SHRP-A-685

Development of SHRP Asphalt Research Program Climatic Databases

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Contents

Abstract

This report describes the development of two climatic databases for use in performance prediction models. The summary weather database includes a number of statistical parameters on seven-day maximum air temperatures and lowest annual temperatures for over 6,000 weather stations in the United States and about 1,800 weather stations in Canada. The daily temperature database contains the maximum and minimum daily temperature data for ten years and the average annual maximum and minimum daily temperatures for each station. The percent coverage of the United States for different temperature intervals is presented. An analysis of the average seven-day maximum air temperature versus the average monthly maximum temperature is included.

Executive Summary

One of the important goals of the asphalt research program of the Strategic Highway Research Program was to develop a series of performance-based specifications and design systems. As part of the program, a series of climatic databases was created. These databases are divided into two categories: summary weather data; and daily temperature data. The former includes a number of statistical parameters on seven-day maximum air temperatures and lowest annual temperatures for over 6,000 weather stations in the United States and about 1800 weather stations in Canada. The weather data from this database is used in calculation of the pavement temperature as well as selection of the appropriate binder grade. The latter database includes the maximum and minimum daily temperature data for ten years as well as the average annual maximum and minimum daily temperatures for each station. The data from this database is used as input for performance prediction models. In addition, the percent coverage of the United States for different temperature intervals is presented. An analysis is also included on comparison of the average seven-day maximum air temperature versus the average monthly maximum temperature.

Introduction

One of the important goals of the asphalt research program of the Strategic Highway Research Program was to develop a series of performance-based specifications and design systems. The environmental conditions are very diverse, and research has shown that these conditions significantly influence pavement performance. Therefore, the effect of climatic factors is incorporated into the specifications and asphalt mix design system developed by SHRP.

SHRP created a number of environmental databases for both the development of specifications and the prediction of pavement performance. Efforts were made to identify the environmental parameters required for this purpose. Two databases were created for the Superpave mix design system.

Development of Databases

Historical weather data can be used to predict weather patterns. For this reason, such data were used to create required databases. Two environmental databases were developed: the Summary Database and the Daily Temperature Database. The first attempt was to identify the climatic parameters required for each database. The former database is to be used in conjunction with selection of the appropriate binder grade for a particular site and also in conjunction with the test criteria that need to be satisfied for both binder and mixture. The latter database includes parameters for use in conjunction with the performance prediction models under the Superpave system.

The minimum and maximum pavement temperatures are determined in the Superpave system using the minimum and maximum air temperatures provided in the database for each location. The results are used to select the appropriate binder grade to resist low temperature cracking and permanent deformation.

The Summary Database

Once climatic elements were identified, EarthInfo Inc. of Boulder, Co was designated to develop the database. The data were computed, customized, and retrieved from four compact disks covering weather data provided by National Climatic Data Center (NCDC) for over 15,000 stations in the United States. For Canada, data from approximately 6700 stations were used. The documentation provided by EarthInfo for both the United States and Canada climatic databases are presented in Appendix D.

Database Elements and Structure

The data files were created both in ASCII and dBase III formats. The entries for the main database include stations with more than twenty years of data (total of approximately 6000 for the United States and 1,800 for Canada). However, another database was created for weather stations with fewer than twenty years of data just in case there is demand for this data due to unanticipated situations. The geographic data attributes for each station (state, county, longitude, latitude and elevation) are included in the database. The U.S. database includes 45 fields as outlined in Appendix A. The Canada database has similar data with the addition of snow data (total of 52 fields). Some examples are also given in Appendix A for contents of the database fields. Stations with very strange temperature values (about 30 stations) and stations with missing values for latitude (about 10 stations) were removed from the database.

The Superpave database uses 10 of the available 45 parameters: state, county, station name, longitude, latitude, elevation, average lowest air temperature, standard deviation for the lowest air temperature, average highest seven-day maximum air temperature, and standard deviation for the average highest seven-day maximum air temperature. These temperatures are used to determine the minimum and maximum pavement temperatures.

The lowest pavement temperature and the highest 7-day averaged daily high pavement temperature are used in selection of the appropriate binder to resist low temperature cracking and permanent deformation, respectively. The lowest air temperature can be directly tied into the lowest pavement temperature, and highest 7-day averaged daily high air temperature can be used to estimate maximum pavement temperature once the latitude of the site is known.

The Lowest Temperature

The lowest pavement temperature at a site is determined based on the lowest air temperature. For this purpose, the lowest air temperature data recorded in the weather stations throughout the United States and Canada with more than 20 years of data were used. However, rather than recording data for all the years in the database it seemed logical to use the average value with some statistical parameters to yield a reasonable distribution for the lowest temperature prediction. In order to determine what parameters are required a number of cities throughout the United States with diverse environmental conditions were selected. For each city the lowest annual temperature was obtained for the years for which records were available. For Minneapolis/St Paul, 100 years of records were available. For most, as many as 30 to 40 years of data were available. Here, the lowest annual temperature is defined as the lowest single temperature recorded throughout the whole year. The figures in Appendix B exhibit the frequency distribution of the lowest recorded temperatures for some of the cities. Analysis of these data by the asphalt research program statisticians revealed that a weibull distribution fits data better than a normal distribution. However, a normal distribution is also believed to yield reasonable results. Therefore, it was decided to collect the following five parameters for prediction of the lowest temperature:

1. The lowest temperature ever recorded (TMin)
2. The mean of all lowest temperatures (The summation divided by number of years of record)
3. The median of all lowest temperatures
4. The standard deviation of all lowest temperatures
5. The number of years of records used to determine the above parameters.

To improve reliability in predictions only stations with more than 20 years of records were selected. For any year, the lowest temperature recorded in the station is found. The process is repeated for all the years for which data are available. The lowest values obtained this way for all the years are averaged.

Example:

Lowest Air Temperature in	1940	-16°C (on Dec 23)
	1941	-20°C (on Jan 7)
	1942	- 4°C (on Jan 21)
	....	
	....	
	1990	-26°C (on Feb 2)
Average		-15°C

The average lowest air temperature obtained this way is converted into the pavement temperature.

The Highest 7-Day Averaged Daily High Temperature

The permanent deformation is believed to correlate better with the highest seven-day averaged daily maximum pavement temperature rather than highest monthly maximum pavement temperature. Here, the average seven-day maximum air temperature in a year is defined as the average value of maximum daily air temperatures for seven consecutive days in a year. In any year, seven consecutive days are selected. The maximum air temperature for each of these seven days is found. The average of these maximum temperatures is determined. A marching forward in time takes place, i.e. the first day of the seven-day sequence is dropped and one day is added to the end to complete the set again, and the calculations are repeated. This way, a large number of average seven-day maximum air temperatures are obtained. The largest of all these averages for that particular year is selected as the 'Highest Averaged seven-day Daily Maximum Air Temperature'. The process is repeated for all the years for which temperature records are available. For example, if there are 30 years of record at one station, 30 values will be obtained for 7-day maximum temperature, one for each year. The mean value of these 30 numbers will be calculated, and converted into pavement temperature.

Example:

Year: 1940

		Temp.(°C)
Day	210 (July 29)	37
	211	39
	212	41
	213	38
	214	35
	215	35
	216	37
	Average	37.4 (call it THIGH1)

Assume the above average is the highest maximum temperature for seven consecutive days in 1940.

Repeat for all other years (example: 1940 through 1990 which gives 51 years of record). Find the average of all the values (THIGH1 through THIGH51) and convert it into pavement temperature.

As was the case for the lowest temperature, statistical parameters were selected for future predictions of maximum temperature rather than using calculated values for all the years. To investigate the distribution of maximum temperature throughout the years, the average maximum temperature of the hottest month (the highest mean maximum temperature) for each year was determined. This monthly temperature parameter was used because at the time the seven-day maximum temperature was not available to investigate the distribution. The frequency distributions are shown in Appendix B. Statistical analysis of this data indicated that a normal distribution will be sufficient for prediction purposes. To be consistent with the lowest temperature category, however, the same kind of parameters were also selected for the maximum temperature as follows:

1. The highest average seven-day maximum air temperature
2. The mean value of all average seven-day maximum air temperatures
3. The standard deviation for all years of record
4. The median of all average seven-day maximum air temperature
5. Number of years of record used to determine the above parameters

Other Database Parameters

Even though the lowest air temperature and the average seven-day maximum temperature were the main parameters to be included in the database, some other useful factors were also included for comparison purposes as well as for unanticipated needs. Appendix A presents all the parameters covered in the summary database, as well as some examples of database fields.

Seven-Day Maximum Temperature versus Monthly Average Maximum Temperature.

As mentioned before, the SHRP recommendation is to use the average-highest seven-day maximum temperature at a site as the environmental criterion in selection of the appropriate binder to resist permanent deformation. It has also been a subject of interest to investigate how the permanent deformation is related to the monthly maximum temperature. For this reason, it was decided to compare monthly maximum and seven-day maximum temperatures and evaluate their correlations. Here, the seven-day temperature is defined as was discussed before. The monthly average maximum temperature is considered to be the average maximum temperature of the hottest month of the year (average daily maximum temperature of the hottest month). For regional comparison, the United States was divided into six different regions and a plot of seven-day maximum temperature versus monthly maximum temperature was obtained for each region based on the available climatic data. A regression analysis was carried on for each region and the R^2 value was determined. The regions and the corresponding regression equations and R^2 values are presented in Tables 1 and 2, respectively. The corresponding graphs are presented in Appendix C. The correlation is also reported for all the stations combined together throughout the United States. It can be seen that the highest correlation exists for the West and Rockies regions (R^2 higher than 0.85). The overall correlation for U.S. yields an R^2 of 0.90. Monthly maximum and 7-day maximum temperatures are also correlated for some of the cities as shown in figures of Appendix C. In general, it can be seen that 7-day and monthly temperatures have a strong correlation in most cases. On the average, the 7-day temperature is about 5 to 7°F higher than the monthly temperature. However, in some of the states (such as in Wisconsin and Nebraska, as can be seen in the figures of Appendix C), there are a small number of stations (compared to the total number in that state) that give a considerably higher difference than 5 to 7°F. These areas tremendously influence the correlation between the 7-day and monthly temperatures and result in a poor R^2 value. the relationship will be highly improved if these few stations are not included in the analysis.

Table 1. Categorizing states in different regions for comparing 7-day maximum temperature versus average daily maximum temperature.

Region	States
West	AZ, CA, NV, OR, UT, WA
Rockies	CO, ID, MT, NM, WY
Midwest	IL, IA, KS, MI, MN, MO, ND, NE, SD, WY
South	AL, AR, FL, GA, LA, MS, OK, TX
Northeast	CT, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT
North Central	IN, KY, NC, OH, SC, TN, VA, WV

Table 2. Regression Equations obtained for each region

West	$T_w = 12.68 + 0.93T_m$	$R^2 = 0.96$
Rockies	$T_w = 20.91 + 0.83T_m$	$R^2 = 0.85$
Midwest	$T_w = 49.87 + 0.50T_m$	$R^2 = 0.57$
South	$T_w = 39.72 + 0.62T_m$	$R^2 = 0.60$
North East	$T_w = 52.35 + 0.44T_m$	$R^2 = 0.58$
North Central	$T_w = 46.62 + 0.53T_m$	$R^2 = 0.64$
All U.S.	$T_w = 14.13 + 0.92T_m$	$R^2 = 0.90$

T_w = Mean Highest 7-Day Averaged Daily High Temperature
T_m = Mean Highest Monthly Averaged Daily High Temperature

II. The Daily Temperature Database

The performance based models are used as part of the Superpave system to predict the future pavement performance. Among the variables required as input to these models is the daily pavement temperature distribution throughout the year. These pavement temperatures are calculated by integrated model of the climatic effects on pavements, which requires daily air temperature as an input. Therefore, it became necessary to create a series of data files containing daily minimum and daily maximum air temperatures for appropriate stations. These files are used along with a series of other files as input to the integrated model.

Data Elements and Structure

Ten-Year Period Daily Temperature Files

Each file of the database includes three columns. The first column includes the day of the year. Numbers 1 through 365 are in this column, with number 1 indicating January 1. The second and third columns include daily minimum and daily maximum temperatures at each station for each day of the year, respectively. The data are provided for 10 consecutive years in 10 different files. There are 3 lines of header information at the top of each file. These lines include information on state, country, identification, latitude, longitude, and elevation of the station. Contents of the database and the format of the data structure are shown in Appendix B. These files are used as input for permanent deformation analysis.

Annual Average Daily Temperature Files

For each station there is an additional file covering average daily minimum and maximum temperatures for 365 days of the year. This file also has the same header information and the same data structure as for the daily temperature file. These files are used as input for permanent deformation analysis.

Selection of Weather Stations

Certain criteria needed to be satisfied in the process of selecting appropriate weather stations. Ideally, it was desired to select all the stations with 100 percent coverage (i.e. with no single day of missing data during the 10-year period). However, such a restriction would not yield sufficient distribution of stations throughout each state. On the other hand, loose restrictions would yield too dense a population of stations on one hand, and considerable amount of missing data for some stations on the other hand. Therefore, a compromise had to be made in the selection process.

First, all the stations with fewer than 10 years of data were eliminated; then it was decided to include only stations with at least a certain percent coverage during the 10 year period (for example, stations with at most 182 days missing during the 10-year period for 95 percent coverage and stations with at most 146 days missing for 95 percent coverage). In addition, no more than seven consecutive days were allowed to be missing in a month and no more than 18 days total were allowed to be missing in a year. If percent coverage was satisfied but the single month or single year criterion, as explained above, was not, then two attempts could be made to replace that particular year with a preceding year with sufficient data. If a satisfactory year could not found, that station would be dropped and would not be included in the database.

Summary Files

In addition to the ten-year period daily temperature file and annual average daily temperature files, a summary data file was created for each state to include information on all the state weather stations used in the daily temperature database.

Temperature Intervals and Binder Specification

The SHRP performance-based binder and mixture specifications were developed based on the tests related to the pavement performance under different climatic conditions. The effect of environmental conditions on specifications is taken into account by considering various temperature regions. It is possible for two places that have the same air temperature conditions but are at different geographically locations to have different pavement temperatures. In specifications, the regions are developed based on the highest seven-day averaged daily maximum pavement temperature and the lowest mean pavement temperature. For this reason, however, the binder and mixture specifications are tied to the pavement temperature rather than the air temperature.

The binder specification would be very simple if we could produce an asphalt that was highly resistant to rutting in the hottest areas of the country and at the same time performed well in the coldest regions. Such an asphalt does not yet exist or is not feasible to produce. It is a necessity to produce different binder grades for different climatic conditions. It is important to know how low and high air temperatures are distributed throughout the country in order to develop realistic ranges for pavement temperature and to determine how many different binder grades are required. The number of different binder grades for specification purposes also depends on the cost and feasibility of producing a certain grade.

Using wider temperature ranges results in fewer number of grades. This has advantages in binder production and storage because fewer binders need to be produced. Such advantage is gained at the cost of probably being too conservative and using more expensive asphalt to resist permanent deformation or cracking at a place where a binder with a lower distress resistance capability might perform satisfactorily. Using very narrow temperature ranges (i.e. using a larger number of climatic regions) results in a larger number of different binder grades. Even though this has the advantage of probably using a more suitable binder at the right place, it has two disadvantages: on one hand, production and storage of a large number of different grades may not be feasible or economical. On the other hand, some binder grades might be rarely used because only a limited number of areas might fall in a certain category of temperature ranges to require a certain grade of asphalt. Therefore, there is some compromise involved in selecting appropriate temperature ranges, in addition to the criteria discussed before. As a first step to develop pavement temperature ranges for specifications, the mean highest seven-day air temperature distribution and the lowest air temperatures distribution throughout the United States are investigated.

About 6,000 weather stations throughout the country were selected. Ninety-eight percent of these stations have air temperature records for more than 20 years. The remaining two percent have records for more than ten years. The numerical distribution of temperatures is given in Table 3. Temperature ranges both for mean highest seven-day and mean lowest temperatures are selected at 5°C intervals. It can be noticed that as expected, the major concentration of stations is almost in the middle part of the table. The following interesting statistics are derived based on the data represented in Table 1.

Approximately 95% of stations report the mean highest seven-day temperature between 25 and 40°C.

Approximately 86% of stations report mean highest seven-day temperature between 30 and 40°C.

Approximately 75% of stations have their mean highest seven-day temperature between 30 and 40°C while, at the same time, have their lowest recorded temperature between -45 and -15 °C.

The largest concentration of mean lowest temperature is in the range of -25° to -40°C for places where mean highest seven-day temperature varies between 30°C and 35°C (about 30% of all stations).

This data is presented in Table 2 in a combined and summarized form. The percent coverage column in this table indicates number of weather stations falling in a certain category as a percent of total number of stations. This column approximately indicates area coverage in the United States as a percent of total area for each temperature range category. Considering distribution of these coverages is important in deciding how many different binder grades are required and which grades will be most heavily used. This table indicates that 58 percent of

Table 3. Distribution of Temperature Intervals in the United States

7-day TMax, °C / TMin, °C	$T_w < 20$	$20 \le T_w < 25$	$25 \le T_w < 30$	$30 \le T_w < 35$	$35 \le T_w < 40$	$40 \le T_w < 45$	$T_w \ge 45$	Total
$T_l > 0$	NONE	2 (0.03)	28 (0.4)	67 (1.1)	1 (0.02)	NONE	NONE	98
$-5 < T_l \le 0$	1 (0.02)	8 (0.1)	13 (0.2)	35 (0.6)	2 (0.03)	3 (0.05)	1 (0.02)	63
$-10 < T_l \le -5$	3 (0.05)	6 (0.1)	18 (0.2)	58 (0.9)	103 (1.6)	53 (0.8)	7 (0.1)	248
$-15 < T_l \le -10$	2 (0.03)	12 (0.2)	17 (0.3)	68 (1.1)	210 (3.4)	53 (0.8)	3 (0.05)	365
$-20 < T_l \le -15$	9 (0.1)	11 (0.2)	43 (0.7)	131 (2.1)	**404 (6.5)**	31 (0.5)	1 (0.02)	630
$-25 < T_l \le -20$	5 (0.1)	6 (0.1)	27 (0.4)	282 (4.5)	**452 (7.2)**	15 (0.2)	NONE	787
$-30 < T_l \le -25$	5 (0.1)	10 (0.2)	40 (0.6)	**501 (8.0)**	**410 (6.6)**	3 (0.05)	NONE	969
$-35 < T_l \le -30$	7 (0.1)	14 (0.2)	104 (1.7)	**746 (11.9)**	**423 (6.8)**	1 (0.02)	NONE	1295
$-40 < T_l \le -35$	3 (0.05)	10 (0.2)	97 (1.6)	**565 (9.0)**	213 (3.4)	2 (0.03)	NONE	890
$-45 < T_l \le -40$	4 (0.1)	19 (0.3)	98 (1.6)	**421 (6.7)**	85 (1.9)	1 (0.02)	NONE	628
$T_l \le -45$	6 (0.1)	22 (0.4)	51 (0.8)	107 (1.7)	54 (1.3)	5 (0.1)	NONE	245
Total	45	120	536	2981	2357	167	12	6218

Notes
1. T_l is the lowest recorded air temperature.
2. T_w is the mean highest 7-day averaged daily high air temperature.
3. The number in each cell indicates the number of weather stations for each interval.
4. The number inside parentheses indicates the number of stations as a percent of total stations for each interval.

the total area belongs to the 30° to 40°C range (mean highest seven-day air temperature) and -20° to -30°C range (the lowest recorded air temperature).

