)

This script is identical to extrm_update.scr, except the data directory path points to the backup data directory.

Example:

/usr/public/climate/DIR.utl/climExtremeUpdate /usr1/climate/backup SEA__

h. nrmls_update.scr

The Xmclimate utility climDailyNrmls automatically calculates daily and monthly 30-year normals (at present 1961-1990) for temperature, precipitation, snowfall, and snow depth for a given station. The utility is based upon the same spline routine used by NCDC to calculate 30-year normals.

Only one command is required for each station, including a combined station.

This program is executed from the command line using the following format:

/usr/public/climate/DIR.utl/climDailyNrmls -stn SEA__ -ddir
/usr/public/climate/storage '\'
-msgDays 5 -msgYears 5

Command line arguments:

-stn = station ID
-ddir = location of station files
-msgDays = Normals will be calculated for a given day if only up to 5 days for a given data element within the 30-year period are missing on the given day..
-msgYears = Normals will be calculated for a given month if only up to 5 months for a given data element within the 30-year period are missing for the given month.

i. nrmls_update_bak.scr (optional)

The script nrmls_update_bak.scr is identical to nrmls_update.scr, except the data directory path points to the backup data directory.

Example:

**/usr/public/climate/DIR.utl/climDailyNrmls -stn SEA -ddir '\'
/usr1/climate/backup -msgDays 5 -msgYears 5**

VI. CREATING THE DATABASE

i. Ensure that all the scripts created in section 5 are of the proper format, have the correct POR, station ID, WBAN ID, and name. It is not possible to make corrections to these elements after a file has been created. Files with errors must be re-built from scratch. It is important to create log files, when executing the scripts described in this section, to aid in trouble-shooting any problems that may occur. Typical errors are typos in station names, IDs, or WBANs. Correct any problems before continuing.

ii. Run the script climCreateFile.scr. Write the output for the script to a log file to track any errors that may occur, (e.g, **climCreateFile.scr > logfile)**. An error will occur if attempting to create a file with the same filename as another file.

iii. Run the script clim3200convert.scr. Write the output for the script to a log file to track any errors that may occur. The version of clim3200convert included with xmclimate is very inefficient. It may take 2 to 4 days for the script to complete the download. Another version of the utility, included with the AKclimate software package, is 50 to 70% faster. The process will proceed more quickly if the *.DAT file, from the CD-ROM, is copied to the same hard drive where the data files are resident. A new utility will be included with the AKclimate software package, that will complete the data loading process in 1 to 3 hours.

It is important to check the log file to ensure that the data were loaded into the data files properly. The output from the two current versions of clim3200convert is difficult to interpret. The new version, expected release April 1998, will produce output in a more useable format.

iv. Run the script clim3200convert_96.scr . Write the output from the script to a log file to track any errors that may occur.

v. Run the script clim_update.scr to bring the database up to date using the final TD3200 monthly data files released by NCDC. Write the output from the script to a log file to track any errors that may occur.

Ex. **clim_update.scr /usr/public/climate/newdata/marfin-or. 03 1998**

Data for the most recent year can be obtained through FTP from NCDC. Data are maintained on the NCDC FTP site only until one calendar year of data have been released. Data from this year are then deleted as data from the next year are released. Use caution when downloading and using these data, as the filename for any given month of data does not reference the valid year of the data. Final data or preliminary data are available.

Naming convention for final data: **marfin-or.** [month]fin-[state].
Naming convection for preliminary data: **marpre-or.** [month]pre-[state].

Steps to download the data (current as of January 1998):

ftp ftp.ncdc.noaa.gov
login: anonymous
password: your full e-mail address

For final data: **cd /pub/data/rcc/final**
For preliminary data: **cd /pub/data/rcc/prlim**

vi. After the database is up to date, run the script nrmls_update.scr. This script will calculate 30-year normals for the period 1961-1990. Write the output from the script to a log file to track any errors that may occur.

vii. The final step in the database creation process is to run the script extrm_update.scr. This script will calculate the extremes for each station in the database. Write the output from the script to a log file to track any errors that may occur.

VII. UPDATING THE DATABASE

After completing the database creation process, the next step is the development of a procedure to update the climate data on a real-time or near real-time basis. There are three time levels for updating: Updating on a daily basis, 2 to 3 months after the fact, and 6 to 7 months after the fact. General procedures for creating an auto-update plan will be discussed, however actual implementation of an auto-update plan is site specific and depends on the resources of each office. A complete set of utilities for auto-updating is included in the AKclimate software package.

a. Daily Updating

There are several data sources available for updating certain stations in the climate database on a daily basis. These sources include but are not limited to: Hourly observations, the State Temperature and Precipitation (STP) product, and other SHEF

code products. Any regularly issued product that contains temperature, precipitation, and snowfall data could be used, but discussion will be limited to the aforementioned three products, as these are the most reliable sources. Approximately 10 to 20 percent of the stations in the database can be updated daily. Data loaded into a climate data file in the daily updating process cannot be considered official. These data will be overwritten by official NCDC data as it becomes available.

Another item to consider when deciding what data source and procedure to use for daily updating, is the time of day the daily climate observation is taken. At most first order stations, and ASOS sites the climate observation is taken at local midnight, but not always. Most cooperative stations take the 24-hour climate observation in the early morning or late afternoon.

Hourly Observations: Temperature, precipitation, and on occasion snow depth information can be used to update climate stations at or near airports. Software routines can parse the observations for the 24-hour temperature maximum and minimum, precipitation and snow depth. This is a relatively easy task for observations from sites equipped with ASOS sensors and select first order stations, as 24-hour maximum and minimum temperatures are reported on the local midnight observation and 24-hour precipitation is reported at 12Z. ASOS instruments also report hourly precipitation. Caution must be used when using hourly observations, as the quality of the data may be suspect at times.

