National Climatic Data Center

DATA DOCUMENTATION

FOR

DATA SET 9641F (DSI-9641F)

MONTHLY DIVISIONAL NORMALS AND STANDARD DEVIATIONS OF TEMPERATURE, PRECIPITATION, AND DEGREE DAYS (1971-2000 and previous normals periods)

December 19, 2002

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1. Abstract: This Climatography includes normals and standard deviations for the five 30-year normals periods and the 70-year period between 1931-2000 for each climate division. A *climate division* represents a region within a state that is as climatically homogeneous as possible. The divisional data are used for research applications in hydrology, agriculture, energy supply, *etc.*, where data averaged over an area rather than for a point (station) is needed. Divisional data are used to assess large-scale climatic features with respect to a long period (*i.e.*, decadal, 30-year period, *etc.*). There are 344 climate divisions in the conterminous U.S., with additional divisions in Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, and Pacific trust territories. Divisional boundaries generally coincide with county boundaries except in the western U.S., where they are based largely on drainage basins. The divisions have been established for the benefit of researchers in hydrology, agriculture, energy supply, etc., who require data averaged over an area of a state rather than for a point (station). Divisional data have been found to be useful for building larger area averages (e.g., for entire states or regions). The data presented have many applications, but like all climatological products they must be used within the framework for which they were designed.

The normals and standard deviations include values for each of the 12 calendar months and an annual value. The divisional data are displayed by name and number for a state or territory. Data for the conterminous United States are presented alphabetically, followed by data for Alaska, Hawaii, Puerto Rico, the Virgin Islands, and Pacific trust territories. The data elements, presented in separate sections, include time of observation-corrected mean temperature (degrees F), precipitation (inches), and heating and cooling degree days (base 65 degrees F).

COMPUTATIONAL PROCEDURES

Monthly divisional average temperature and total precipitation data are derived by giving equal weight to all stations reporting both temperature and precipitation within a climatological division, except for Hawaii, where any available stations (including precipitation-only stations) are used. The number of reporting stations within a division varies from month-to-month and year-to-year. Station data are *not* adjusted for inhomogeneities.

Temperature values are corrected for time of observation in the conterminous U.S. In the conterminous U.S., observers at National Weather Service cooperative stations often take one observation per day, and the ending time of the climatological day can vary from station-to-station as well as year-to-year. Differences of the 24-hour period over which maximum and minimum temperature (as well as average temperature) is reported impact the calculated monthly mean temperature. These potential biases are rectified by adjusting for varying observation times using a model (Karl *et al.*, 1986) to adjust the climate division averages such that all stations end their climatological day at midnight (*i.e.*, climatological and calendar day coincide).

Monthly divisional temperature normals and 70-year averages are computed by adding the yearly values for a given month and then dividing by the number of years in the period. The annual normal and 70-year average are computed by adding all of the monthly normal or long-term average values and then dividing by 12. Precipitation normals and long-term means are computed in a similar manner, except for the annual, which is the sum of monthly values.

Sequential monthly degree days are derived using a modification of the Rational Conversion Formulae developed by Thom (1954, 1966). This technique utilizes the historical monthly average temperature and its corresponding standard deviation (over the standardizing period 1931-2000) to compute degree days. The modified Thom technique derives the monthly degree days using a spline fit of the monthly mean temperature and standard deviations to ameliorate the month-to-month step function that is inherent with only a single monthly input. The procedure for the computation of the divisional degree day normals involves:

1. Calculation of the standard deviations of the temperatures for each of the 12 calendar months over the standardizing period;
2. Use of the modified Thom technique to compute the heating and cooling degree days for every month and year in the period 1931-2000;
3. Calculation of the 30-year normals and 70-year (1931-2000) long-term averages of the degree days using the procedure discussed above.

Standard deviations are computed using the sum and sum square values from the corresponding period of month-year sequential values. For annual temperature, the sum and sum square of the annual values are used, while for annual precipitation, the sum and sum square of monthly values are used.

A normal has been defined by international agreements as the arithmetic average or mean of a climatological element over three consecutive decades. A standard deviation for a period measures the spread or dispersion of the period's values about their mean; i.e., their deviation from the mean. The standard deviation or dispersion about the mean is small if the values are closely bunched about their mean, and it is large if the values are scattered widely about their mean.

Normals and standard deviations were computed for the following periods: 1931-60, 1941-70, 1951-80, 1961-90, and 1971-2000. In addition, long-term means were computed for the 1931-2000 period. The monthly normals for a division were computed by adding the 30 (or more) values from the appropriate time period for a given month and then dividing by the number of years in the period. For temperature, the annual normals and annual long-term averages were computed by adding all of the monthly normal or monthly long-term average values and then dividing by 12. For precipitation and degree days, the annual normals and annual long-term averages were computed by adding the 12 monthly normal or long-term monthly average values.