The lowest pavement temperature is expected to be, in most cases, slightly higher than or equal to the lowest air temperature. Under rare conditions, the lowest air temperature might slightly exceed the lowest pavement temperature. Even if such a case might occur, the difference between the two will be trivial. For these reasons, it seems reasonable and safe to assume that the lowest pavement temperature is equal to the lowest air temperature. However, conversion of the mean highest seven-day air temperature to the pavement temperature is not so straight forward a matter. Quite often, maximum pavement temperature can be significantly higher than the maximum air temperature. Pavements at different latitudes will have different temperatures under the same environmental conditions and the same ambient temperature conditions because of the significant effect of radiation. At lower latitudes (southern regions) the pavement temperature during hot, sunny days can reach, on the average, about 25°C higher than the air temperature, whereas at higher latitudes (northern regions), the difference, on the average, would be around 15°C. Therefore, the pavement temperature distribution does not have the same coverage throughout the United States as the one given for the air temperature in Table 4. This table can be used, however, as a guideline for the selection of reasonable pavement temperature ranges to cover the United States in the most appropriate manner. Cost and feasibility of production and storage, as well as technical aspects, are among important factors in the selection of appropriate temperature intervals.

Table 4. Percent Coverage of Certain Temperature Intervals for the United States.

Mean Highest 7-day Averaged Daily High Air Temperature (°C)	Lowest Air Temperature (°C)	Percent Coverage of U.S.
$T_w < 25$	$T_l > -25$	1.0
	$T_l \leq -25$	1.6
$25 \leq T_w < 30$	$T_l > -10$	1.0
	$-20 < T_l \leq -10$	1.0
	$-30 < T_l \leq -20$	1.1
	$-40 < T_l \leq -30$	3.2
	$T_l \leq -40$	2.4
$30 \leq T_w < 35$	$T_l > -10$	2.6
	$-20 < T_l \leq -10$	3.2
	$-30 < T_l \leq -20$	12.6
	$-40 < T_l \leq -30$	21.1
	$T_l \leq -40$	8.5
$35 \leq T_w < 40$	$T_l > -10$	1.7
	$-20 < T_l \leq -10$	9.9
	$-30 < T_l \leq -20$	13.9
	$-40 < T_l \leq -30$	10.2
	$T_l \leq -40$	2.2
$T_w > 40$	$T_l > -25$	2.7
	$T_l \leq -25$	0.2

Note: These results are extracted from the data presented in Table 3.
T_w: Mean highest 7-day averaged daily high air temperature
T_l: Lowest recorded air temperature

Appendix A. Contents of the summary database and examples of the contents

ORGANIZATION OF WEATHER DATA

Col.	Parameter	Code
1	State	State
2	County	County
3	Station	Station
4	Longitude	Longitude
5	Latitude	Latitude
6	Elevation	Elevation
7	All time record lowest temperature.	TMin
8	Mean of all annual lowest temperature.	TMin Avg
9	Median of all annual lowest temperatures.	TMin Med
10	Standard Deviation corresponding to Column 8.	TMin Std
11	Highest value of all lowest temperatures.	TMin High
12	Number of data points (number of years)	TMin Num
13	Lowest Mean Monthly (of the coldest month) ever recorded.	TLow
14	Month of Lowest Mean Monthly.	Month L
15	Average of all means calculated in Column 13.	TLow Avg
16	Median corresponding to Column 13.	TLow Med
17	Standard Deviation corresponding to Column 15.	TLow Std
18	Number of data points.	TLow Num
19	Mean Minimum Annual Temperature.	TYear Min
20	All time record highest temperature.	TMax
21	Mean of all annual highest temperatures.	TMax Avg
22	Median of all annual highest temperatures.	TMax Med
23	Standard Deviation Corresponding to Column 21.	TMax Std
24	Number of Data Points.	TMax Num
25	Highest Monthly Avg. Daily High Temperature ever recorded.	THigh
26	Month of the Highest Monthly Averaged Daily High Temperature.	Month H
27	Average of all means calculated in Column 25.	THigh Avg
28	Median of all means calculated in Column 25.	THigh Med
29	Standard Deviation Corresponding to Column 27.	THigh Std
30	Number of Data Points.	THigh Num

31	Highest 7-Day Averaged Daily High Temperature ever recorded.	THighW
32	Average of all highest 7-Day Temperatures as defined in Column 31.	THighW Avg
33	Median corresponding to Column 31.	THighW Med
34	Standard Deviation corresponding to Column 31.	THighW Std
35	Number of Data Points.	THighW Num
36	Mean Maximum Annual Temperature	TYear Max
37	Highest total annual precipitation ever.	PRCP Max
38	Lowest total annual precipitation .	PRCP Min
39	Mean of annual precipitations.	PRCP Avg
40	Median of total annual precipitations.	PRCP Med
41	Standard Deviations.	PRCP Std
42	Number of Data Points.	PRCP Num
43	Percent Coverage for TMin.	TMin Pct
44	Percent Coverage for TMax.	TMax Pct
45	Percent Coverage for PRCP.	PRCP Pct

Examples

Example for Column 7:

Jan. 4, 1981 Temp. = -15°F

Example for Column 8:

Temp. (lowest in year)

Jan. 5, 1975	-4
Jan. 9, 1976	-6
Feb. 1, 1977	-8
Dec. 31, 1978	-12

$$\text{Mean} = \left(\frac{(-4) + (-6) + (-8) + (-12)\ldots}{\text{number of years}} \right)$$

Example for Column 13

Mean lowest temp. (of the coldest month)

	JAN	LOW	
1975	1	5	= avg -1
	2	-3	
	:	:	
	31	-10	
1936	1	-2	= avg -4
	2	-6	
	:	:	
	31	5	
	:	:	= avg -2

Smallest average goes into Column 7.

Example for Column 20:

July 21, 1948 Temp. = 105° F

3/17/93/9:37 MEP/ARP/rs

Example for Column 21:

July 6, 1945	104
July 22, 1946	99
:	:
:	:
Aug. 3, 1981	106
:	:
:	:

$$\text{Mean} = \frac{104 + 99 + \ldots + 106 + \ldots}{\text{number of years}}$$

Example for column 25:

	JULY	HIGH	
1935	1	99	
	2	105	} avg. = 101
	:	:	
	31	101	
1936	1	98	
	2	103	} avg. = 104
	:	:	
	31	106	
	:	:	
	:	:	} avg. = 102

<u>Highest average goes into Column 23.</u>

Example for Column 31:

Average of seven consecutive days in a year giving the highest temperature (record highest ever).

Say: July, 1956 103

Example for Column 37:

Highest total annual precipitation happened in 1981 and it was equal to 53 inches.

Example for Column 38:

Lowest total annual precipitation happened in 1953 and it was equal to 24 inches.

Example for Column 39:

	Inches of Precipitation
1935	40
1936	45
:	:
1982	28
:	:
:	:

$$\text{avg.} = \frac{40 + 45 + \ldots\ldots + 28 + \ldots\ldots}{\text{number of years}}$$

THE DAILY TEMPERATURE DATABASE: FILE FORMAT AND CONTENTS

File Format

STATE	LONGITUDE	ID
COUNTY	LATITUDE	YEAR BEG
STATION	ELEVATION	YEAR END

1985 (or AV)	TMIN	TMAX
1	29	45
2	.	.
.		
.		
.		
243	61	87
.		
.		
.		
365	34	50

File Name: TX387685

Explanation of characters for the file name:
Characters 1 and 2: State Abbreviation
Characters 3 through 6: Station ID (if a station has a single digit ID, use zeros, example: If ID is 7, use 0007)
Characters 7 and 8: Year for which data is reported in the file, or if the file is for average temp, use 'AV'

Above Example: State TX, Station 3876, Year 1985)

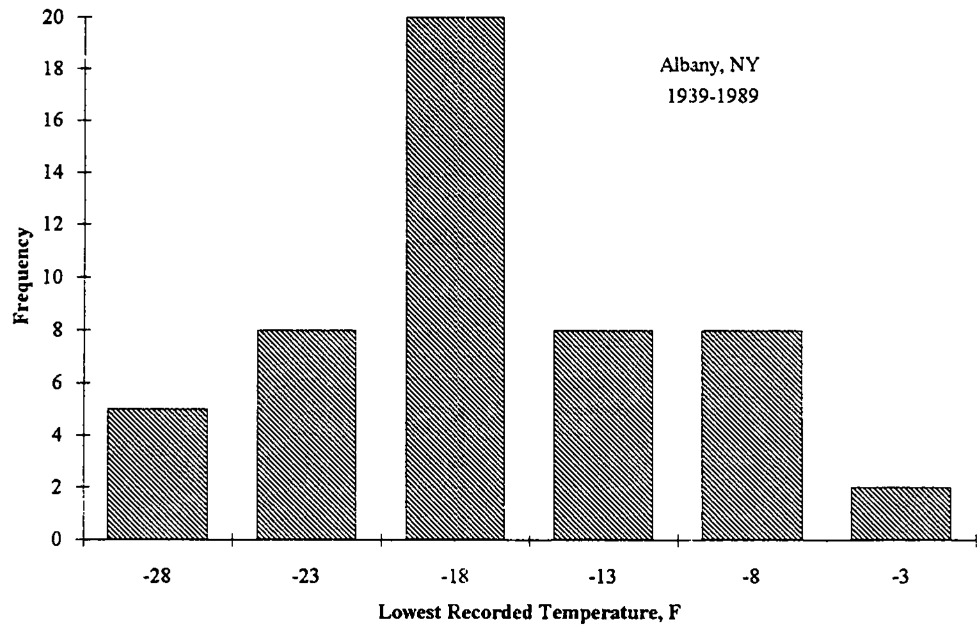
Labeling Diskettes: TXMMT-1/4

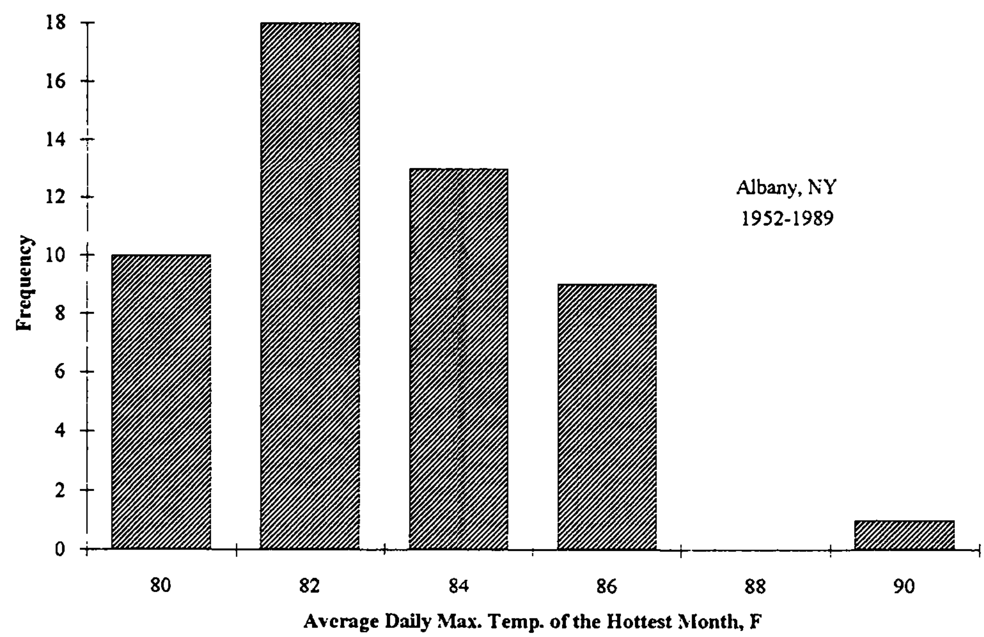
Explanation of characters for the diskette label:
Characters 1 and 2: State Abbreviation
Characters 3 through 6: Always use 'MMT-'
Character 7: Diskette Number
Character 8: Always use symbol '/'
Character 9 Total number of Diskettes for the State

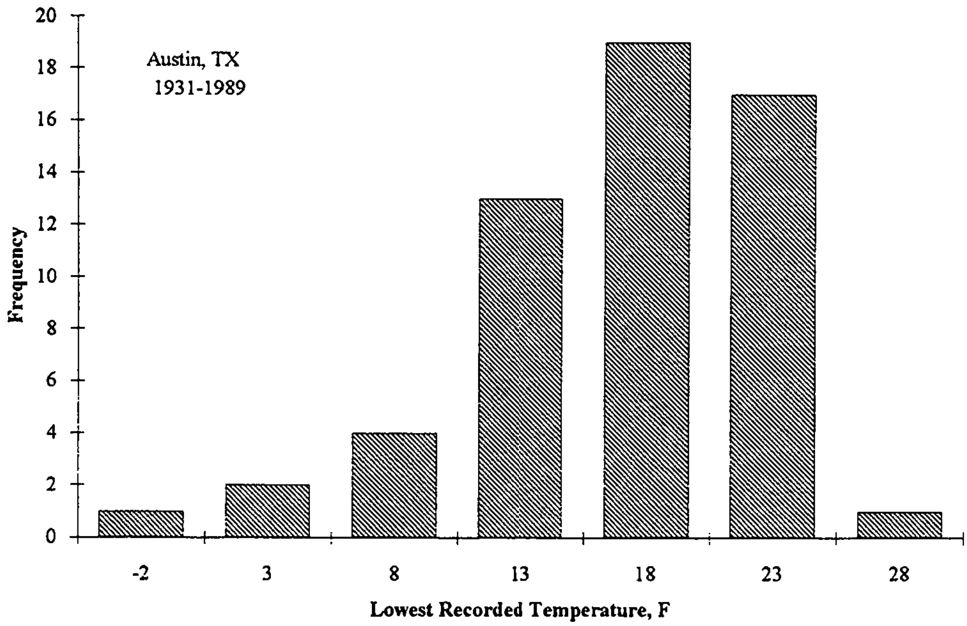
Summary File

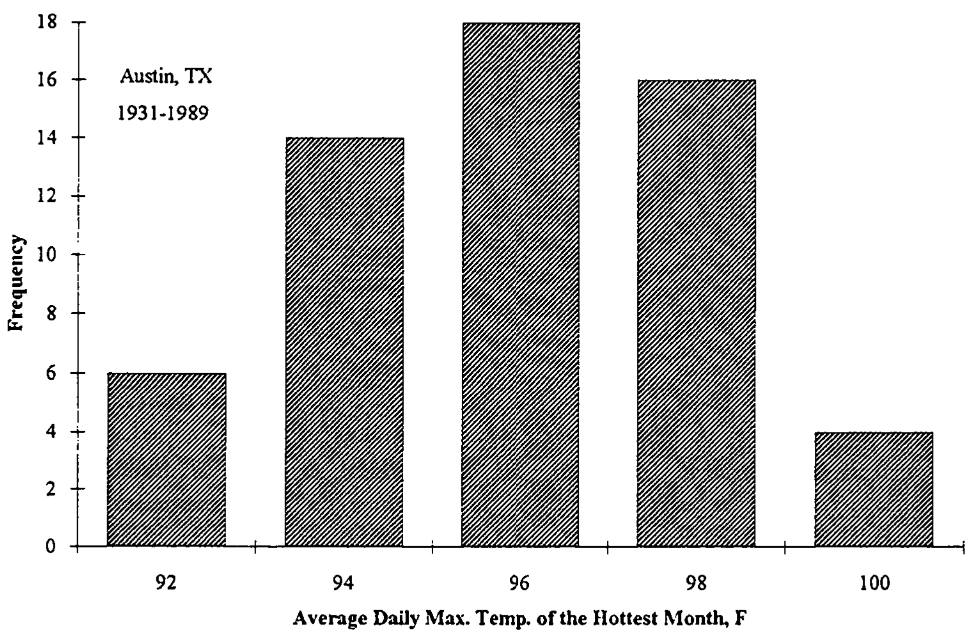
State	County	Station	ID	Latitude	Longitude	Elevation	CoverageYear	FileName
TX	Travis	....	1234	......	....	....	1985	TX123485

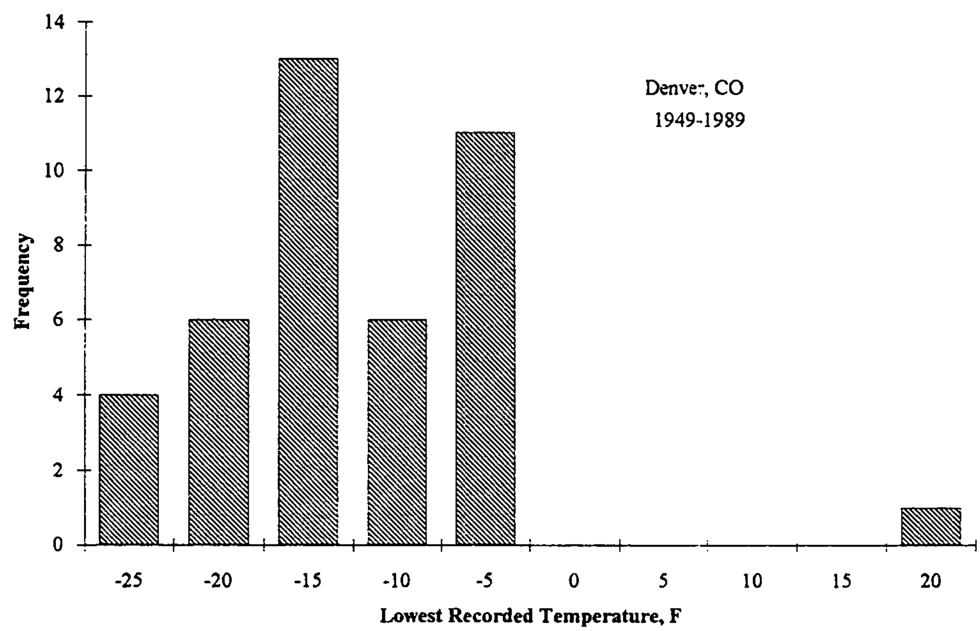
Appendix B. Distribution of the lowest temperature of the year and average daily maximum temperature for some major cities in the United States