The STP Product: The State Temperature and Precipitation product is issued in most states at least twice per day; around 00Z and 12Z. The STP product is in the SHEF code format and can be decoded by any SHEF decoder. The STP product generally contains data from airport sites and cooperative stations. The 12Z product generally contains the 24-hour maximum temperature, overnight minimum temperature, 24-hour precipitation, and occasionally snow depth and snowfall information. The 00Z product generally contains the afternoon maximum temperature, 24-hour minimum temperature, 24-hour precipitation, and occasionally snow depth and snowfall information. The content of both products varies from state to state. The data are usually reliable, but coding and other errors can be a factor.

Other SHEF Products: In many states, 24-hour climate observations from selected cooperative stations are transmitted in SHEF format in RR* products (in some states the climate observations are transmitted through the STP product). With the implementation of the ROSA system, the availability of daily climate observations from cooperative stations will increase rapidly. Data from RR products are usually very reliable, but coding and other errors can be a factor.

Suggested procedures for selecting data for updating: A '+' next to a time, indicates the product to be parsed for the climate data is issued on the next Zulu day. No mark indicates the current Zulu day. A '-' indicates the previous Zulu day.

Although the STP product is used in the following examples, any SHEF code product with the appropriate information could be used.

Example: For climate data on the 23rd, use data from the +12Z STP (the STP issued around 24/1200Z).

Each data source is listed in order of priority, with the highest data source listed first. If that particular source is unavailable, use the next data source in the list.

1. For airport sites that take a midnight observation or cooperative stations located near airports that do not transmit a daily climate observation electronically.

Temperature:

1. The 24-hour maximum and minimum temperature from the midnight observation.
2. The maximum 24-hour temperature from the +12Z STP, and the 24-hour minimum from the +00Z STP.
3. If data from the +12Z STP are unavailable, use the +00Z STP for the maximum temperature.
4. If data from the +00Z STP are unavailable, use the 12Z STP for the minimum temperature.
5. Temperature data determined from hourly observations. Use this data with caution.
6. List the data element as missing.

Precipitation:

1. 24-hour precipitation from the +12Z STP.
2. 24-hour precipitation from the +00Z STP.
3. 24-hour precipitation calculated from the hourly observations. Use these data with caution.
4. List the data element as missing

Snow Depth:

Snow Depth is normally entered into the climate record on the date it was measured.

1. The 12Z STP.
2. The 00Z STP.
3. The -00Z STP.
4. The 12Z hourly observation.
5. The 00Z hourly observation.
6. The -00Z hourly observation.
7. List the data element as missing

2. For airport sites and cooperative stations that report climate data twice per day on the STP product, that do not take a midnight observation.

Temperature:

1. The maximum 24-hour temperature from the +12Z STP, and the 24-hour minimum from the +00Z STP.
2. If data from the +12Z STP are unavailable, use the +00Z STP for the maximum temperature.
3. If data from the +00Z STP are unavailable, use the 12Z STP for the minimum temperature.
4. Temperature data determined from hourly observations (at airport sites). Use this data with caution.
5. List the data element as missing.

Precipitation:

1. 24-hour precipitation from the +12Z STP.
2. 24-hour precipitation from the +00Z STP.
3. 24-hour precipitation calculated from the hourly observations (at airport sites). Use this data with caution.
4. List the data element as missing.

Snow Depth:

1. The 12Z STP.
2. The 00Z STP.
3. The -00Z STP.
4. The 12Z hourly observation (at airport sites).
5. The 00Z hourly observation (at airport sites).
6. The -00Z hourly observation (at airport sites).
7. List the data element as missing.

3. For airport sites or cooperative stations that take the climate observation once per day during the morning.

1. For all elements, the best source of data is the 12Z STP or RR* product as these products contain the actual daily climate observations. Note that data elements from this type of climate observation are normally entered into the climate record on the day the observation was taken. Even though the 24-hour maximum temperature probably occurred on the previous calendar day, the temperature is recorded in the climate record on the current calendar day.
2. List the data elements as missing.

4. For airport sites or cooperative stations that take the climate observation once per day during the afternoon.

1. For all elements the best source of data is the +00Z STP or RR* product as these products contain the actual daily climate observations.
2. List the data elements as missing.

Once the daily data have been collected, the next step is loading the data into the database. This can be done using the utility clim_input, included with the AKclimate software package. Otherwise, a routine can be developed using the netcdf libraries. The netcdf file format of the climate data files can be obtained by using ncdump, a utility included with Xmclimate.

The suggested time for the auto-update is mid to late morning, as the climate observations and any corrections or updates to the STP or RR* products are usually completed by this time.

b. Updating with Preliminary NCDC Data

Approximately two to three months after the fact, NCDC releases preliminary climate data in the TD3200 format for each state. These data can be downloaded from the NCDC FTP site and loaded into the climate database (see section 6e). The utility ncdcget_p, included with the AKclimate software package, will automatically download the necessary files and load the data into the climate database.

After downloading the files, the next step before loading the preliminary data, is the erasing of any daily data that were loaded into the database. This is necessary to ensure non-official data do not remain in the database. The utility clim3200convert, used to load the data into the database, will not overwrite any data element on a given day if the element is missing from the TD3200 file. The utility clean_file, included with the AKclimate software package, can be used to erase data. Otherwise, a routine can be developed using the netcdf library.

After erasing any old data, run the script clim_update.scr to load the preliminary data into the database.