If an annual normal were computed by averaging the annual values obtained for each year in the period, it may be slightly different from the sum of the 12 monthly normals (long-term averages) because of rounding differences.

DIFFERENCES FROM PREVIOUS DIVISIONAL NORMALS

The normals and standard deviations in this data set make up *Climatography of the United States, No. 85* Divisional Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1971-2000 (and previous normals periods). The monthly and annual temperature and precipitation normals and standard deviations for 1931-60, 1941-70, 1951-80, and 1961-90 for some divisions may differ from the corresponding normals and standard deviations printed in earlier editions of *Climatography of the United States, No. 85*. This is due to two reasons. First, station data were *not* adjusted for inhomogeneities in the 1931-2000 release. Second, the composition of the

divisional data base changed in the 1980s due to the need to include corrected and late station reports. These updates made for a more complete and accurate release of values in the 1931-1990 publication, in which difference from previous publications were indicated with an comparison indicator flag ('*'), as documented in topic 6.

The 1931-2000 release includes supplemental divisional data for Hawaii. Hawaiian Hydrological Divisions were included in the data set to better summarize the impact of varied topography and the locations of the observation stations in Hawaii on highly localized precipitation patterns. These patterns are at a finer resolution than the island-by-island climate divisions. Research by NWS's Hydrometeorological Design Studies Center (NOAA, 2002) has led to the establishment of regional divisions for precipitation frequency studies. Data based on these divisions are included in the publication *Climatography of the United States, No. 85* at the end of the precipitation section.

2. Element Names and Definitions: The data are archived in eight files of fixed-length ASCII format.

File 1. 1931-2000 DIVISIONAL SEQUENTIAL TEMPERATURE
(9641F_1971-2000_NORM_CLIM85_TEMP_SEQ)
File 2. 1931-2000 DIVISIONAL TEMPERATURE NORMALS
(9641F_1971-2000_NORM_CLIM85_TEMP_AVG)
File 3. 1931-2000 DIVISIONAL SEQUENTIAL PRECIPITATION
(9641F_1971-2000_NORM_CLIM85_PRCP_SEQ)
File 4. 1931-2000 DIVISIONAL PRECIPITATION NORMALS
(9641F_1971-2000_NORM_CLIM85_PRCP_AVG)
File 5. 1931-2000 DIVISIONAL SEQUENTIAL HEATING DEGREE DAYS
(9641F_1971-2000_NORM_CLIM85_HDD_SEQ)
File 6. 1931-2000 DIVISIONAL HEATING DEGREE DAY NORMALS
(9641F_1971-2000_NORM_CLIM85_HDD_AVG)
File 7. 1931-2000 DIVISIONAL SEQUENTIAL COOLING DEGREE DAYS
(9641F_1971-2000_NORM_CLIM85_CDD_SEQ)
File 8. 1931-2000 DIVISIONAL COOLING DEGREE DAY NORMALS
(9641F_1971-2000_NORM_CLIM85_CDD_AVG)

ELEMENT	WIDTH	POSITION
ELEMENT CODE	1	001-001
STATE IDENTIFIER CODE	2	002-003
CLIMATE DIVISION NUMBER (Value=01 to 10)	2	004-005
BEGINNING YEAR (e.g., 1971)	4	006-009
ENDING YEAR (e.g., 2000)	4	010-013
MONTHLY VALUE FOR JANUARY	5	014-018
COMPARISON INDICATOR FOR JANUARY	1	019-019
MONTHLY VALUE FOR FEBRUARY	5	020-024
COMPARISON INDICATOR FOR FEBRUARY	1	025-025
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MONTHLY VALUE FOR NOVEMBER	5	074-078
COMPARISON INDICATOR FOR NOVEMBER	1	079-079
MONTHLY VALUE FOR DECEMBER	5	080-084
COMPARISON INDICATOR FOR DECEMBER	1	085-085

ANNUAL VALUE	6	086-091
COMPARISON INDICATOR FOR ANNUAL VALUE	1	092-092
STATISTIC CODE	1	093-093
DEGREE DAY BASE TEMPERATURE (Degree Days Only)	3	094-096

ELEMENT CODES:

1 = Mean Temperature
2 = Total Precipitation
3 = Heating Degree Days
4 = Cooling Degree Days

STATE IDENTIFIER CODES:

01 Alabama	19 Massachusetts	37 Rhode Island
02 Arizona	20 Michigan	38 South Carolina
03 Arkansas	21 Minnesota	39 South Dakota
04 California	22 Mississippi	40 Tennessee
05 Colorado	23 Missouri	41 Texas
06 Connecticut	24 Montana	42 Utah
07 Delaware	25 Nebraska	43 Vermont
08 Florida	26 Nevada	44 Virginia
09 Georgia	27 New Hampshire	45 Washington
10 Idaho	28 New Jersey	46 West Virginia
11 Illinois	29 New Mexico	47 Wisconsin
12 Indiana	30 New York	48 Wyoming
13 Iowa	31 North Carolina	49 not used
14 Kansas	32 North Dakota	50 Alaska
15 Kentucky	33 Ohio	66 Puerto Rico
16 Louisiana	34 Oklahoma	67 Virgin Islands
17 Maine	35 Oregon	91 Pacific Islands
18 Maryland	36 Pennsylvania	

STATISTIC CODES:

1 = Sequential Year-Month Value
2 = Mean: Beginning to Ending Year, Inclusive
3 = Standard Deviation: Beginning to Ending Year, Inclusive

All files share the same format:

ELEMENT CODE

This 1-digit code indicates the element type (temperature, precipitation, heating degree days, or cooling degree days corresponding to 1, 2, 3, or 4, respectively) (Position 01).

STATE IDENTIFIER CODE

The 2-digit code indicating the state (see above). Codes 01-48 are used for conterminous U.S. States (the District of Columbia is included in Maryland (state 18). Code 49 is not used. Code 50 is for Alaska, code 51 is for Hawaii. Territories are assigned the following codes: 66=Puerto Rico, 67=U.S. Virgin Islands, and 91=Pacific Islands (U.S. Pacific Trust Territories) (Position 02-03).

CLIMATE DIVISION NUMBER

This number refers to the portion of a state or territory that make up a climate division. A climate division represents a region within a state that is as climatically homogeneous as possible. Divisions generally coincide with county boundaries except in the western U.S., where they are based largely on drainage basins.

Climate divisions are numbered from 01 to 10. Most states have fewer than 10 divisions. Rhode Island (state 37) is comprised of a single division. There is no division 04 in Nebraska, and no division 01 in the Pacific Islands. The District of Columbia is included in division 04 of Maryland (state 18). The Virgin Islands data from St. Thomas, St. Croix, and St. John have been combined into a three-island average (Position 04-05).

BEGINNING YEAR

The first year of a normals or long-term mean period (e.g., 1931, 1941, 1951, 1961, 1971) (Position 06-09).

ENDING YEAR

The last year of a normals or long-term mean period (e.g., 1960, 1970, 1980, 1990, 2000) (Position 10-13).

MONTHLY/ANNUAL VALUE

The data value. For sequential files, this value is the month-year mean or total. For normals files, this value is the arithmetic mean of the sequential values for the period including the beginning to ending year (Position 14-91).

COMPARISON INDICATOR

An asterisk '*' indicates that a value is different from what was previously published (for 1961-1990 data set only) (Position 19, 25, etc.).

The data value. For sequential files, this value is the year-month mean or total. For mean files, this value is the arithmetic mean of the sequential values for the period including the beginning to ending year (Position 14-91).

STATISTIC CODE

This 1-digit code indicates the data type (sequential year-month values, period mean, period standard deviation corresponding to 1, 2, or 3, respectively). The period is defined to be the beginning year through the ending year, inclusive (Position 93).

DEGREE DAY BASE TEMPERATURE

The temperature in degrees Fahrenheit from which degree day computations are based (Position 94-96).

COMPARISON INDICATOR: An asterisk '*' indicates that a value is different from what was previously published (for 1961-1990 data set only).

UNITS: Temperature (degrees Fahrenheit) and degree day values are in whole units, while the precipitation values are in hundredths of an inch.

File 1. 1931-2000 DIVISIONAL SEQUENTIAL TEMPERATURE (9641F_1971-2000_NORM_CLIM85_TEMP_SEQ)

This file contains the official divisional sequential monthly and annual temperature values for January 1931 through December 2000. The following values specifically identify this file:

ELEMENT CODE = 1
STATISTIC CODE = 1

File 2. 1931-2000 DIVISIONAL TEMPERATURE NORMALS (9641F_1971-2000_NORM_CLIM85_TEMP_AVG)

This file contains the official divisional monthly and annual temperature means and standard deviations for January 1931 through December 2000. The following values specifically identify this file:

ELEMENT CODE = 1
STATISTIC CODE = 2 or 3

File 3. 1931-2000 DIVISIONAL SEQUENTIAL PRECIPITATION (9641F_1971-2000_NORM_CLIM85_PRCP_SEQ)

This file contains the official divisional sequential monthly and annual precipitation values for January 1931 through December 2000. The following values specifically identify this file:

ELEMENT CODE = 2
STATISTIC CODE = 1

File 4. 1931-2000 DIVISIONAL PRECIPITATION NORMALS (9641F_1971-2000_NORM_CLIM85_PRCP_AVG)

This file contains the official divisional monthly and annual precipitation means and standard deviations for January 1931 through December 2000. The following values specifically identify this file:

ELEMENT CODE = 2
STATISTIC CODE = 2 OR 3

File 5.* 1931-2000 DIVISIONAL SEQUENTIAL HEATING DEGREE DAYS (9641F_1971-2000_NORM_CLIM85_HDD_SEQ)

This file contains the official divisional sequential monthly and annual heating degree day values for January 1931 through December 2000. The following values specifically identify this file:

ELEMENT CODE = 3

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STATISTIC CODE = 1

File 6.* 1931-2000 DIVISIONAL HEATING DEGREE DAY NORMALS (9641F_1971-2000_NORM_CLIM85_HDD_AVG)

This file contains the official divisional monthly and annual heating degree day totals and standard deviations for January 1931 through December 2000. The following values specifically identify this file:

ELEMENT CODE = 3
STATISTIC CODE = OR 3

File 7.* 1931-2000 DIVISIONAL SEQUENTIAL COOLING DEGREE DAYS (9641F_1971-2000_NORM_CLIM85_CDD_SEQ)

This file contains the official divisional sequential monthly and annual cooling degree day values for January 1931 through December 2000. The following values specifically identify this file:

ELEMENT CODE = 4
STATISTIC CODE = 1

File 8.* 1931-2000 DIVISIONAL COOLING DEGREE DAY NORMALS (9641F_1971-2000_NORM_CLIM85_CDD_AVG)

This file contains the official divisional monthly and annual cooling degree day totals and standard deviations for January 1931 through December 2000. The following values specifically identify this file:

ELEMENT CODE = 4
STATISTIC CODE = 2 OR 3

NOTE ON DEGREE DAY ELEMENTS (4.5-4.8): Degree days are a derived quantity computed using a modification to the H.C.S. Thom method for a standardizing period of 1931-2000 (see topic 58). Therefore, caution should be exercised in comparing with previously published results.

3. Start Date: The normals period covered by this data set is 1931-2000. The earliest Start Date is 19310101.

4. Stop Date: The normals period covered in this data set is 1931-2000. The latest Stop Date is 20001231.

5. Coverage: Climate division data across the USA, including the 50 states and possessions (Puerto Rico, Virgin Islands, and Pacific Islands).

a. Southernmost Latitude: 15S
b. Northernmost Latitude: 72N
c. Westernmost Longitude: 64W
d. Easternmost Longitude: 121E

6. How to Order Data:

Ask NCDC's Climate Services about the cost of obtaining this data set.
Phone: 828-271-4800
FAX: 828-271-4876

E-mail: NCDC.Orders@noaa.gov

7. Archiving Data Center:

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, NC 28801-5001
Phone: (828) 271-4800.

8. Technical Contact:

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, NC 28801-5001
Phone: (828) 271-4800.

9. Known Uncorrected Problems: None.

10. Quality Statement: The monthly data that were input to the examination and adjustment algorithms had undergone range, climatology, and allowed value checks at the NCDC's Data Operations Branch. Preparation of the normals sequential values was conducted using statistical assessments by NCDC's Scientific Services Division.

Benign neglect, state of the art processing, and limited money/people resources all contributed toward less than optimum conditions in maintaining integrity of the digital files. Many of these shortcomings are now recognized and efforts continue to upgrade the principal data sets.

11. Essential Companion Datasets: *Climatography of the United States, No. 81* Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1971-2000

12. References:

Climatography of the United States, Number 81: Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1971-2000. National Climatic Data Center, Asheville, NC.

Climatography of the United States, Number 84: Daily Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1971-2000. National Climatic Data Center, Asheville, NC.

Guttman, N.B. and R.G. Quayle, 1995: "A Historical Perspective of U.S. Climate Divisions", Bulletin of the American Meteorological Society, Statistical descriptors of climate, Bulletin of the American Meteorological Society, Vol. 77, no. 2, pp. 293-303.

Karl, T.R., C.N. Williams, Jr., P.J. Young, and W.M. Wendland,1986: "A model to estimate the time of observation bias associated with monthly mean maximum, minimum, and mean temperatures for the United States," Journal of Climate and Applied Meteorology, Vol. 25, pp. 145-160.