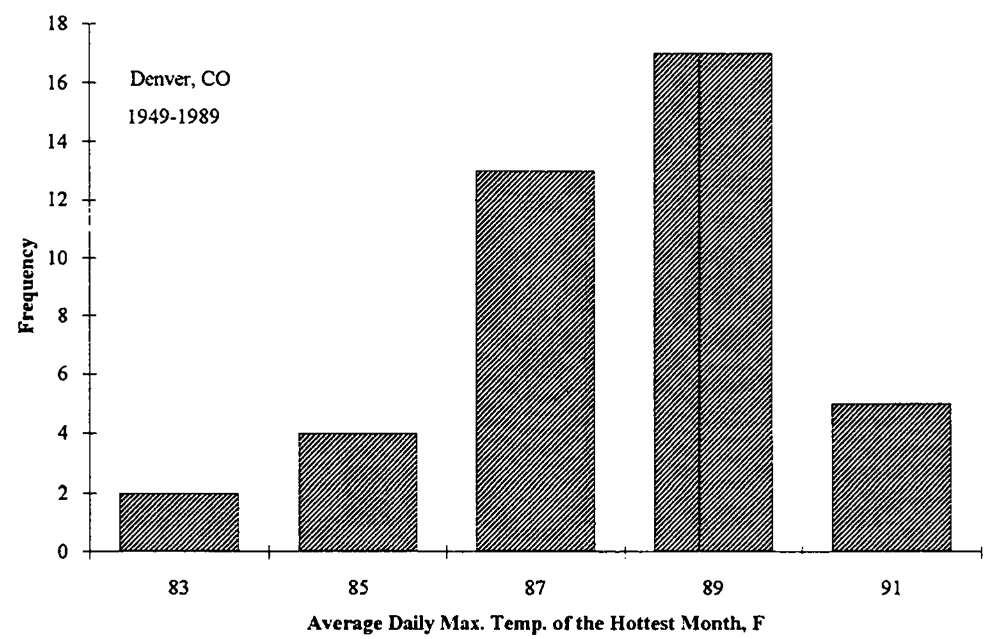

20
18
16
14
12
10
8
6
4
2
0
Frequency
Albany, NY
1939-1989
-28
-23
-18
-13
-8
-3
Lowest Recorded Temperature, F

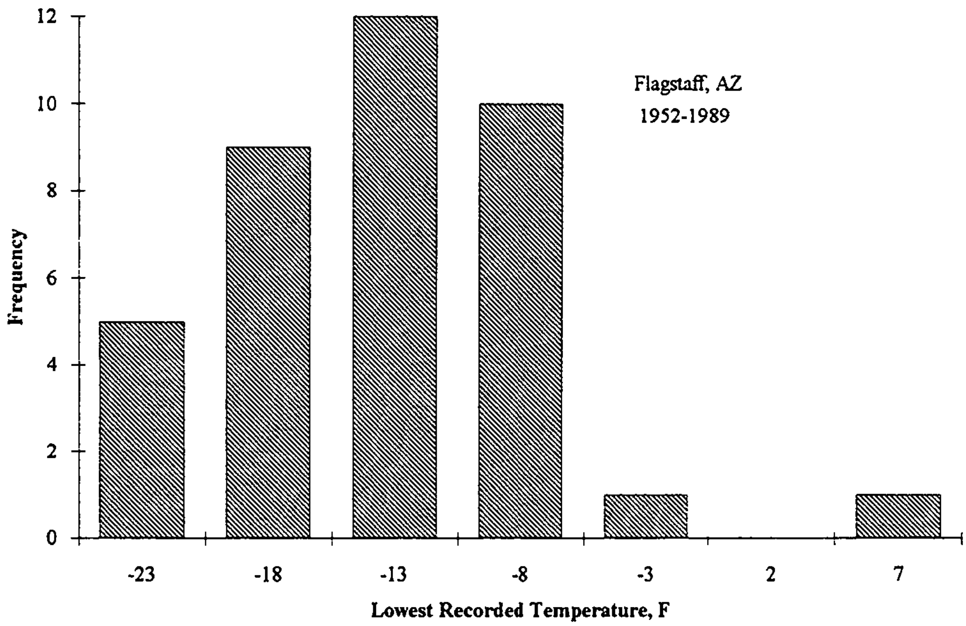

18
16
14
12
10
8
6
4
2
0
Frequency
Albany, NY
1952-1989
80
82
84
86
88
90
Average Daily Max. Temp. of the Hottest Month, F

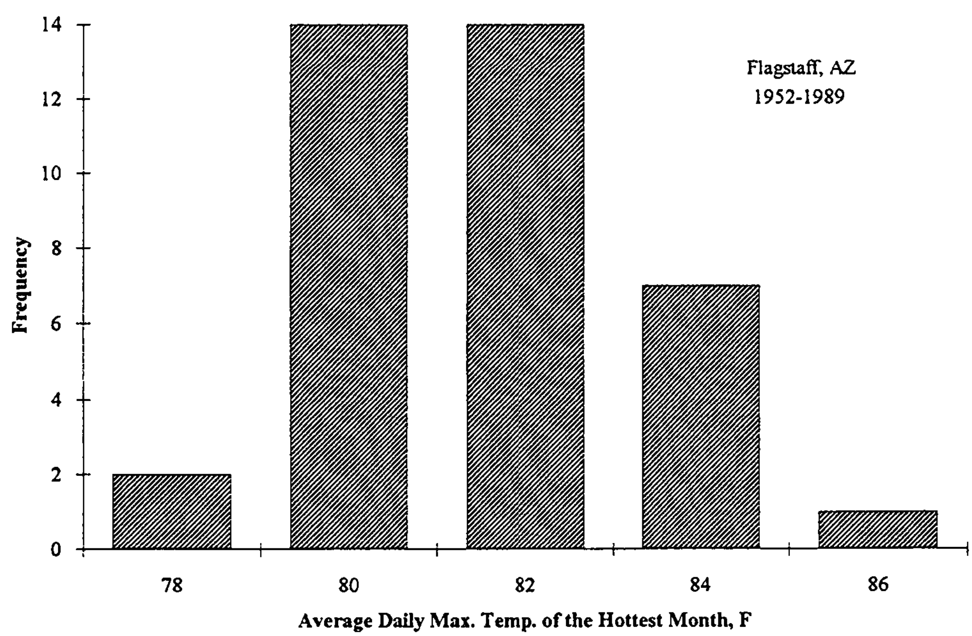

Austin, TX
1931-1989
Frequency
0
2
4
6
8
10
12
14
16
18
20
-2
3
8
13
18
23
28
Lowest Recorded Temperature, F

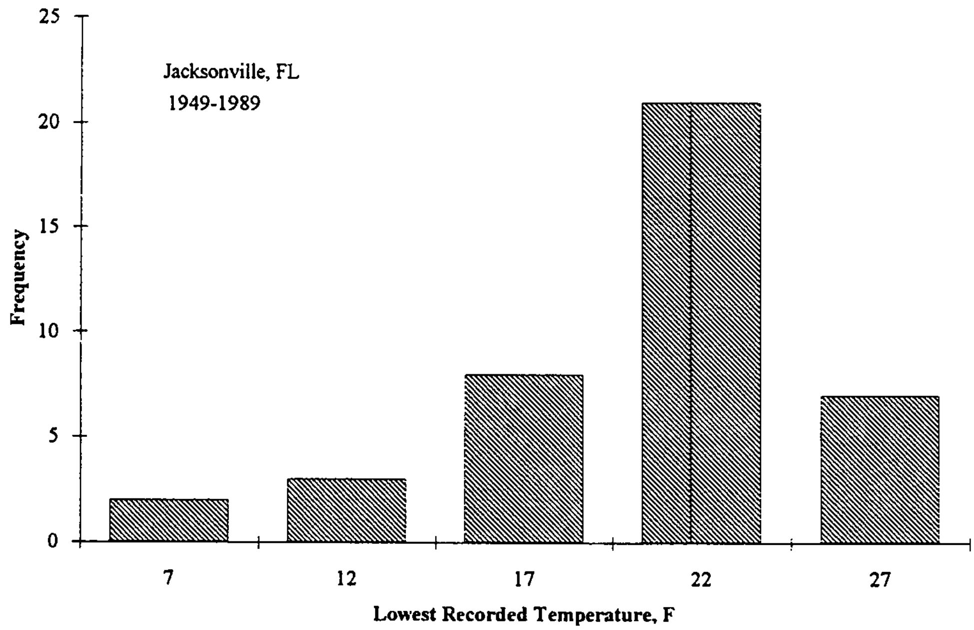

Austin, TX
1931-1989
Frequency
0
2
4
6
8
10
12
14
16
18
92
94
96
98
100
Average Daily Max. Temp. of the Hottest Month, F

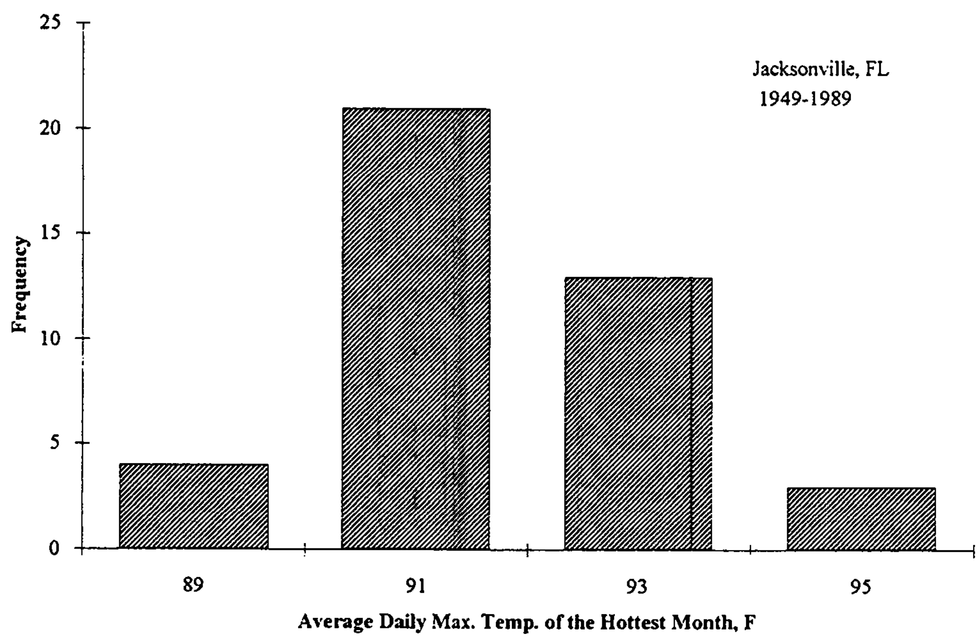

Denver, CO
1949-1989
Frequency
0
2
4
6
8
10
12
14
-25
-20
-15
-10
-5
0
5
10
15
20
Lowest Recorded Temperature, F

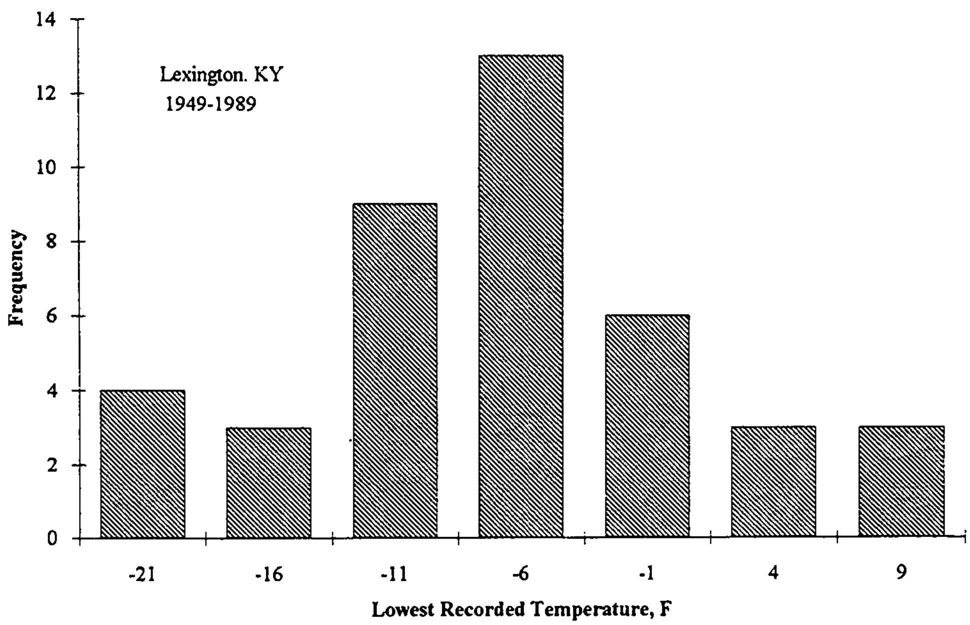

Denver, CO
1949-1989
Frequency
0
2
4
6
8
10
12
14
16
18
83
85
87
89
91
Average Daily Max. Temp. of the Hottest Month, F

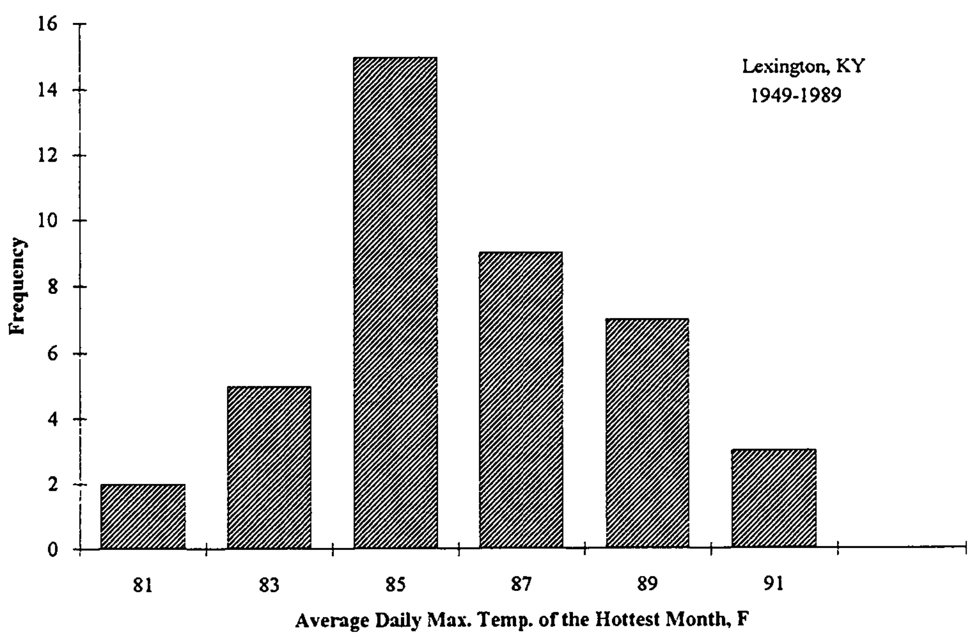

12
10
8
6
4
2
0
Frequency
Flagstaff, AZ
1952-1989
-23
-18
-13
-8
-3
2
7
Lowest Recorded Temperature, F

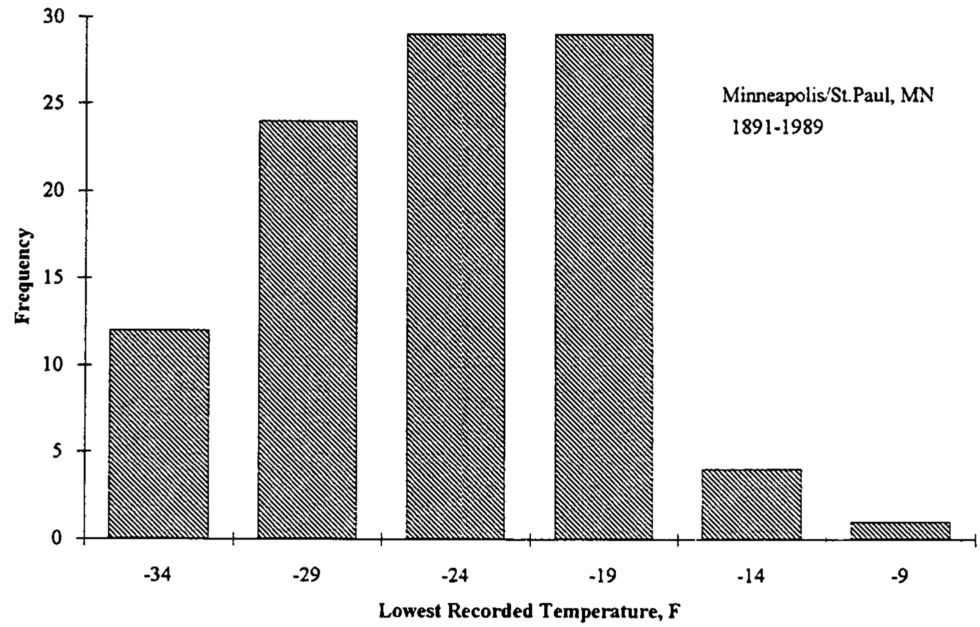

14
12
10
8
6
4
2
0
Frequency
Flagstaff, AZ
1952-1989
78
80
82
84
86
Average Daily Max. Temp. of the Hottest Month, F