Example: **clim_update.scr /usr/public/climate/newdata/augpre-or. 08 1998**

Update the extremes list: Example: **extrm_update.scr > logfile &**

c. Updating with Final NCDC Data

Approximately six to seven months after the fact, NCDC releases final quality controlled climate data in the TD3200 format for each state. These are the same data that will appear in the State Climate Directory. These data can be downloaded from the NCDC FTP site and loaded into the climate database (see section 6e). The utility ncdcget_f,

included with the AKclimate software package will automatically download the necessary files and load the data into the climate database.

As with the daily data, it is important to erase any preliminary data prior to loading the final data into the database. See section 7b.

After erasing any old data, run the script clim_update.scr to load the final data into the database.

Example: **clim_update.scr /usr/public/climate/newdata/augfin-or. 08 1998**

Update the extremes list: Example: **extrm_update.scr > logfile &**

VIII. DATABASE MAINTENANCE

a. General Information

As climate stations open, close, and move in the future, it will be necessary to update the scripts used to create and update the database. The station CPM is the best source for information regarding the opening and closing of stations. With the increasing availability of climate data for daily updating, scripts associated with the auto-update procedures may need to be checked on a regular basis. Even though the creation scripts may not be used again, keeping these scripts updated is important, if large portions of the database need to be re-built. Any portion of a script, even a single command, can be block copied and executed if necessary. Edit all the necessary scripts at the same time to ensure the appropriate changes are made. Maintaining good records will aid in the process.

When a new station opens, add the station to the database as soon as possible. This will ensure that all available data for the station is included in the data file. If the station is added after data first becomes available for the station from NCDC, it will be necessary to load data for the station from older NCDC monthly TD3200 files. It is important to save the monthly NCDC files for at least one year, not only to add data from newly opened stations, but for re-building climate data files, if necessary.

b. Backup Files

If complete backup files of the database are maintained, they should be updated only with final data from NCDC. This will ensure that non-official data do not contaminate the backup files. Follow the steps in 7c to update the backup files using the scripts clim_update_bak.scr and extrm_update_bak.scr. If corrections are made to historical data in the working data files, the backup data files should also be corrected for consistency.

c. 30-Year Normals

During the year 2001, new 30-year normals for the stations can be calculated using steps outlined in section 6f for the working database and the backup files.

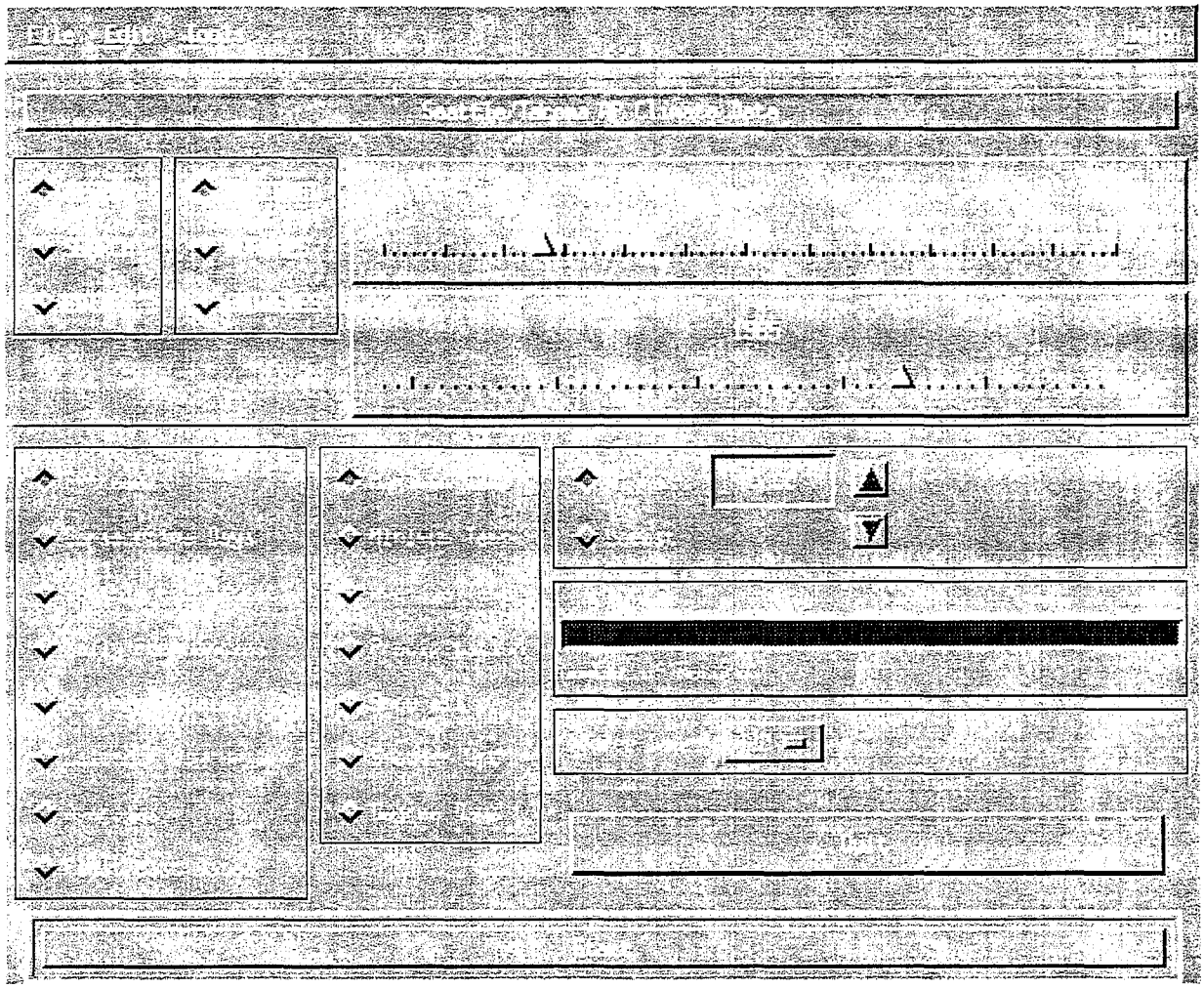

Figure 1. Xmclimate: Main display screen in display mode.