NOAA, 2002: Hawaii Precipitation Frequency Study: Update of *Technical Paper No. 43*, NOAA/NWS/Office of Hydrology.

Thom, H.C.S., 1954a: "The rational relationship between heating degree days and temperature." Monthly Weather Review, Vol. 82, pp. 1-6.

Thom, H.C.S., 1954b: "Normal degree days below any base." Monthly Weather Review, Vol. 82, pp. 111-115.

Thom, H.C.S., 1966: "Normal degree days above any base by the universal truncation coefficient." Monthly Weather Review, Vol. 94, pp. 461-465.

Appendix A. Sensor Name and Operating Principles:

Divisional data is based on station data, including both professionally-maintained and volunteer sites that make up the Cooperative Observer Network. Instrumentation since 1931 has been varied, but generally includes the following:

Minimum Temperature; Maximum Temperature

In the beginning years of this data set, liquid-in-glass thermometers were used to measure these elements. This thermometer is a liquid-filled, U-shaped capillary tube with reservoirs at each end. Two floating indicators to mark the highest and lowest temperature that occurred between resetting times. Resetting is supposed to be done every 24 hours at the same clock time.

For approximately 400 stations in this data set (First-Order Stations), temperature values were observed hourly from hygro-thermometers that are part of the Automated Surface Observing System (ASOS). Prior to ASOS, hygrothermometers were used back to the universal installation of hygro-thermometers in the 1960's, when hourly temperatures were observed with psychrometers and thermographs.

Precipitation

The instrument generally in use for this data set was the 8 inch Standard Rain Gauge. Daily precipitation was measured visually to the nearest .01 inch. Occasionally stations used non-standard gauges (4 inch/plastic).

For approximately 400 stations in this data set (First-Order Stations), precipitation was observed hourly from one of two types of recording rain gauges:

Weighing Rain Gauge (pre-ASOS)

The gauge records the weight of a precipitation-collecting bucket via a spring mechanism, connected to a pen, that records on a paper chart. Records precipitation to a hundredth of an inch (0.01").

Tipping Bucket Rain Gauge

The gauge records the number of times in a 5-minute period that a small collecting bucket that holds one hundredth of an inch (0.01") of water is filled, tips over, and empties. The recorded number of tips is telemetered to a collection site.

Appendix B. Additional Station Information

Station Location Accuracy: Location accuracy is to the nearest minute of Latitude/Longitude. Elevation accuracy varies from the nearest foot to nearest Topographic Map Contour interval.

Divisional boundaries are based on criteria established by the National Climatic Data Center (Guttman and Quayle, 1995).

Station Observation Schedule: The observation schedule varied with station. Some stations (Cooperative Stations) made once-daily readings of daily (24-hour) maximum and minimum temperature and total precipitation in the morning, some in the afternoon, some in the evening, and some at midnight. Other stations (First-Order Stations) had more frequent (hourly) observation schedules and reported daily (24-hour) maximum and minimum temperature and total precipitation on a midnight-to-midnight (calendar) basis.

Station Data Time Averaging: The data values in this data set are based on 30-year and long-term averages of monthly mean maximum temperature, monthly mean minimum temperature, monthly mean temperature, monthly total degree days, and monthly total precipitation.

Station Grouping, Using Spatial Sampling: Sampling for missing values according to methodology discussed above.

Network Participation: The Cooperative Observer Network was used for this data set, which is comprised of U.S. stations primarily staffed by "cooperative" observers. The vast majority of these observers are volunteers (non-paid, private individuals) for the National Weather Service (NWS). The cooperative stations are augmented by professionally operated NWS stations, also part of the Cooperative Observer Network and located predominantly at airports.

Geographical Criteria for Selecting Stations: Data computed from stations lying within geographic boundaries of each climate division.

Geographical Distribution: There are 344 climate divisions in the conterminous U.S., with additional division in Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, and Pacific trust territories. Divisions generally coincide with county boundaries except in the western U.S., where they are based largely on drainage basins.

Elevation Statement: Most of the stations contributing to the climate division data had elevations below 1000 meters above sea level. The minimum elevation is -60 meters and the maximum is 3300 meters. Climate division mean elevations vary markedly across the United States.

Missing Data Periods: The year-month sequential file includes estimates of missing values in order to achieve serial completeness. Station inputs vary from month to month.

Error Detection and Correction: Station data is quality controlled through neighbor validation on a monthly basis.

Missing Value Estimates: Missing data were estimated from neighboring stations.

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