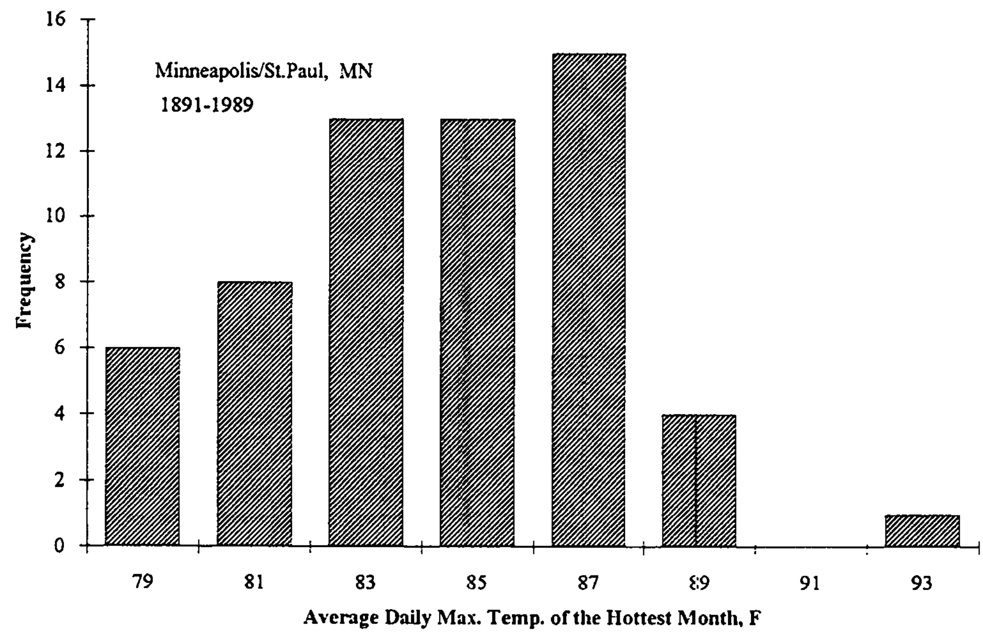

25
20
15
10
5
0
Frequency
Jacksonville, FL
1949-1989
7
12
17
22
27
Lowest Recorded Temperature, F

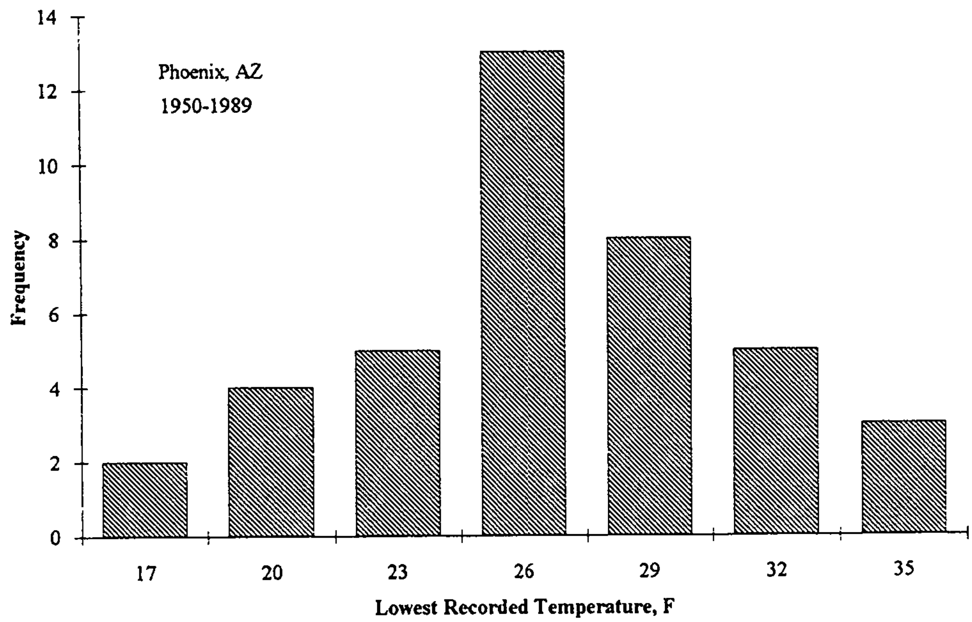

25
20
15
10
5
0
Frequency
Jacksonville, FL
1949-1989
89
91
93
95
Average Daily Max. Temp. of the Hottest Month, F

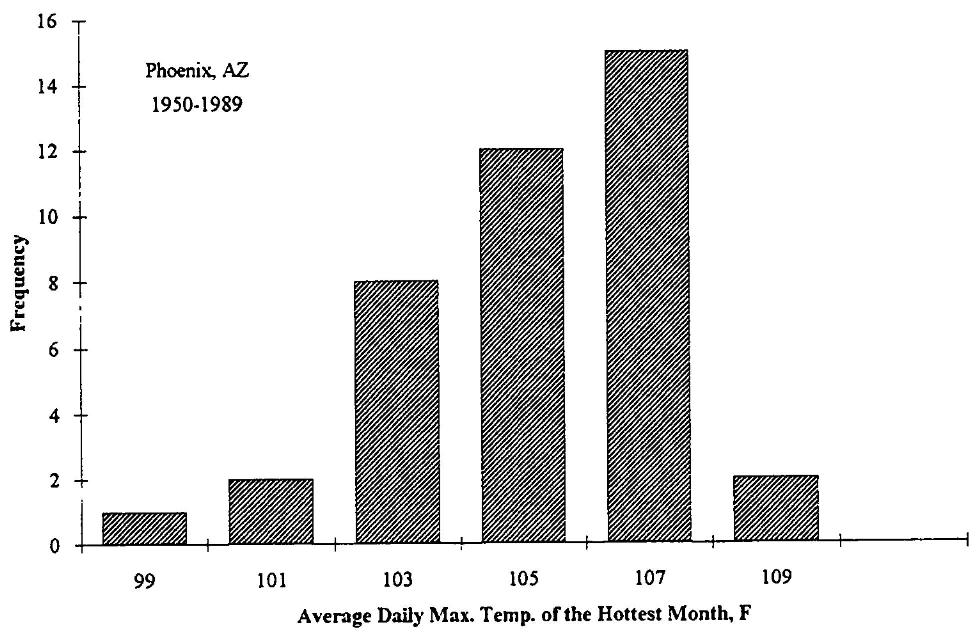

Lexington. KY
1949-1989
Frequency
14
12
10
8
6
4
2
0
-21
-16
-11
-6
-1
4
9
Lowest Recorded Temperature, F

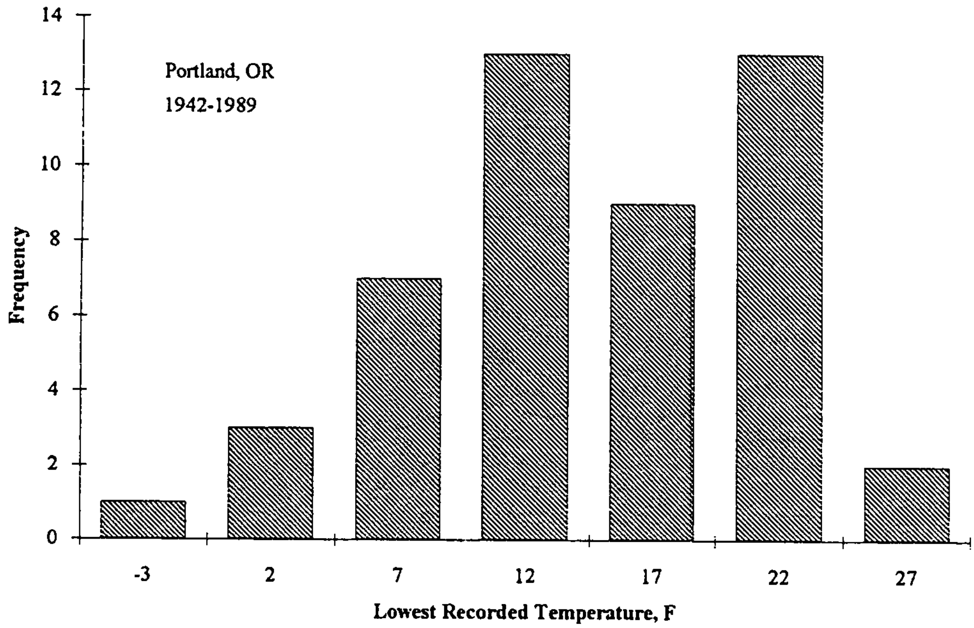

Lexington, KY
1949-1989
Frequency
16
14
12
10
8
6
4
2
0
81
83
85
87
89
91
Average Daily Max. Temp. of the Hottest Month, F

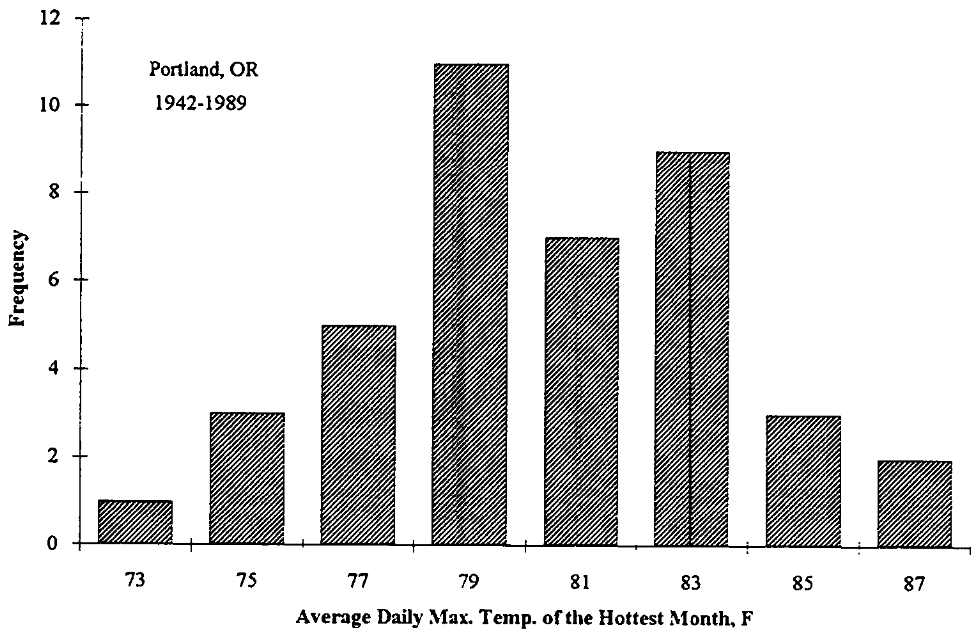

30
25
20
15
10
5
0
Frequency
Minneapolis/St.Paul, MN
1891-1989
-34
-29
-24
-19
-14
-9
Lowest Recorded Temperature, F

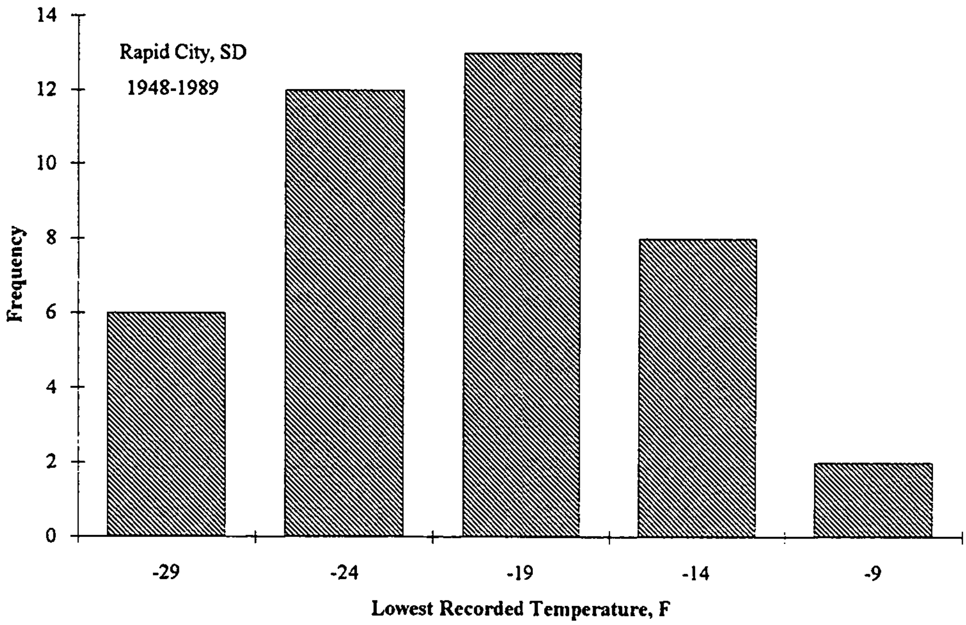

16
14
12
10
8
6
4
2
0
Frequency
Minneapolis/St.Paul, MN
1891-1989
79
81
83
85
87
89
91
93
Average Daily Max. Temp. of the Hottest Month, F

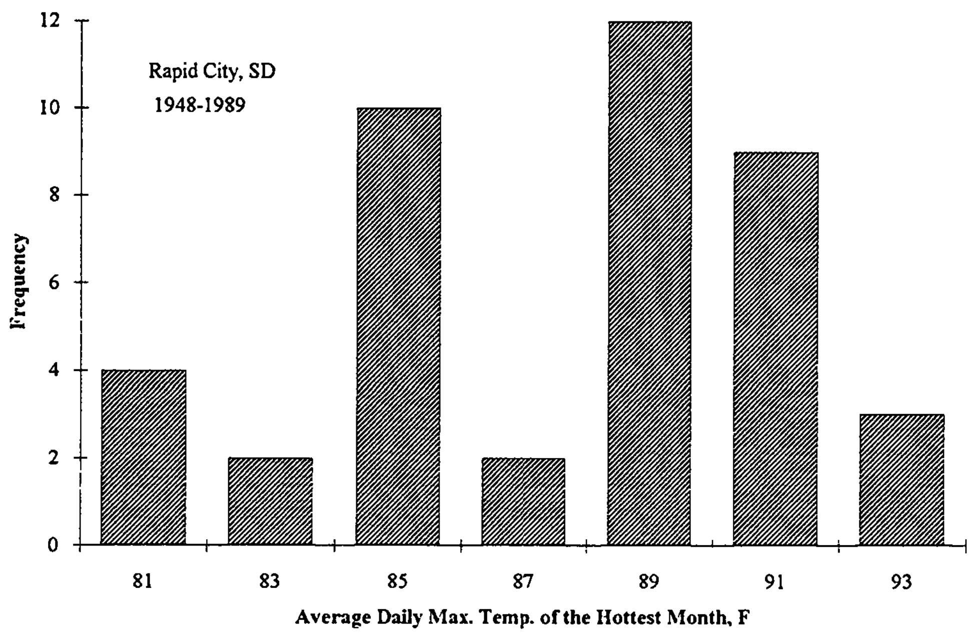

Phoenix, AZ
1950-1989
Frequency
0
2
4
6
8
10
12
14
17
20
23
26
29
32
35
Lowest Recorded Temperature, F

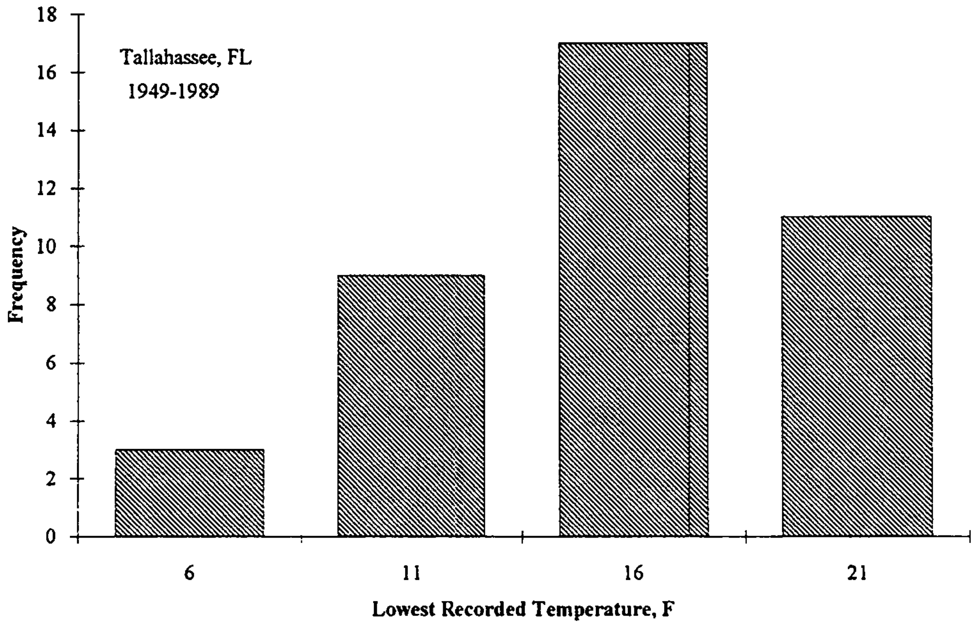

Phoenix, AZ
1950-1989
Frequency
0
2
4
6
8
10
12
14
16
99
101
103
105
107
109
Average Daily Max. Temp. of the Hottest Month, F


Portland, OR
1942-1989
Frequency
Lowest Recorded Temperature, F
14
12
10
8
6
4
2
0
-3
2
7
12
17
22
27

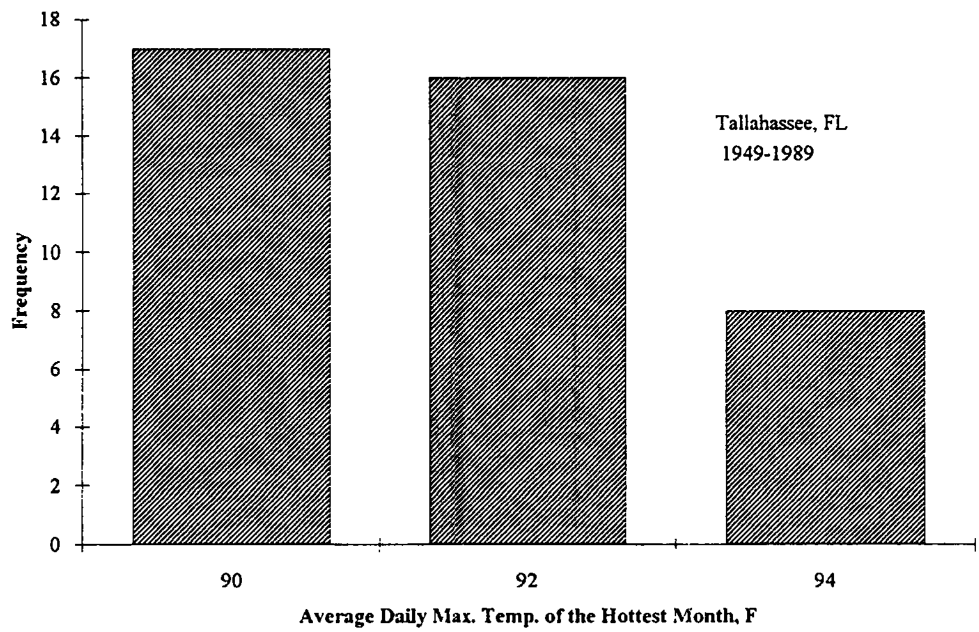

Portland, OR
1942-1989
Frequency
Average Daily Max. Temp. of the Hottest Month, F
12
10
8
6
4
2
0
73
75
77
79
81
83
85
87