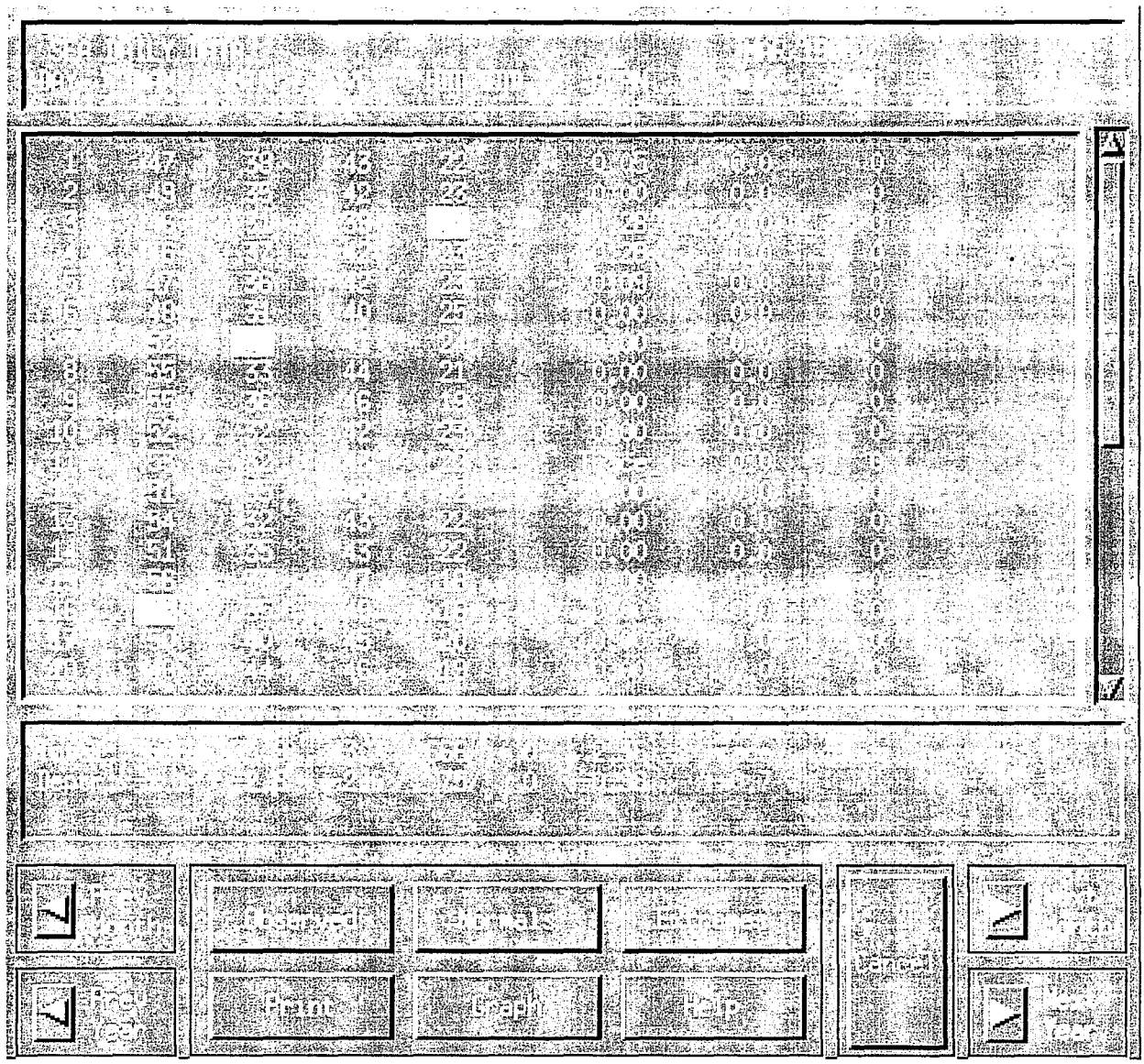

Figure 2. Xmclimate: Observed data display screen.