Rapid City, SD
1948-1989
Frequency
0
2
4
6
8
10
12
14
-29
-24
-19
-14
-9
Lowest Recorded Temperature, F

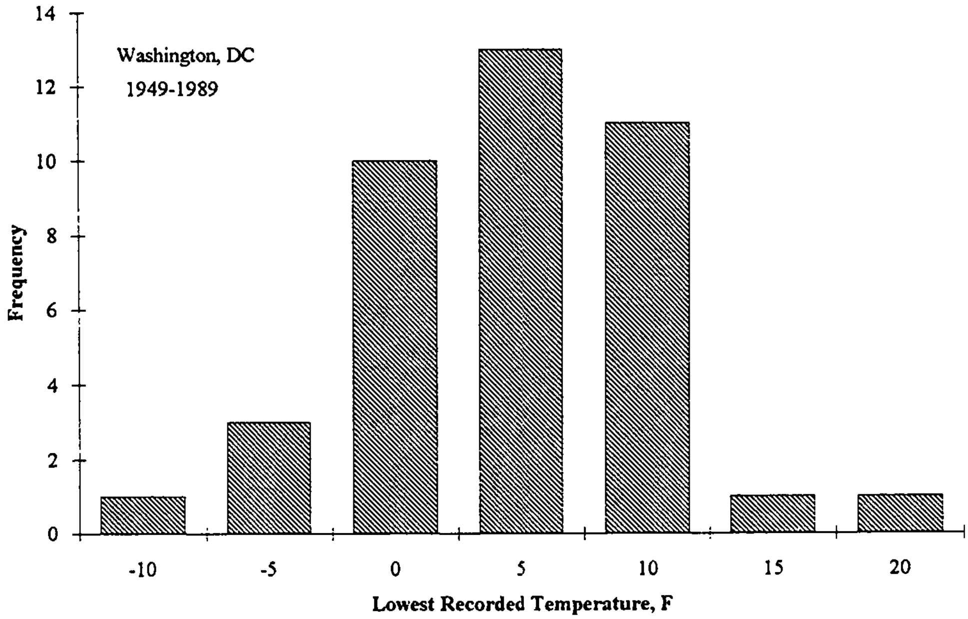

Rapid City, SD
1948-1989
Frequency
0
2
4
6
8
10
12
81
83
85
87
89
91
93
Average Daily Max. Temp. of the Hottest Month, F

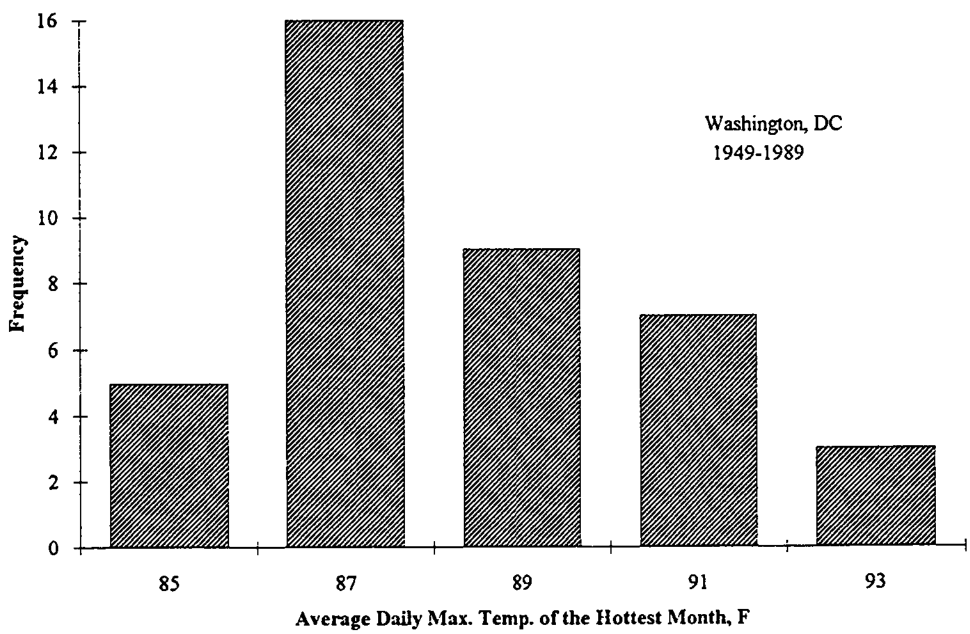


18
16
14
12
10
8
6
4
2
0
Frequency
Tallahassee, FL
1949-1989
6
11
16
21
Lowest Recorded Temperature, F

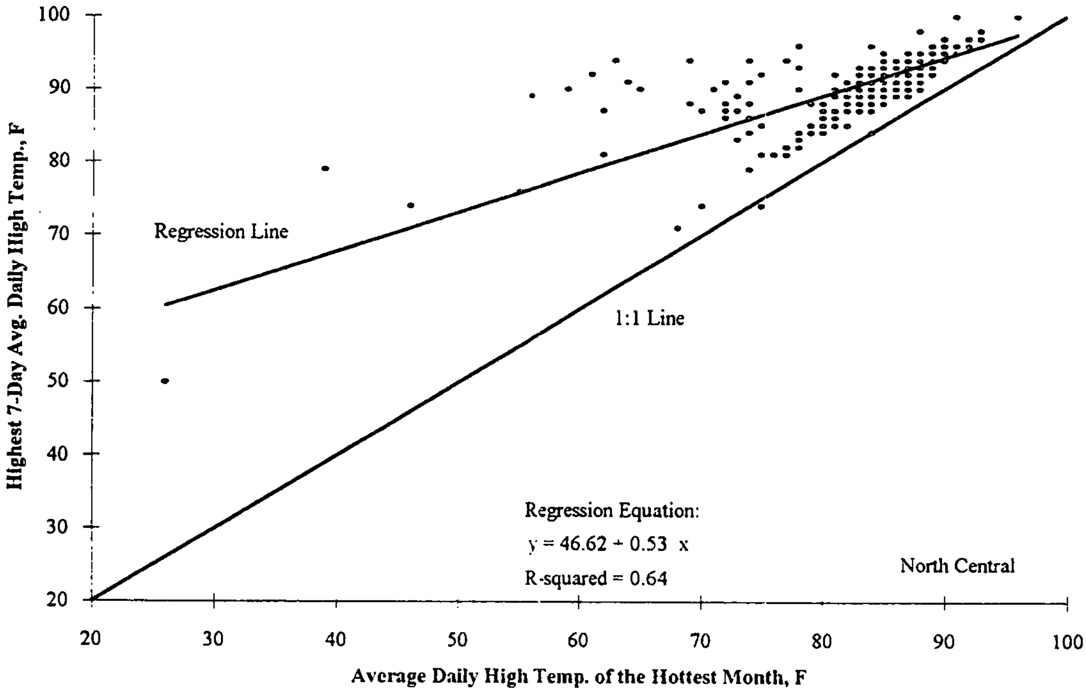


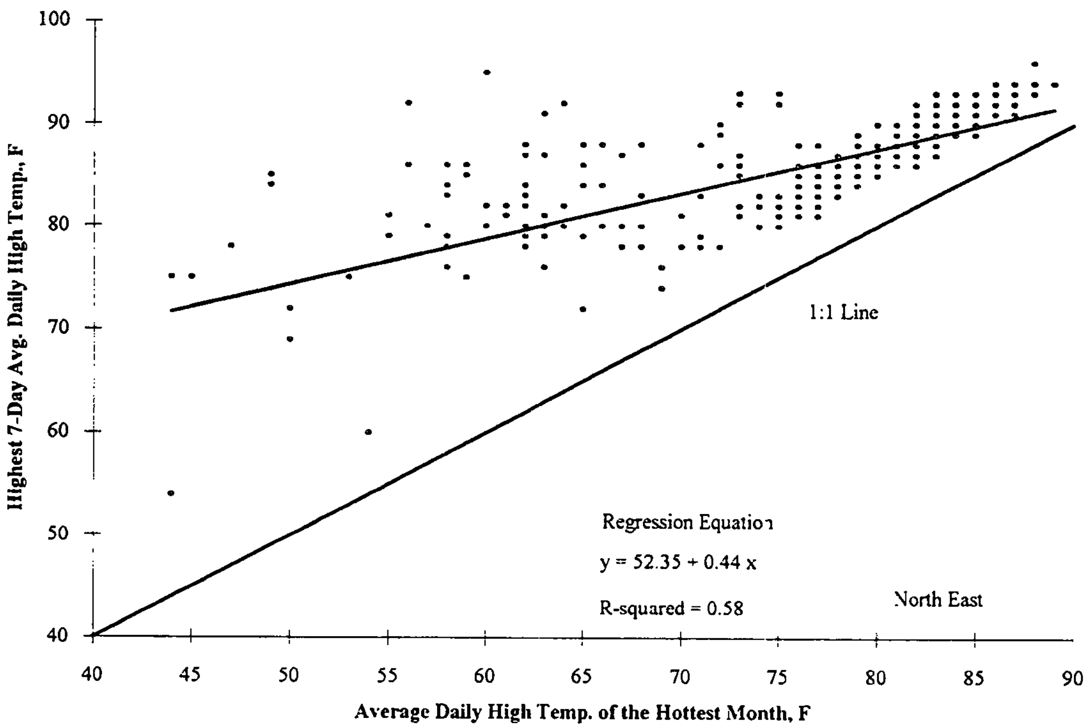
18
16
14
12
10
8
6
4
2
0
Frequency
Tallahassee, FL
1949-1989
90
92
94
Average Daily Max. Temp. of the Hottest Month, F

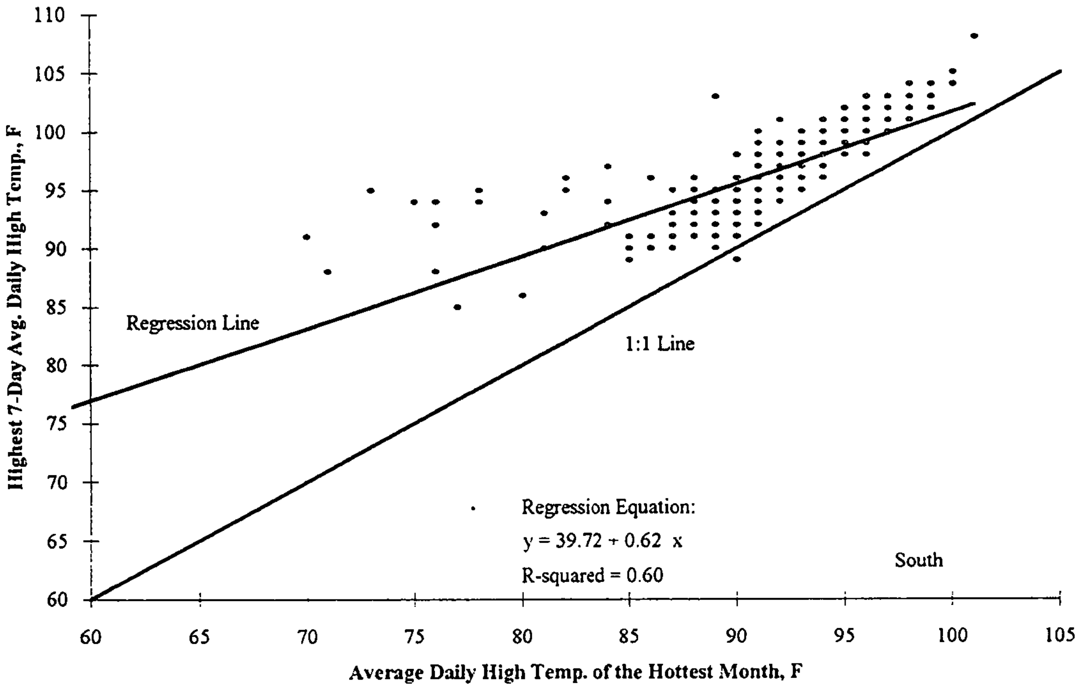

Washington, DC
1949-1989
Frequency
14
12
10
8
6
4
2
0
-10
-5
0
5
10
15
20
Lowest Recorded Temperature, F

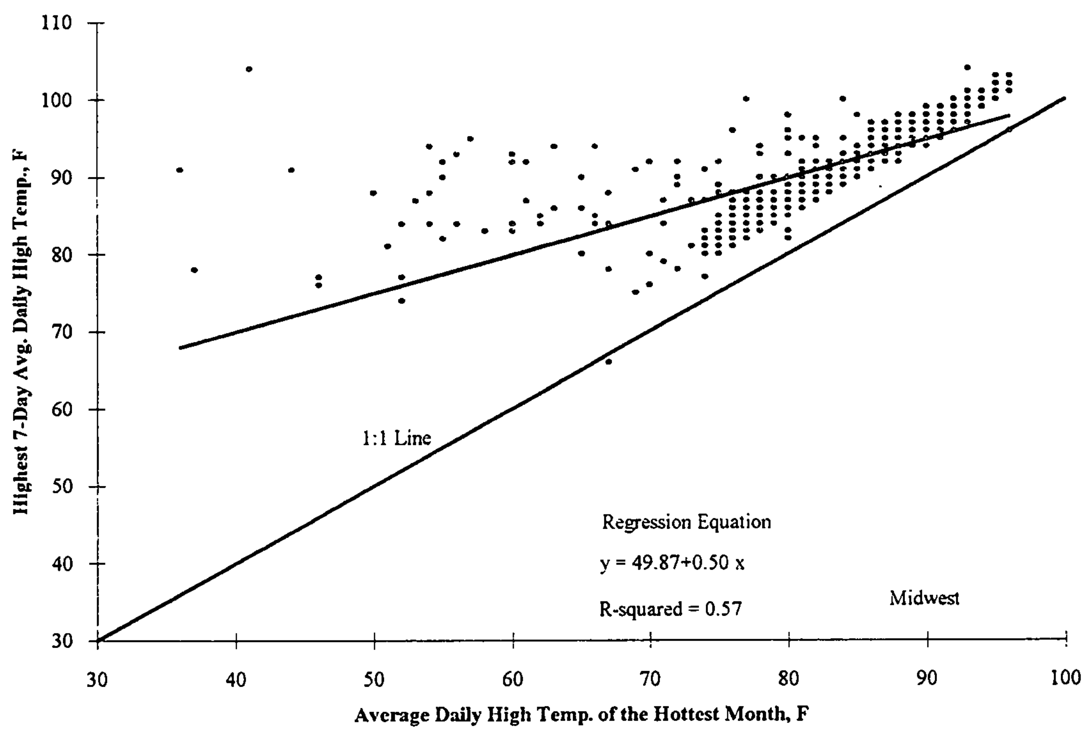

Washington, DC
1949-1989
Frequency
16
14
12
10
8
6
4
2
0
85
87
89
91
93
Average Daily Max. Temp. of the Hottest Month, F

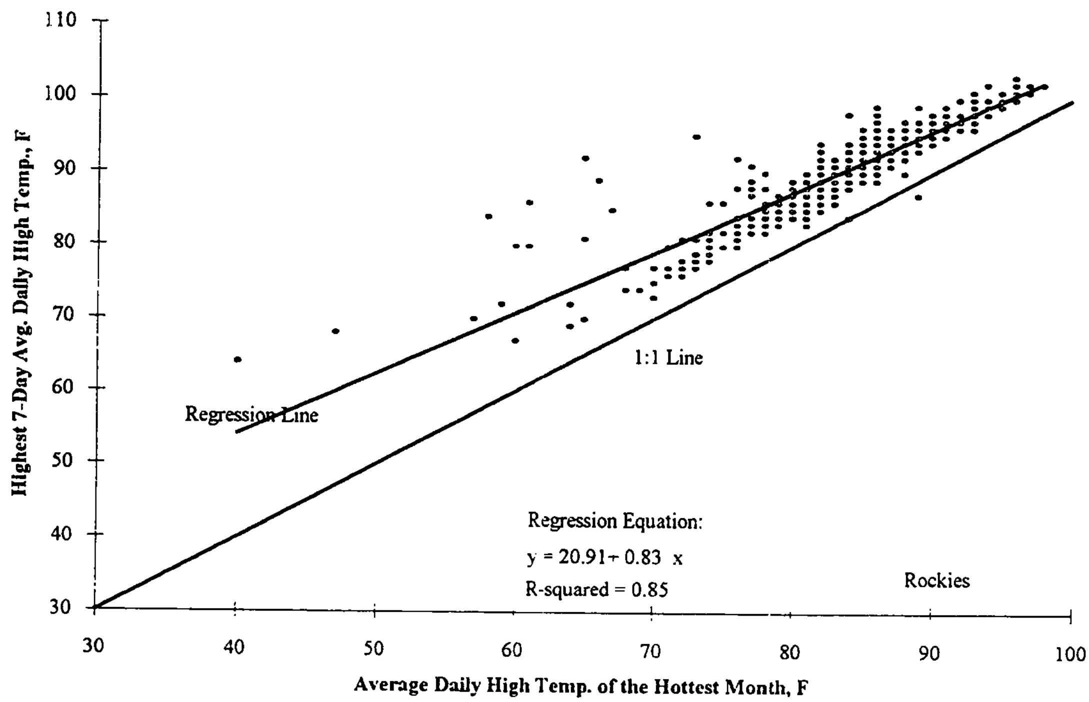
Appendix C. Average seven-day maximum temperature versus average monthly maximum temperature for different regions and some example cities


100
90
80
70
60
50
40
30
20
Highest 7-Day Avg. Daily High Temp., F
Regression Line
1:1 Line
Regression Equation:
y = 46.62 + 0.53 x
R-squared = 0.64
North Central
20
30
40
50
60
70
80
90
100
Average Daily High Temp. of the Hottest Month, F

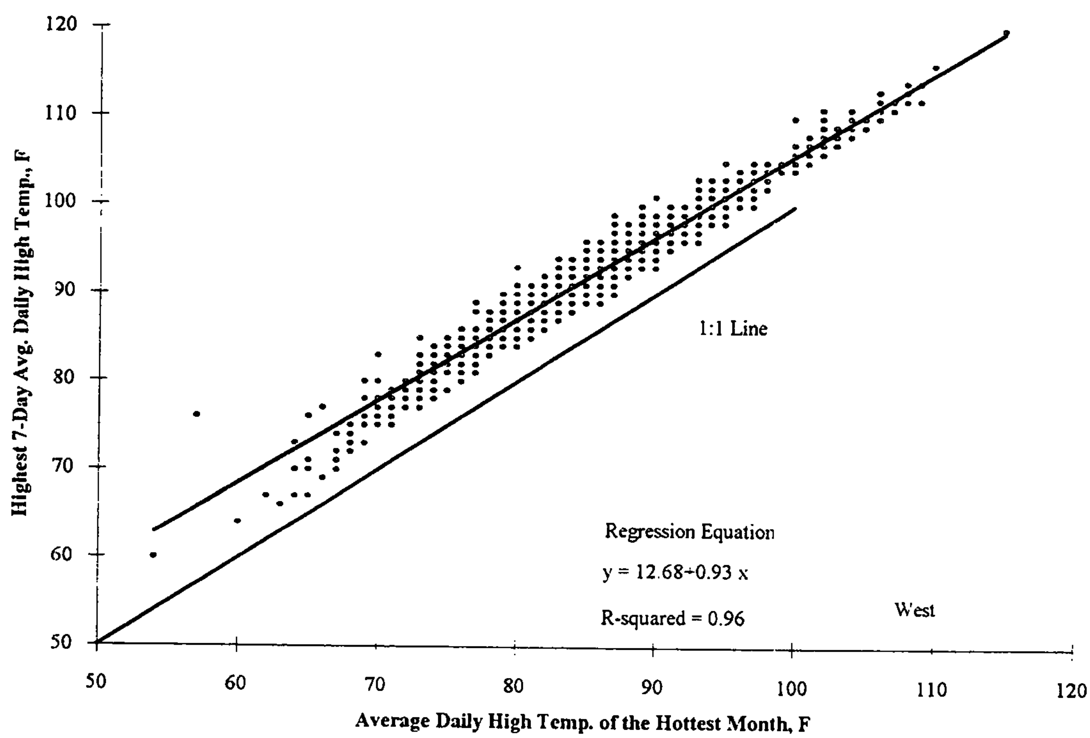

100
90
80
70
60
50
40
Highest 7-Day Avg. Daily High Temp., F
1:1 Line
Regression Equation
y = 52.35 + 0.44 x
R-squared = 0.58
North East
40
45
50
55
60
65
70
75
80
85
90
Average Daily High Temp. of the Hottest Month, F


Highest 7-Day Avg. Daily High Temp., F
Average Daily High Temp. of the Hottest Month, F
Regression Line
1:1 Line
Regression Equation:
y = 39.72 + 0.62 x
R-squared = 0.60
South

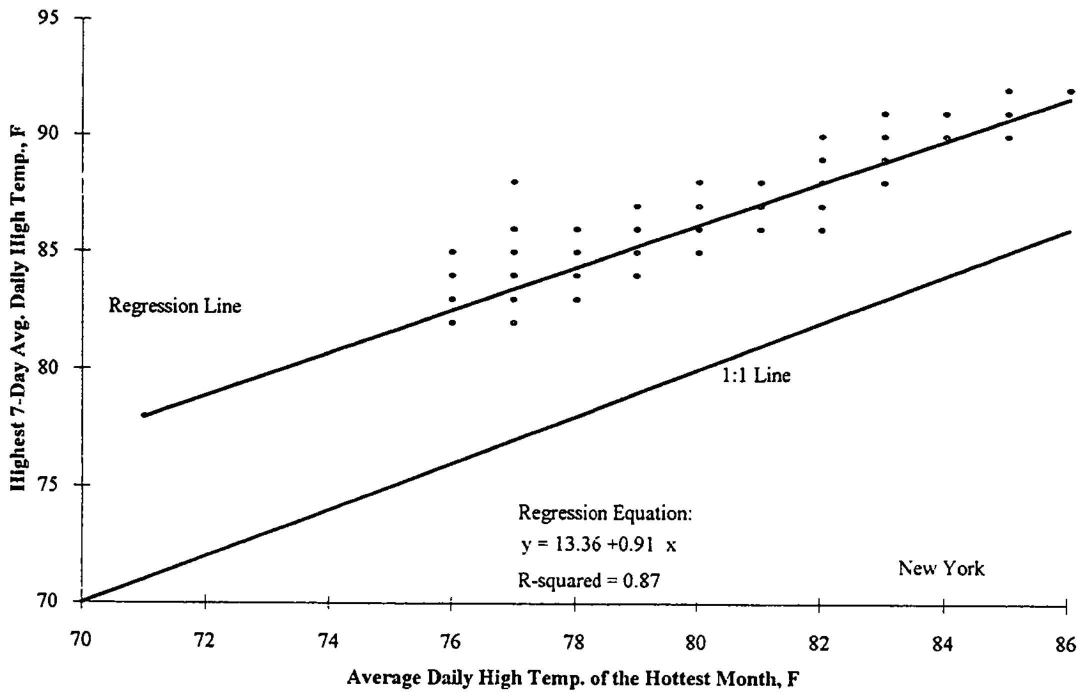

Highest 7-Day Avg. Daily High Temp., F
Average Daily High Temp. of the Hottest Month, F
1:1 Line
Regression Equation
y = 49.87+0.50 x
R-squared = 0.57
Midwest

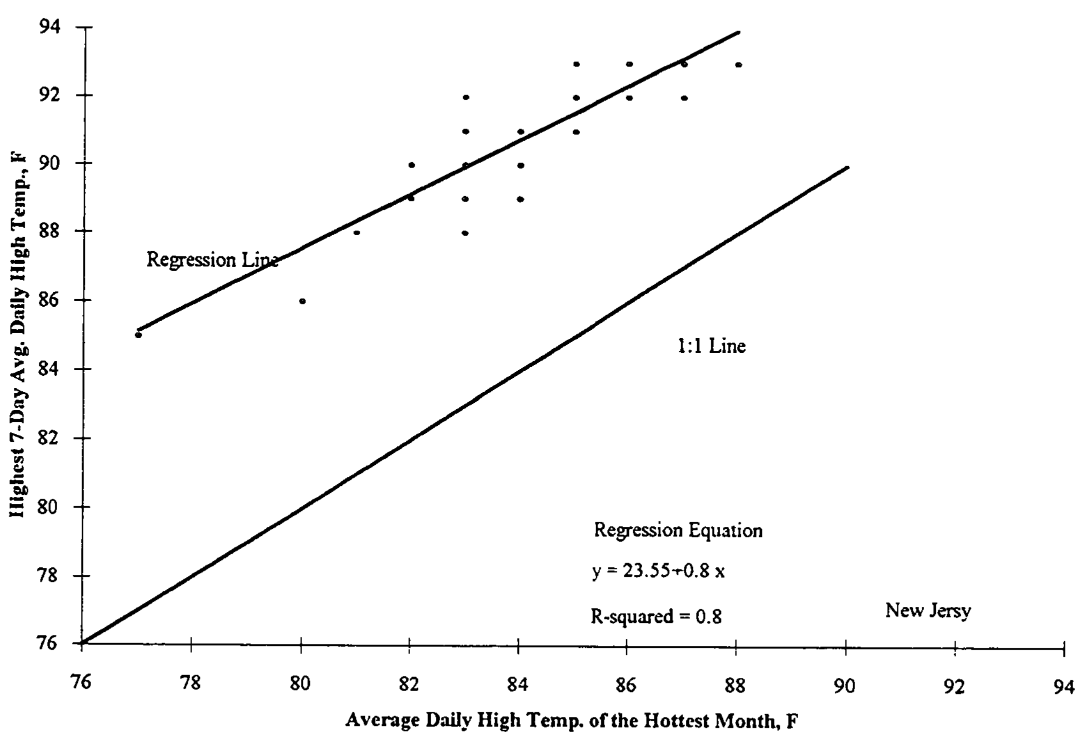


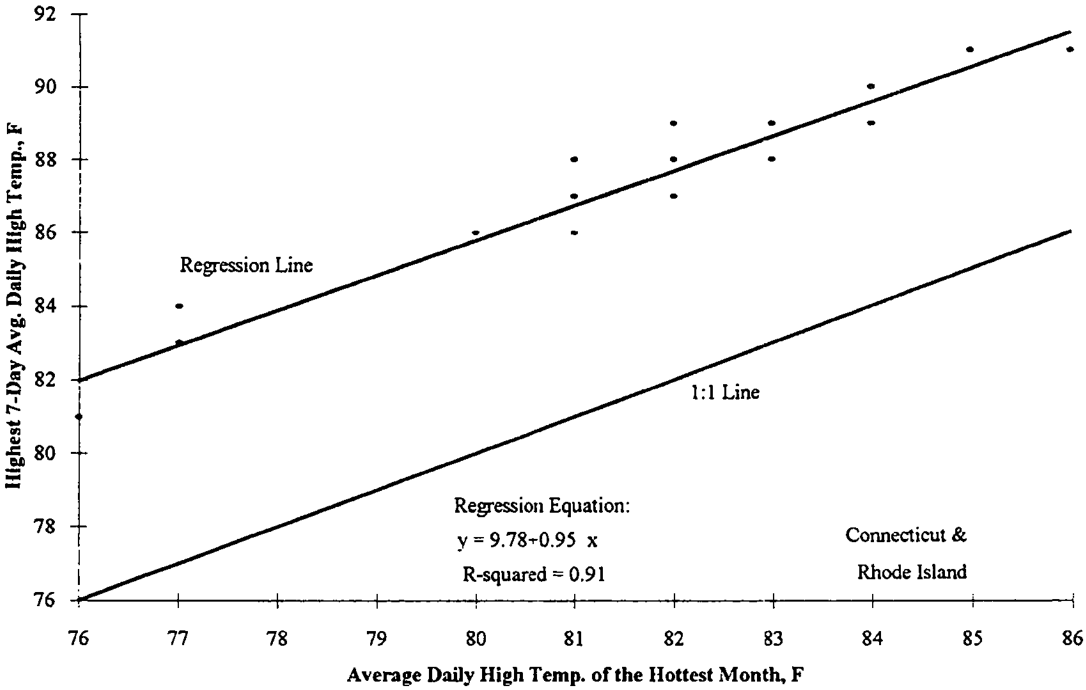
Highest 7-Day Avg. Daily High Temp., F
Average Daily High Temp. of the Hottest Month, F
Regression Line
1:1 Line
Regression Equation:
y = 20.91+ 0.83 x
R-squared = 0.85
Rockies

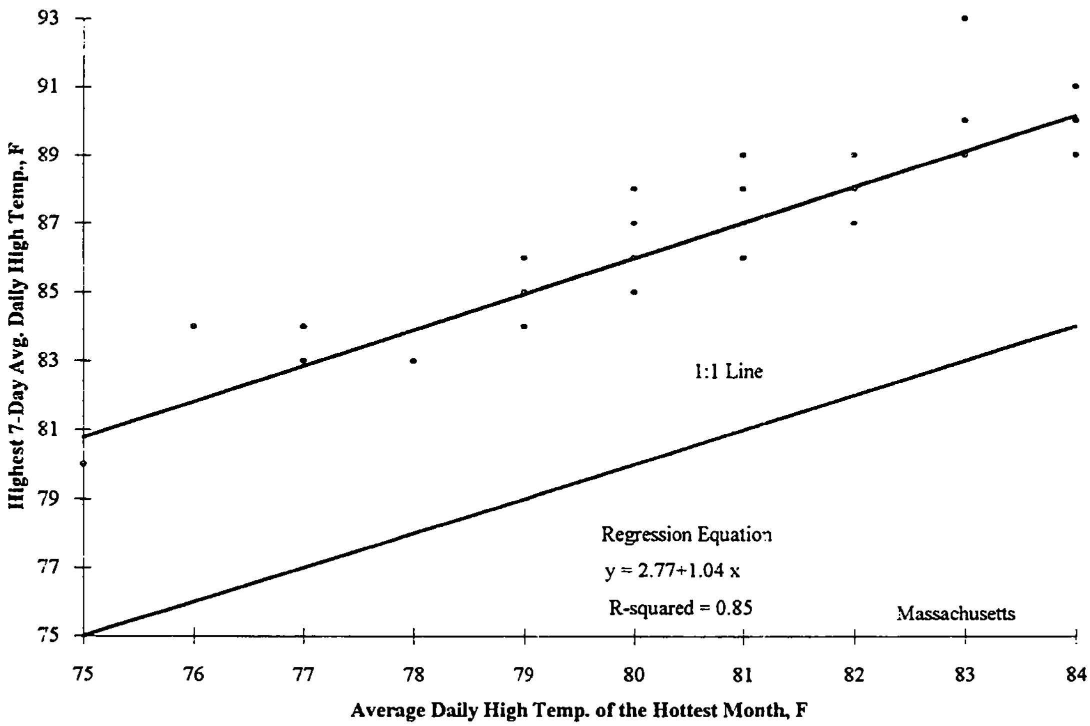


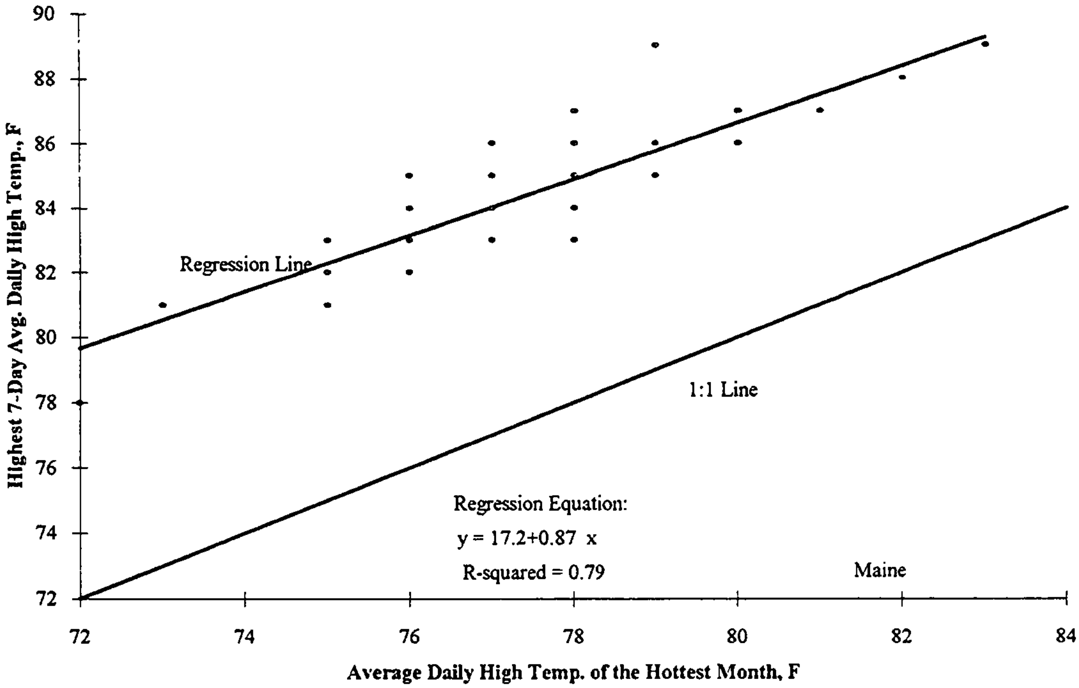
Highest 7-Day Avg. Daily High Temp., F
Average Daily High Temp. of the Hottest Month, F
1:1 Line
Regression Equation
y = 12.68+0.93 x
R-squared = 0.96
West

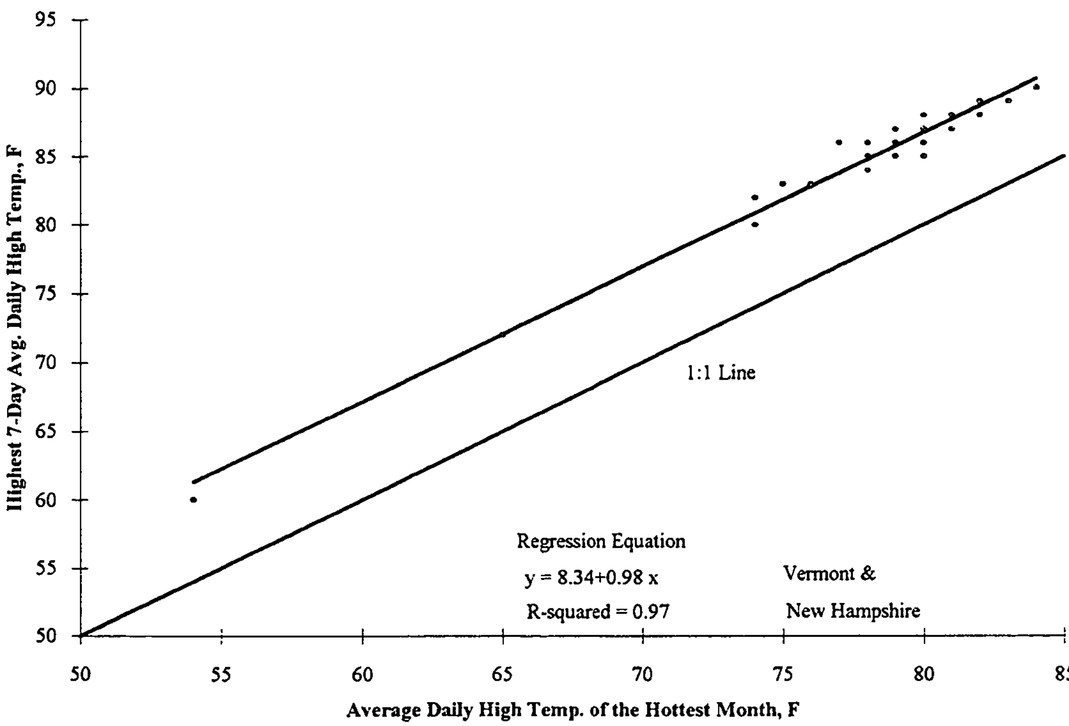

Highest 7-Day Avg. Daily High Temp., F
Average Daily High Temp. of the Hottest Month, F
95
90
85
80
75
70
70
72
74
76
78
80
82
84
86
Regression Line
1:1 Line
Regression Equation:
y = 13.36 +0.91 x
R-squared = 0.87
New York