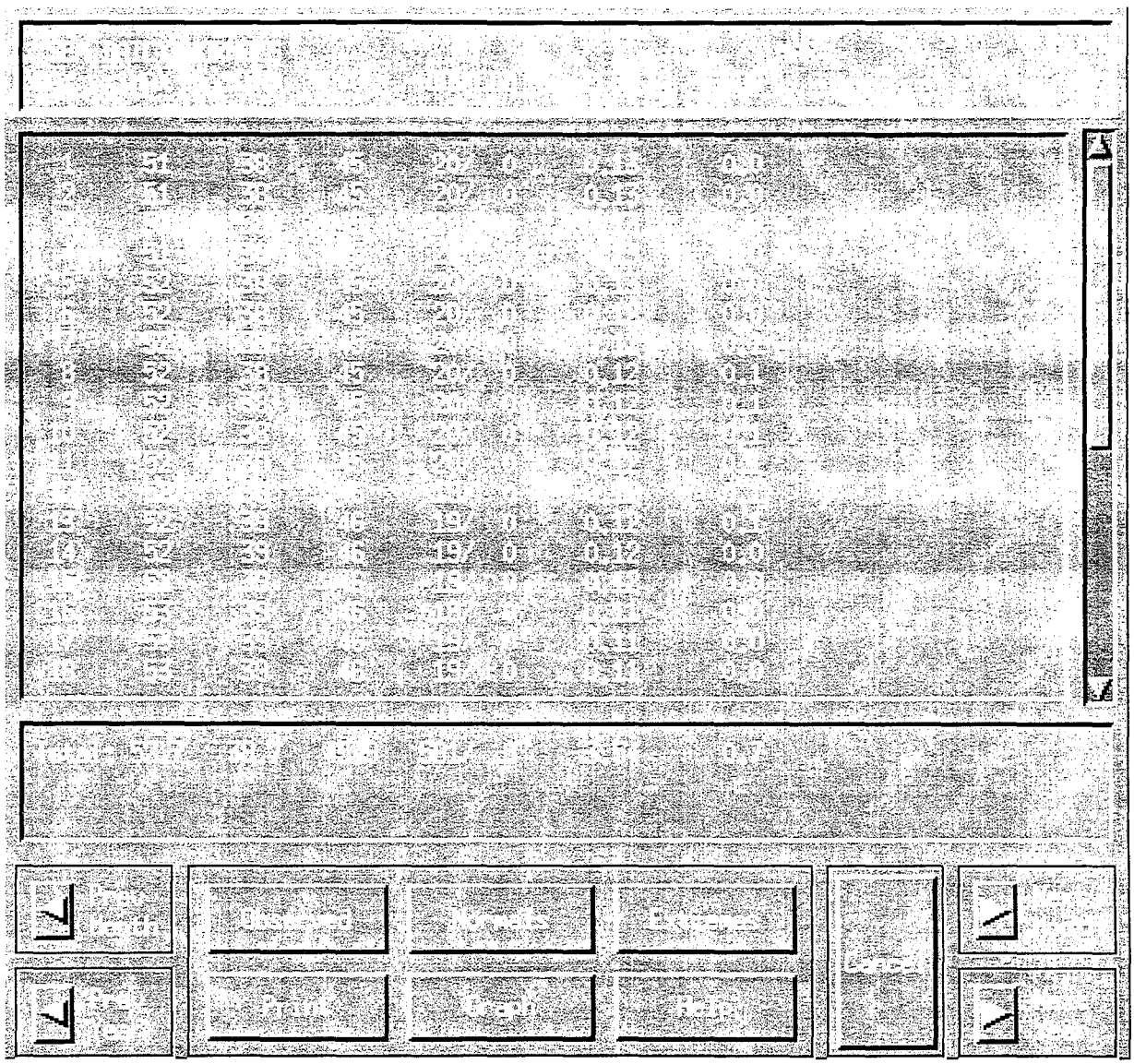

Figure 3. Xmclimate: Daily normals display screen.

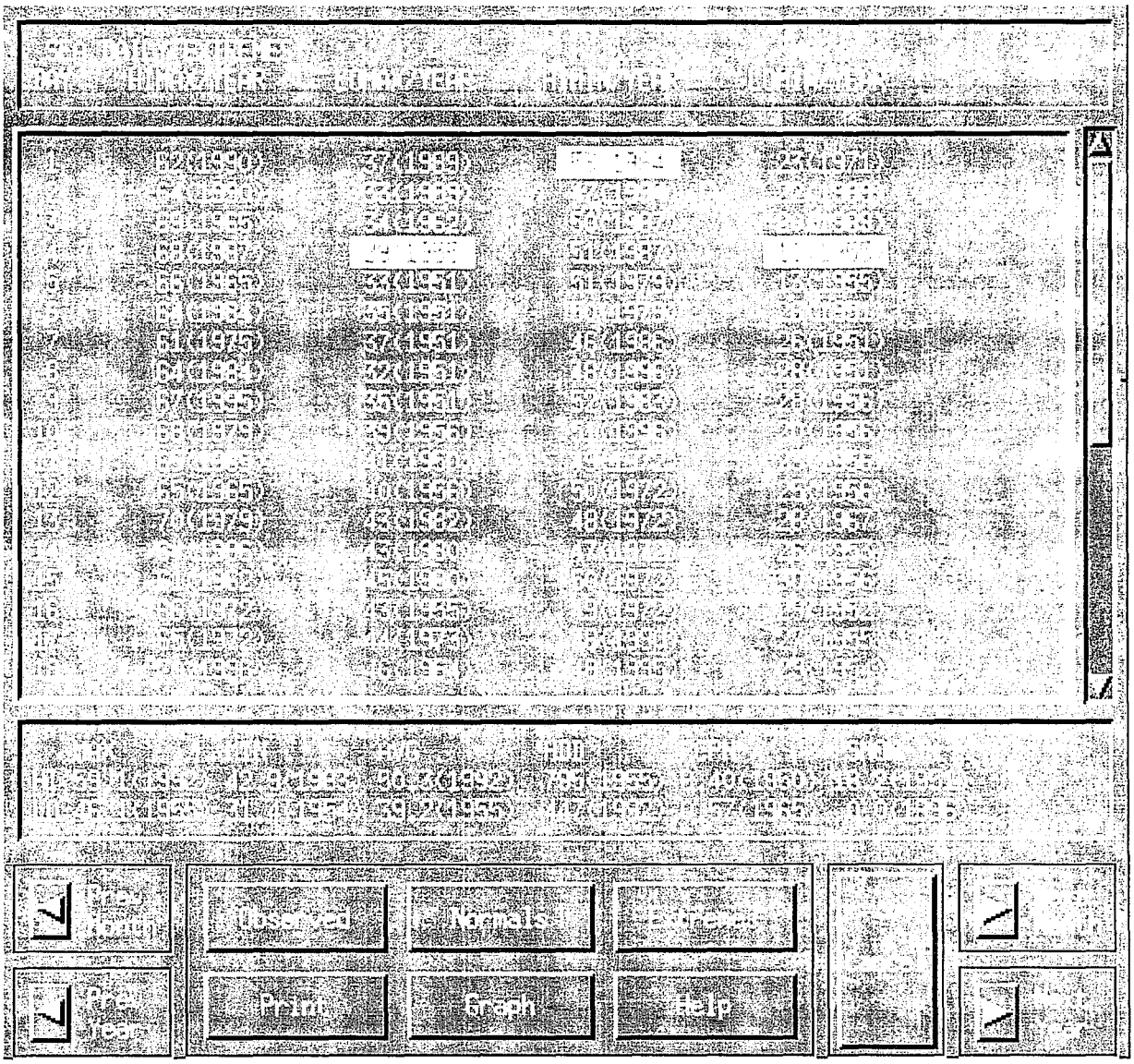

Figure 4. Xmclimate: Extreme data display screen.

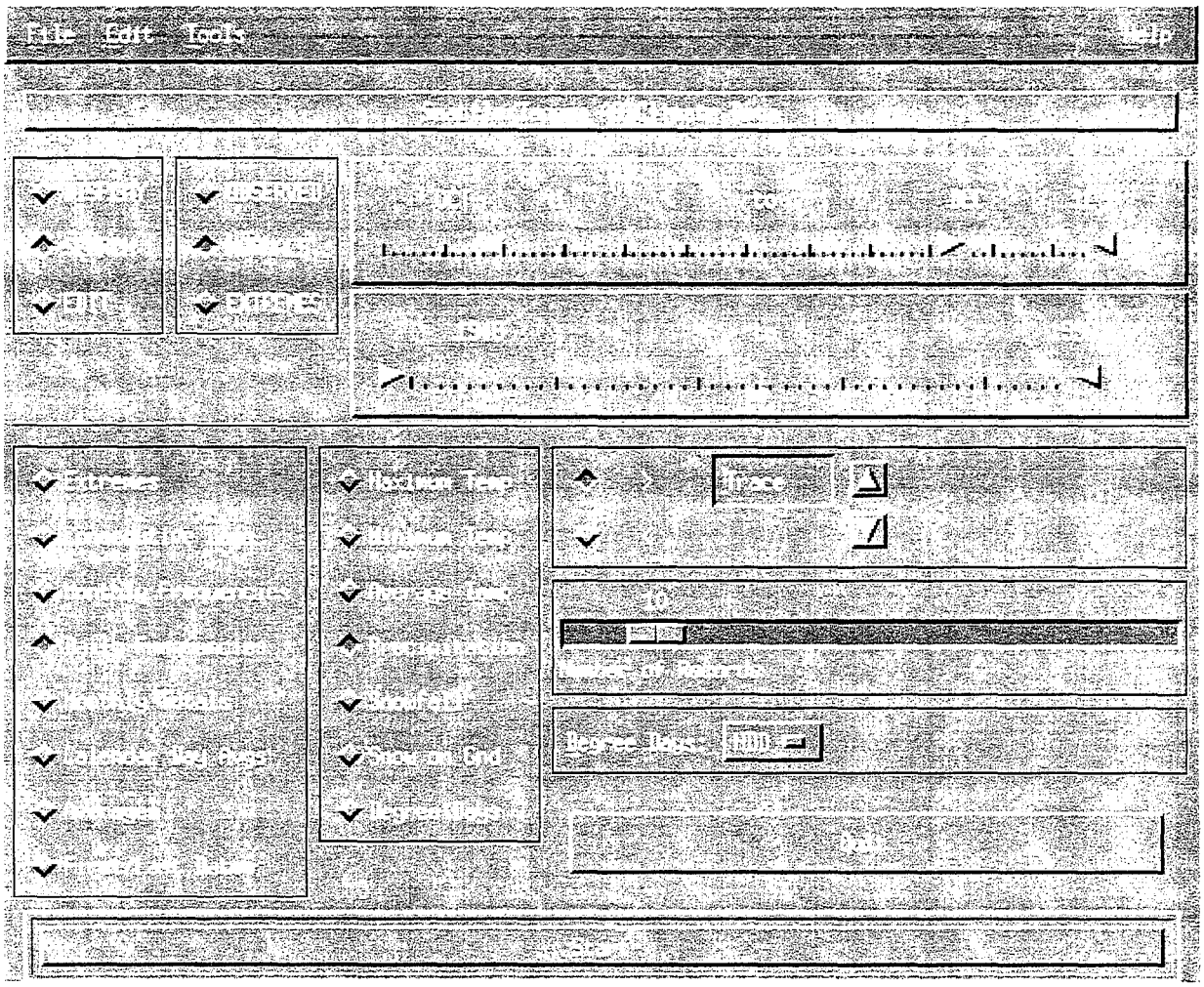

Figure 5. Xmclimate: Main display screen in search mode.