Highest 7-Day Avg. Daily High Temp., F
Average Daily High Temp. of the Hottest Month, F
94
92
90
88
86
84
82
80
78
76
76
78
80
82
84
86
88
90
92
94
Regression Line
1:1 Line
Regression Equation
y = 23.55+0.8 x
R-squared = 0.8
New Jersy

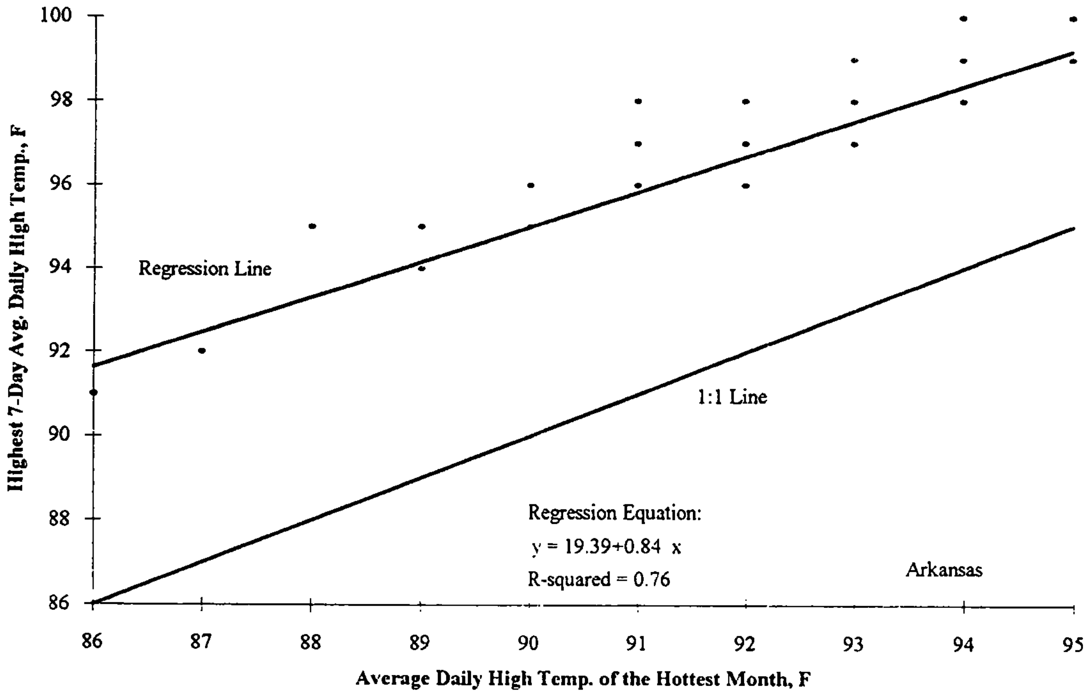

92
90
88
86
84
82
80
78
76
Highest 7-Day Avg. Daily High Temp., F
Regression Line
1:1 Line
Regression Equation:
y = 9.78+0.95 x
R-squared = 0.91
Connecticut &
Rhode Island
76
77
78
79
80
81
82
83
84
85
86
Average Daily High Temp. of the Hottest Month, F

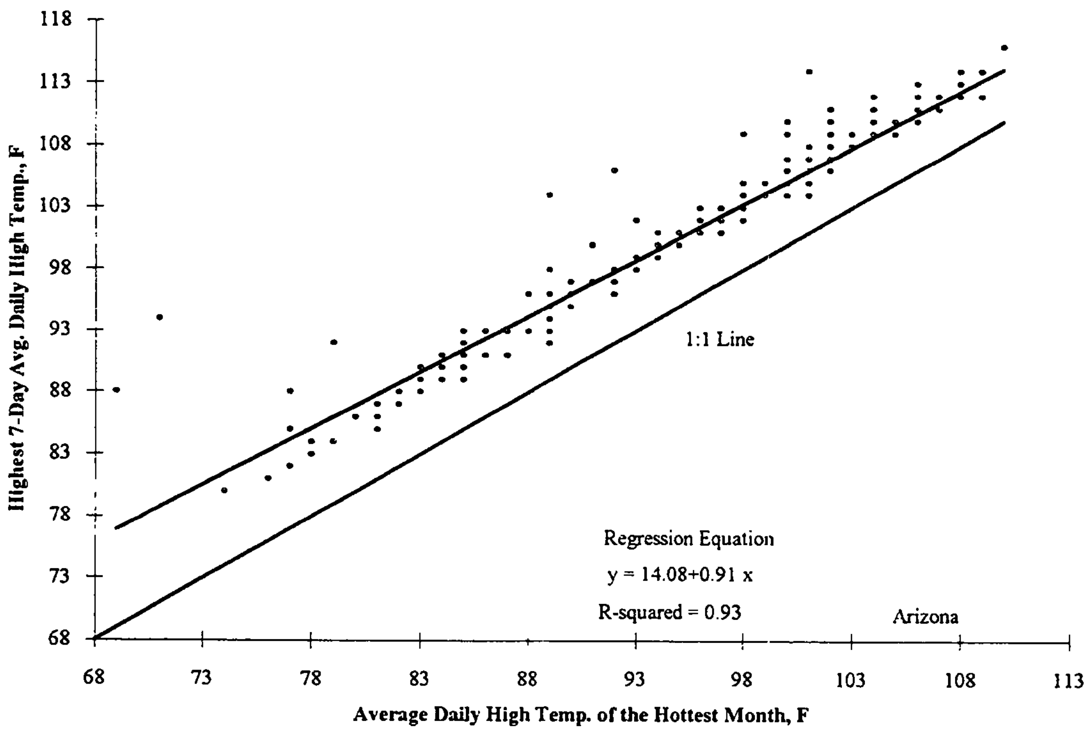

93
91
89
87
85
83
81
79
77
75
Highest 7-Day Avg. Daily High Temp., F
1:1 Line
Regression Equation
y = 2.77+1.04 x
R-squared = 0.85
Massachusetts
75
76
77
78
79
80
81
82
83
84
Average Daily High Temp. of the Hottest Month, F

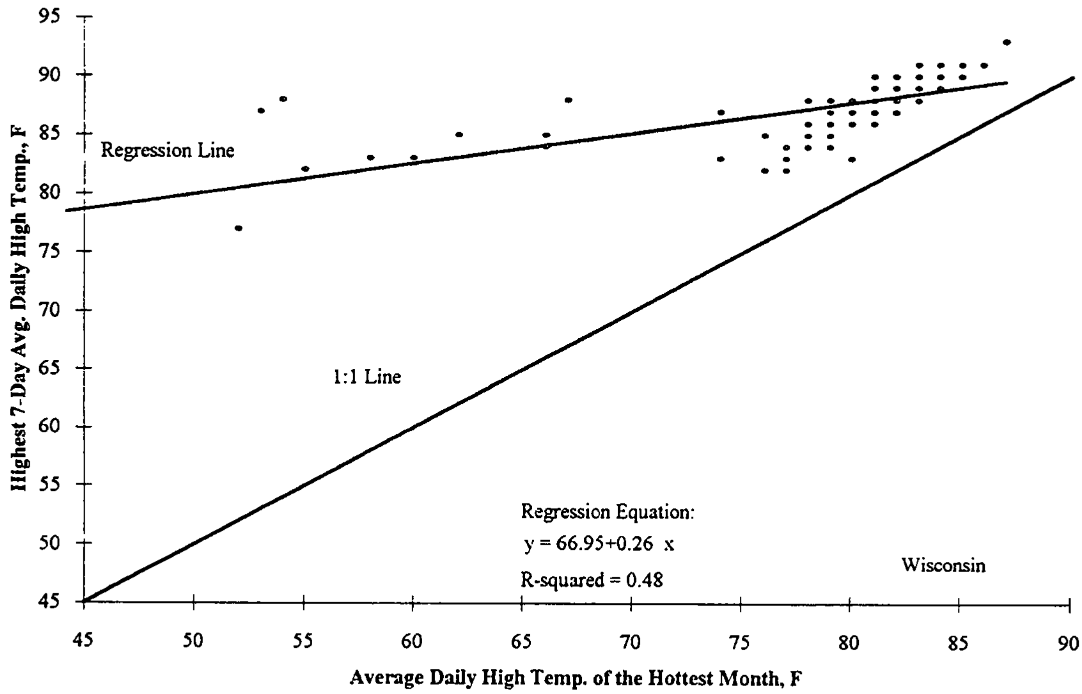


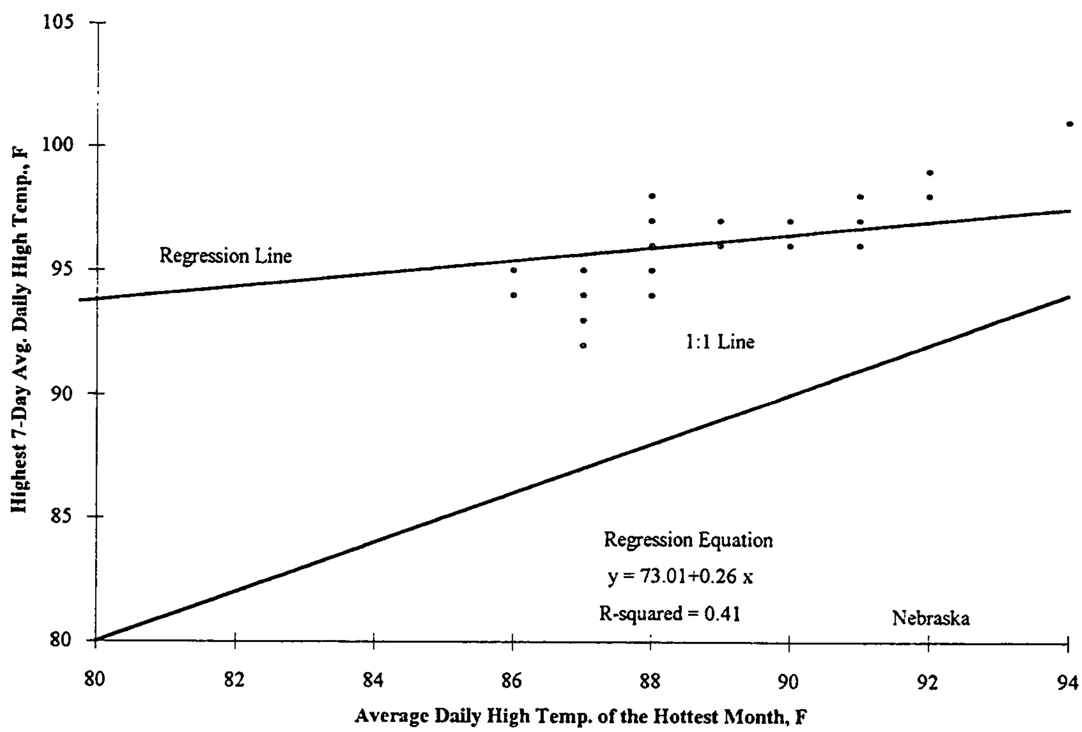


MEVTNHTW.XLS


Highest 7-Day Avg. Daily High Temp., F
Average Daily High Temp. of the Hottest Month, F
Regression Line
1:1 Line
Regression Equation:
y = 19.39+0.84 x
R-squared = 0.76
Arkansas


Highest 7-Day Avg. Daily High Temp., F
Average Daily High Temp. of the Hottest Month, F
1:1 Line
Regression Equation
y = 14.08+0.91 x
R-squared = 0.93
Arizona


95
90
85
80
75
70
65
60
55
50
45
Highest 7-Day Avg. Daily High Temp., F
Regression Line
1:1 Line
Regression Equation:
y = 66.95+0.26 x
R-squared = 0.48
Wisconsin
45
50
55
60
65
70
75
80
85
90
Average Daily High Temp. of the Hottest Month, F


105
100
95
90
85
80
Highest 7-Day Avg. Daily High Temp., F
Regression Line
1:1 Line
Regression Equation
y = 73.01+0.26 x
R-squared = 0.41
Nebraska
80
82
84
86
88
90
92
94
Average Daily High Temp. of the Hottest Month, F

Appendix D. Documentation for climatic databases

Provided by EarthInfo, Inc.

UNITED STATES
WEATHER DATABASE
DOCUMENTATION FOR
SHRP
ASPHALT RESEARCH PROGRAM
PROVIDED BY EARTHINFO, INC.

AUGUST 1991

BIG.TXT, SMALL.TXT, AND ALL STATE FILES

New Field	Old Field	Type	Contents
1	1	CHAR	State postal abbreviation.
2	2	CHAR	County name
3	3	CHAR	Station name
4	4	CHAR	Longitude (ddd.mm)
5	5	CHAR	Latitude (ddd.mm)
6	6	FLOAT	Elevation of station, in feet.
7	7	INT	Smallest TMIN ever.
8	8	FLOAT	Mean of smallest TMIN's.
9	9	FLOAT	Median of smallest TMIN's.
10	10	FLOAT	Std. Dev. of smallest TMIN's.
11	11	INT	Largest TMIN ever.
12	12	INT	Number of TMIN years, for above.
13	13	INT	Smallest mean monthly TMIN.
14		CHAR	Month of smallest mean monthly.
15	14	FLOAT	Mean of mean monthly TMIN's.
16	15	FLOAT	Median of mean monthly TMIN's.
17	16	FLOAT	Std. Dev. of mean monthly TMIN's.
18	17	INT	Number of mean monthly TMIN's.
19	33	FLOAT	Daily average TMIN.
20	18	INT	Largest TMAX ever.
21	19	FLOAT	Mean of largest TMAX's.
22	20	FLOAT	Median of largest TMAX's.
23	21	FLOAT	Std. Dev. of largest TMAX's.
24	22	INT	Number of TMAX years, for above.
25	23	INT	Largest mean monthly TMAX.
26		CHAR	Month of largest mean monthly.
27	24	FLOAT	Mean of mean monthly TMAX's.
28	25	FLOAT	Median of mean monthly TMAX'S.
29	26	FLOAT	Std. Dev. of mean monthly TMAX's.
30	27	INT	Number of mean weekly TMAX's.
31	28	INT	Highest mean weekly TMAX.
32	29	FLOAT	Mean of mean weekly TMAX's.
33	30	FLOAT	Median of mean weekly TMAX's.
34	31	FLOAT	Std. Dev. of mean weekly TMAX's.
35		INT	Number of mean weekly TMAX's.
36	32	FLOAT	Daily average TMAX.
37	34	FLOAT	Maximum annual PRCP.

CONTINUATION

38	35	FLOAT	Minimum annual PRCP.
39	36	FLOAT	Mean of annual PRCP.
40	37	FLOAT	Median of annual PRCP's.
41	38	FLOAT	Std. Dev. of annual PRCP's.
42	39	INT	Number of PRCP years, for above.
43		FLOAT	TMIN percentage coverage.
44		FLOAT	TMAX percentage coverage.
45		FLOAT	PRCP percentage coverage.

Fields

TMINBIG. TXT, TMINSMAL. TXT

1-6	From above field 1-6.
7-19	From above field 7-19.
20	From above field 43.

TMAXBIG.TXT,TMAXSMAL.TXT

1-6	From above fields 1-6.
7-23	From above fields 20-36
24	From above field 44.

PRCPBIG. TXT. PRCPSMAL. TXT

1-6	From above fields 1-6
7-12	From above fields 37-42
13	From above field 45.

File Names

BIG.TXT	All data from all stations with any one parameter having at least 20 years of daily data.
	EAST disc 1834 stations. Central disc 2490 stations. West 1 disc 1677 stations. West 2 disc 3055 stations.
SMALL.TXT	All data from all other stations.
xx.TXT	Data extracted from BIG.TXT by state, where xx is the state postal code.
TMINBIG. TXT TMAXBIG.TXT PRCPBIG.TXT	Data for one parameter where that station has 20 years or more of data for that parameter.
TMINSMAL.TXT TMAXSMAL.TXT PRCPSMAL.TXT	Data for all stations with parameters of less than 20 years.

File Format

Each file is in a format known as "comma-delimited". This format is a ASCII text file, containing readable data. Each line constitutes one record. Within a record can be (virtually) any number of fields, of either the text or numeric variety. Each field is separated by a comma. The end of the record has a carriage-return/linefeed but no trailing comma. A text string is text surrounded by double quotes. A period or minus sign. A numeric field does not have quotes. This file format is accepted by most database management programs as well as most spreadsheets. It can be edited using any ASCII editor.

Data Anomalies

The originating database contains errors and other potentially serious anomalies. Use the percent coverage variables to determine the "worthiness" of the data. If any percent is zero, then the corresponding (TMAX, TMIN, PRCP) data should be ignored. Extremely small percent coverages should also be suspect. Occasionally a station may have one data year, with all data valued being "invalid data". Needless to say, this can throw off some calculations. Some stations are unidentified. these stations are named "????" and have elevations of 9999 and latitude/longitudes of zero. For further reading on the potential data anomalies, consult your climate data manual. Any value of 9999 or -9999 is invalid. Any data with a count of 0 or 1 should not be used.

Data Formulas

Field 7

The smallest TMIN ever is the smallest TMIN value for the entire period of record. The smallest TMIN for each year is saved in an array for use in generating the mean, median, and standard deviation.

Field 11

The largest TMIN ever is the largest TMIN value for the entire period of record.

Fields 13,14

The smallest mean monthly TMIN is generated by first taking the mean of a month's worth of TMIN values. The smallest mean monthly for a year is saved in an array, one value per year of the period of record. The month that the lowest mean occurred is also saved. Field 13 is the smallest mean from the array, with Field 14 being the month the smallest mean occurred.

Field 19

This field is taken from the summary record and is the yearly daily average TMIN.

Field 20

The largest TMAX ever is the largest TMAX value for the entire period of record. The largest TMAX for each year is saved in an array for use in generating the mean, median, and stard deviation.