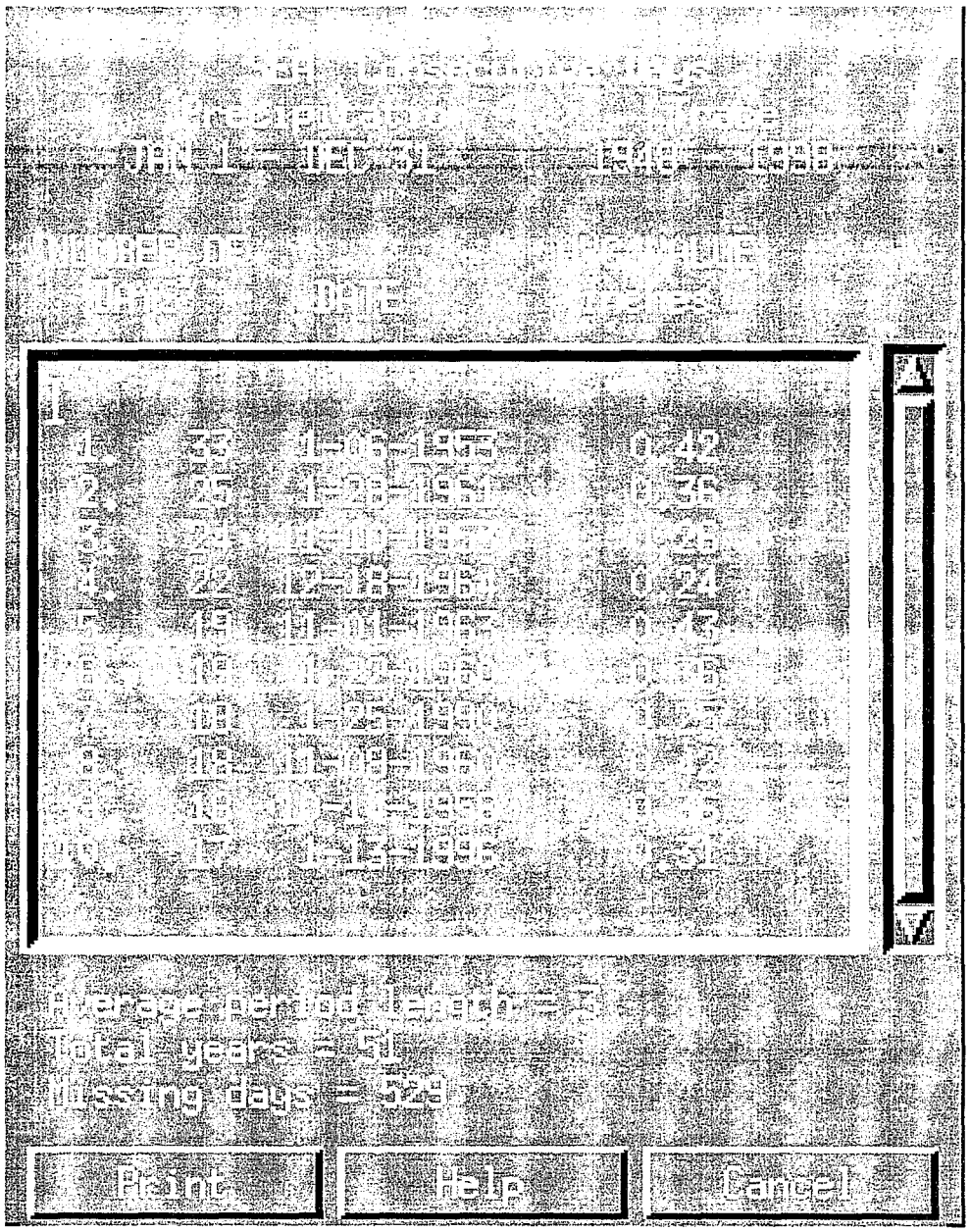

Figure 6. Xmclimate: Search result display. The display shows results of a search for the 10 longest periods of consecutive days with greater than a trace of precipitation at the Seattle/Tacoma Airport. The date the period began and the average daily precipitation total for the period is shown.

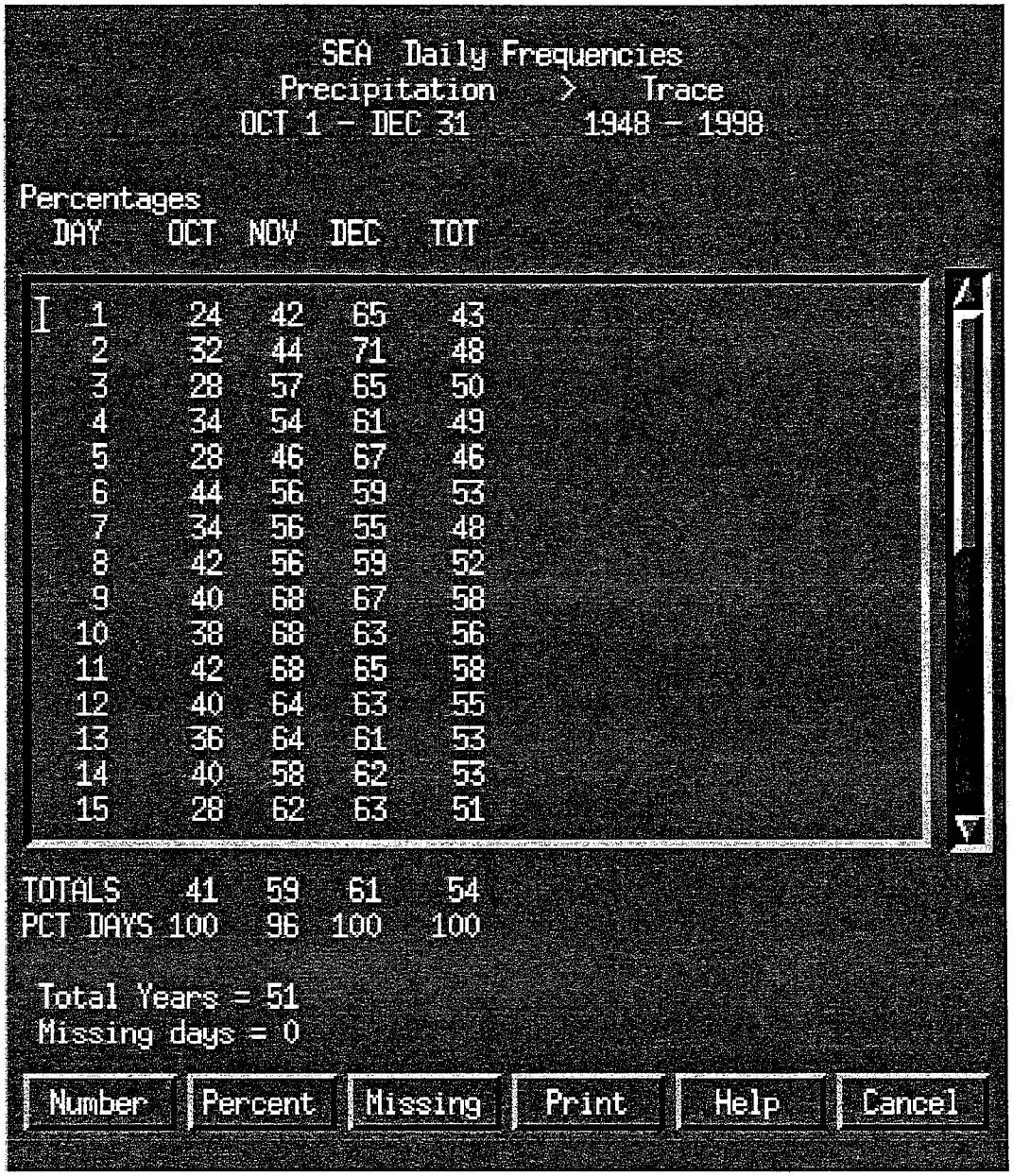

Figure 7. Xmclimate: Search results screen. The results of a search, for the period October 1 through December 31, for the climatological probability of precipitation at the Seattle/Tacoma Airport for each day in the search period.

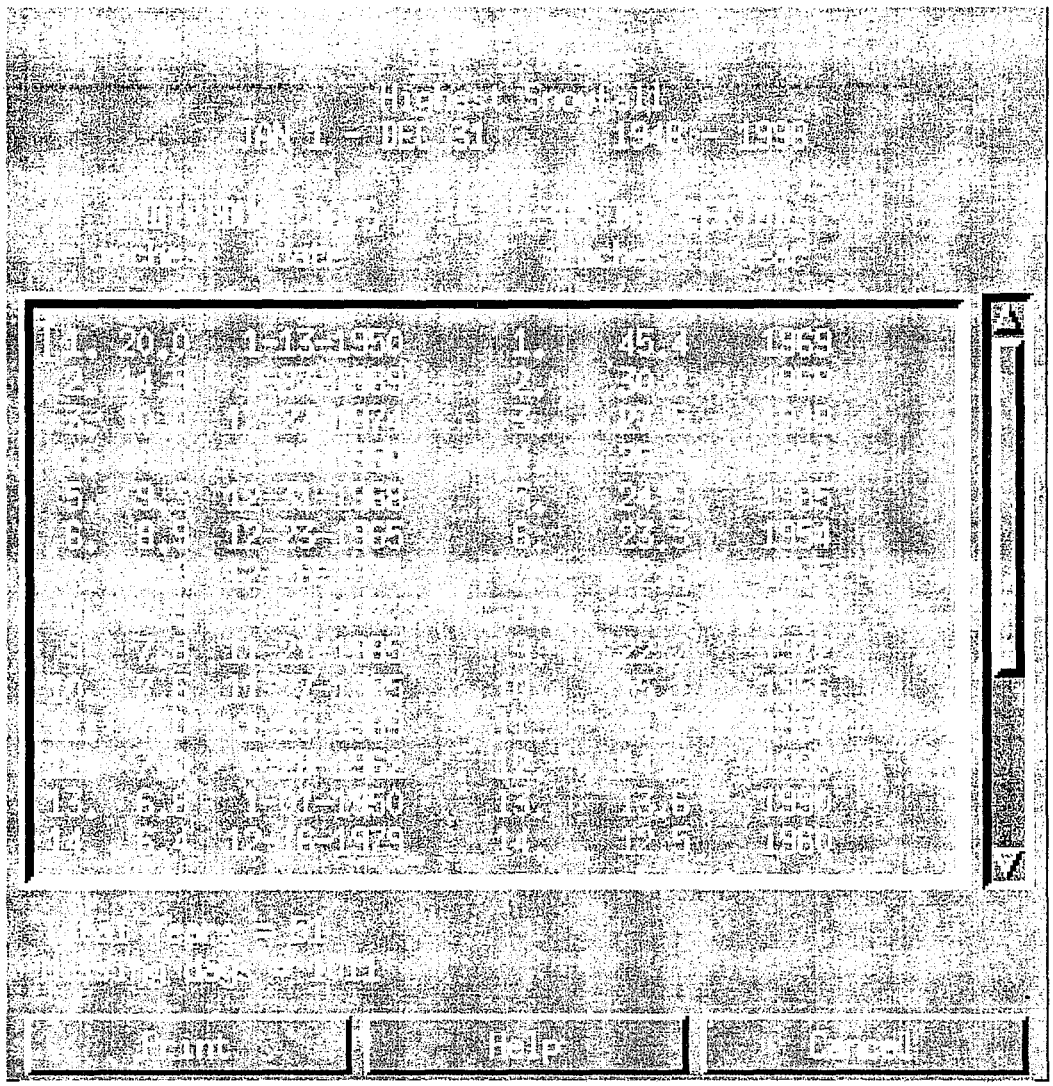

Figure 8. Xmclimate: Search results screen. Results for a search for the greatest daily and annual snowfall totals for the calendar year are listed for the Seattle/Tacoma Airport.

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