Fields 25, 26

The largest mean monthly TMAX is generated by first taking the mean of a month's worth of TMAX values. The largest mean monthly for a year is saved in an array, one value per year of the period of record. The month that the highest mean occurred is also saved. Field 25 is the largest mean from the array, with Field 26 being the month the largest mean occurred.

Field 28

This field contains the highest mean weekly TMAX. The value is generated by first collecting all TMAX data for May, June, July, August, and September. a 7-day sliding window is used to generate a weekly mean. The highest weekly mean for a year is saved in an array for statistics. This value is the largest mean from that array.

Field 36

This field is taken from the summary record and is the yearly daily average TMAX.

Field 37, 38

The total annual precipitation for each year is saved in an array. These two fields are the largest and smallest of these values, respectively.

General Means

The routine that calculates the mean is presented with an array of values, and a count of values. All values in the array are summed, then divided by the count.

General Median

Using the same array (& count) as the mean, the array is sorted. If there are an odd number of elements, the median is the "middle" element of the array. If there is an even number of elements, then the two in the "middle" are averaged to generate the median.

General Standard Deviation

This routine uses the same array of values as the mean and the median. For each array element, the square of the difference between the element and the mean is summed. these values are then divided by the number of elements minus one. The square root of this result is the standard deviation. The formula used is from the CRC handbook.

Data Values

All temperature values are stored and reported in degrees fahrenheit. All precipitation values are stored as hundredths of an inch. These values are converted to inches and reported as a floating point number.

CANADA
WEATHER DATABASE
DOCUMENTATION FOR
SHRP
ASPHALT RESEARCH PROGRAM
PROVIDED BY
EARTHINFO, INC.

JANUARY, 1992

There are two GROUPS of data files provided. The first group contains data similar to the first contract with the addition of SNOW data. The second group of files contains maximum and minimum humidity data and 12 element arrays for each of these parameters: WIND, TMAX and TMIN.

Each file is provided in two formats, comma delimited ASCII and a dBASE compatible DBF style.

Field descriptions of files in first group:

BIG1.TXT, SMALL1.TXT, and all (Province)1.TXT files.

Field	Type	Contents
1	CHAR	State postal abbreviation.
2	CHAR	County name.
3	CHAR	Station name.
4	CHAR	Longitude (ddd.mm)
5	CHAR	Latitude (ddd.mm)
6	INT	Elevation of station, in feet.
7	INT	Smallest TMIN ever.
8	FLOAT	Mean of smallest TMIN's.
9	FLOAT	Median of smallest TMIN's.
10	FLOAT	Std. Dev. of smallest TMIN's.
11	INT	Largest TMIN ever.
12	INT	Number of TMIN years, for above.
13	FLOAT	Smallest mean monthly TMIN.
14	INT	Month of smallest mean monthly.
15	FLOAT	Mean of mean monthly TMIN's.
16	FLOAT	Median of mean monthly TMIN's.
17	FLOAT	Std. Dev. of mean monthly TMIN's.
18	INT	Number of mean monthly TMIN's.
19	FLOAT	Daily average TMIN.
20	INT	Largest TMAX ever.
21	FLOAT	Mean of largest TMAX's.
22	FLOAT	Median of largest TMAX's.
23	FLOAT	Std. Dev. of largest TMAX's.

24	INT	Number of TMAX years, for above.
25	FLOAT	Largest mean monthly TMAX.
26	INT	Month of largest mean monthly.
27	FLOAT	Mean of mean monthly TMAX's.
28	FLOAT	Median of mean monthly TMAX's.
29	FLOAT	Std. Dev. of mean monthly TMAX's.
30	INT	Number of mean monthly TMAX's.
31	FLOAT	Highest mean weekly TMAX.
32	FLOAT	Mean of mean weekly TMAX's.
33	FLOAT	Median of mean weekly TMAX's.
34	FLOAT	Std. Dev. of mean weekly TMAX's.
35	INT	Number of mean weekly TMAX's.
36	FLOAT	Daily average TMAX.
37	INT	Maximum annual PRCP.
38	INT	Minimum annual PRCP.
39	FLOAT	Mean of annual PRCP's.
40	FLOAT	Median of annual PRCP's.
41	FLOAT	Std. Dev. of annual PRCP's.
42	INT	Number of PRCP years, for above.
43	INT	TMIN percentage coverage.
44	INT	TMAX percentage coverage.
45	INT	PRCP percentage coverage.
46	INT	Highest total SNOW in one year.
47	INT	Lowest total SNOW in one year.
48	FLOAT	Mean annual total snowfall.
49	FLOAT	Median annual total snowfall.
50	FLOAT	Std. Dev. of annual snowfall.
51	INT	Number of SNOW years.
52	INT	SNOW percentage coverage.

Field descriptions of files in the second group:

BIG2.TXT, SMALL2.TXT, and all (Province)2.TXT files.

Field	Type	Contents

1	CHAR	State postal abbreviation.
2	CHAR	County name.
3	CHAR	Station name.
4	CHAR	Longitude (ddd.mm)
5	CHAR	Latitude (ddd.mm)
6	INT	Elevation of station, in feet.
7	FLOAT	Avg daily MAX rel humidity
8	FLOAT	Std dev of above.
9	FLOAT	Avg daily MIN rel humidity
10	FLOAT	Std dev of above.
11 - 35	FLOAT[24]	Avg WIND speed and std for each month.
36 - 47	FLOAT[12]	Avg monthly TMIN for each month
48 - 59	FLOAT[12]	Avg monthly TMAX for each month

The following files are derived from group 1 files where the BIG files have stations with 20 or more years of data:

TMINBIG.TXT, TMINSML.TXT

1-6	From above fields 1-6.
7-19	From above fields 7-19.
20	From above field 43.

TMAXBIG.TXT, TMAXSML.TXT

1-6	From above fields 1-6.
7-23	From above fields 20-36.
24	From above field 44.

PRCPBIG.TXT, PRCPSML.TXT

1-6	From above fields 1-6.
7-12	From above fields 37-42.
13	From above field 45.

SNOWBIG.TXT, SNOWSML.TXT

1-6	From above fields 1-6.
7-12	From above fields 46-51.
13	From above field 52.

FILE NAMES: where # is 1 or 2, indicating the file group:

BIG#.TXT	All data from all stations with any one parameter having at least 20 years of daily data.
SMALL#.TXT	All data from all other stations.
xx#.TXT	Data extracted from BIG#.TXT by province, where xx is the province abbreviation.
TMINBIG.TXT TMAXBIG.TXT PRCPBIG.TXT SNOWBIG.TXT	Data for one parameter where that station has 20 years or more of data for that parameter.
TMINSML.TXT TMAXSML.TXT PRCPSML.TXT SNOWSML.TXT	Data for all stations with parameters of less than 20 years.

File Format

Each file is either a dBASE compatible DBF file with extension ".dbf" or it is "comma-delimited" with an extension of ".txt". "comma-delimited" format is a ASCII text file, containing readable data. Each line constitutes one record. Within a record can be (virtually) any number of fields, of either the text or numeric variety. Each field is separated by a comma. The end of the record has a carriage-return/linefeed but no trailing comma. A text string is text surrounded by double quotes. A numeric field is text containing either digits or a period or minus sign. A numeric field does not have quotes. This file format is accepted by most database management programs as well as most spreadsheets. It can be edited using any ASCII editor.

Data Anomalies

The originating database contains errors and other potentially serious anomalies. Use the percent coverage variables to determine the "worthiness" of the data. If any percent is zero, then the corresponding (TMAX, TMIN, PRCP) data should be ignored. Extremely small percent coverages should also be suspect. Occasionally a station may have one data year, with all data values being "invalid data". Needless to say, this can throw off some calculations. Any value of 9999 or -9999 is invalid.

Data Formulas

Field 7

The smallest TMIN ever is the smallest TMIN value for the entire period of record. The smallest TMIN for each year is saved in an array for use in generating the mean, median, and standard deviation.

Field 11

The largest TMIN ever is the largest TMIN value for the entire period of record.

Fields 13, 14

The smallest mean monthly TMIN is generated by first taking the mean of a month's worth of TMIN values. The smallest mean monthly for a year is saved in an array, one value per year of the period of record. The month that the lowest mean occurred is also saved. Field 13 is the smallest mean from the array, with Field 14 being the month the smallest mean occurred.

Field 19

This field is calculated as the sum of all daily TMIN's divided by the number of TMIN readings over the life of the station.

Field 20

The largest TMAX ever is the largest TMAX value for the entire period of record. The largest TMAX for each year is saved in an array for use in generating the mean, median, and standard deviation.

Fields 25, 26

The largest mean monthly TMAX is generated by first taking the mean of a month's worth of TMAX values. The largest mean monthly for a year is saved in an array, one value per year of the period of record. The month that the highest mean occurred is also saved. Field 25 is the largest mean from the array, with Field 26 being the month the largest mean occurred.

Field 31

This field contains the highest mean weekly TMAX. The value is generated by examining TMAX data for May, June, July, August, and September. A 7-day sliding window is used to generate a weekly mean. The highest weekly mean for each year is saved in an array and this value is the largest mean from that array.

Field 36

This field is computed by dividing the sum of all daily TMAX readings divided by the total number of readings.

Field 37, 38

The total annual precipitation for each year is saved in an array. These two fields are the largest and smallest of these values, respectively. The same technique is used for SNOW, fields 46 and 47.

Percent Coverage

This is calculated by counting the number of days with valid data and the number of possible days from Jan 1 of the first year of record for the station.

General Means and Standard Deviation

The routine that calculates the mean and standard deviation is presented with an array of values, and a count of values.

All values in the array are summed, then divided by the count to produce the mean. At the same time the squares of each element are summed. The std. dev. is then calculated by sqrt((sum-of-squares -(sum-squared / n)) / n -1). Means and std. dev. are reported in the same units as the data. Std. dev. is displayed with one decimal place but the units remain the same. Ie: a mean of 345.6 in PRCP data is 3.456 centimeters since PRCP is reported in hundredths of centimeters.

General Median

Using the same array (and count) as the mean, the array is sorted. If there are an odd number of elements, the median is the "middle" element of the array. If there is an even number of elements, then the two in the "middle" are averaged to generate the median. Medians are reported in the same units as the data.

Data Values

Data are the same units as provided by Canadian Climate Center. Temperature values are in degrees and tenths Centigrade: 321 is 32.1 degrees C. All precipitation values are in hundredths of a centimeter and snow values are in tenths of a centimeter. Humidity is in whole percent. Wind speed is is Kilometers per hour.

OUTPUT ON 5 DISKETTS

A listing of the files contained in the ZIP's on each floppy.

FLOPPY # 1

Searching ZIP: B:BIGDBF.ZIP

Length	Method	Size	Ratio	Date	Time	CRC-32	Attr	Name
1060907	Implode	308542	71%	01-17-92	09:20	d07477e6	--w	BIG1.DBF
1235731	Implode	189863	85%	01-17-92	09:15	29f0a831	--w	BIG2.DBF

1980917	Implode	511137	75%	01-17-92	09:07	e37aadd3	--w	SMALL1.DBF
2307391	Implode	283568	88%	01-16-92	17:52	fd5a2087	--w	SMALL2.DBF
------		------	---					-------
6584946		1293110	81%					4

FLOPPY # 2

Searching ZIP: B:BIGSMALL.ZIP

Length	Method	Size	Ratio	Date	Time	CRC-32	Attr	Name
613124	Shrunk	247208	60%	01-16-92	14:56	840ef68f	--w	BIG1.TXT
750573	Shrunk	155451	80%	01-16-92	16:03	bad11e13	--w	BIG2.TXT
1140880	Shrunk	416860	64%	01-16-92	14:56	57522ecd	--w	SMALL1.TXT
1447479	Shrunk	235499	84%	01-16-92	16:03	b55b5ea6	--w	SMALL2.TXT
------		------	---					-------
3952056		1055018	74%					4

FLOPPY # 3

Searching ZIP: B:PRCPDBF.ZIP

Length	Method	Size	Ratio	Date	Time	CRC-32	Attr	Name
290951	Implode	98981	66%	01-17-92	22:34	529b60bf	--w	PRCPBIG.DBF
544701	Implode	181161	67%	01-17-92	22:37	c13b9ad6	--w	PRCPSML.DBF
291076	Implode	94433	68%	01-17-92	22:39	0eff16f5	--w	SNOWBIG.DBF
544576	Implode	170183	69%	01-17-92	22:43	4b8c8d38	--w	SNOWSML.DBF
------		------	---					-------
1671304		544758	68%					4

Searching ZIP: B:PRCPSNOW.ZIP

Length	Method	Size	Ratio	Date	Time	CRC-32	Attr	Name
225653	Shrunk	90361	60%	01-16-92	15:32	2d47648c	--w	PRCPBIG.TXT
418541	Shrunk	167093	61%	01-16-92	15:32	618e9062	--w	PRCPSML.TXT
217539	Shrunk	85815	61%	01-16-92	15:32	86afe9ef	--w	SNOWBIG.TXT
401333	Shrunk	156242	62%	01-16-92	15:32	4f6b191e	--w	SNOWSML.TXT
------		------	---					-------
1263066		499511	61%					4

FLOPPY # 4

Searching ZIP: B:PROV.ZIP

Length	Method	Size	Ratio	Date	Time	CRC-32	Attr	Name
95199	Shrunk	39393	59%	01-16-92	15:23	16847bf9	--w	AL1.TXT
119669	Shrunk	24020	80%	01-16-92	15:24	6b3300ee	--w	AL2.TXT
115862	Shrunk	46531	60%	01-16-92	15:23	c932ef7d	--w	BC1.TXT
140595	Shrunk	29147	80%	01-16-92	15:24	ab73aa9e	--w	BC2.TXT
38737	Shrunk	16213	59%	01-16-92	15:23	5ff518bb	--w	MA1.TXT
48089	Shrunk	11060	78%	01-16-92	15:24	7860fbab	--w	MA2.TXT
18032	Shrunk	8038	56%	01-16-92	15:23	8152c010	--w	NB1.TXT
21836	Shrunk	5481	75%	01-16-92	15:24	0d9a61b5	--w	NB2.TXT
17369	Shrunk	7833	55%	01-16-92	15:23	c2a90a27	--w	NF1.TXT
20255	Shrunk	6162	70%	01-16-92	15:24	4f2df62e	--w	NF2.TXT
24717	Shrunk	10483	58%	01-16-92	15:23	8f166a9e	--w	NS1.TXT
29618	Shrunk	6935	77%	01-16-92	15:24	7fc23dd8	--w	NS2.TXT
17235	Shrunk	7943	54%	01-16-92	15:23	0480abd8	--w	NW1.TXT
20572	Shrunk	7158	66%	01-16-92	15:24	6e1da31c	--w	NW2.TXT
119052	Shrunk	47925	60%	01-16-92	15:23	8e5b114f	--w	ON1.TXT
145355	Shrunk	30477	80%	01-16-92	15:24	61189be0	--w	ON2.TXT
3441	Shrunk	1763	49%	01-16-92	15:23	040403ba	--w	PE1.TXT
4089	Shrunk	1366	67%	01-16-92	15:24	f7036294	--w	PE2.TXT
95315	Shrunk	39876	59%	01-16-92	15:23	0a4b1c15	--w	QU1.TXT
115740	Shrunk	25693	78%	01-16-92	15:24	1c471b14	--w	QU2.TXT
61076	Shrunk	25173	59%	01-16-92	15:23	56c50c5f	--w	SA1.TXT
76142	Shrunk	16723	79%	01-16-92	15:24	e77fed22	--w	SA2.TXT
7089	Shrunk	3479	51%	01-16-92	15:23	284201cf	--w	YT1.TXT
8613	Shrunk	2851	67%	01-16-92	15:24	5a91648a	--w	YT2.TXT
1363697		421723	70%					24

Searching ZIP: B:PROVDBF.ZIP

Length	Method	Size	Ratio	Date	Time	CRC-32	Attr	Name
168197	Implode	49288	71%	01-17-92	21:31	0b014a41	--w	AL1.DBF
195871	Implode	28858	86%	01-17-92	21:32	b0308680	--w	AL2.DBF
201867	Implode	57352	72%	01-17-92	21:36	f6ef55a6	--w	BC1.DBF
235091	Implode	34115	86%	01-17-92	21:35	4d9653d6	--w	BC2.DBF

68552	Implode	19575	72%	01-17-92	21:41	562c9988	--w	MA1.DBF
79801	Implode	12396	85%	01-17-92	21:40	6b6518ad	--w	MA2.DBF
32607	Implode	9748	71%	01-17-92	21:42	bb10f509	--w	NB1.DBF
37931	Implode	6060	85%	01-17-92	21:43	3a8fd1a7	--w	NB2.DBF
31697	Implode	9508	71%	01-17-92	21:45	64e4fb11	--w	NF1.DBF
36871	Implode	7307	81%	01-17-92	21:46	64dd5497	--w	NF2.DBF
43982	Implode	12664	72%	01-17-92	21:47	c901e126	--w	NS1.DBF
51181	Implode	7726	85%	01-17-92	21:49	827a8207	--w	NS2.DBF
31697	Implode	9762	70%	01-17-92	21:50	e2ae7e09	--w	NW1.DBF
36871	Implode	8507	77%	01-17-92	21:51	7e8086ae	--w	NW2.DBF
206417	Implode	59239	72%	01-17-92	21:52	0c968b61	--w	ON1.DBF
240391	Implode	35871	86%	01-17-92	21:54	b5b935c7	--w	ON2.DBF
7582	Implode	2352	69%	01-17-92	21:55	0f6a4e41	--w	PE1.DBF
8781	Implode	1652	82%	01-17-92	21:55	6c4e99ff	--w	PE2.DBF
165467	Implode	50092	70%	01-17-92	21:57	28fc6f03	--w	QU1.DBF
192691	Implode	30490	85%	01-17-92	21:58	a2784e29	--w	QU2.DBF
107227	Implode	31445	71%	01-17-92	22:00	35b905bc	--w	SA1.DBF
124851	Implode	19451	85%	01-17-92	22:00	d9872c0c	--w	SA2.DBF
13952	Implode	4433	69%	01-17-92	22:02	018a3373	--w	YT1.DBF
16201	Implode	3403	79%	01-17-92	22:03	7022a9d6	--w	YT2.DBF
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2335776		511294	79%					24

FLOPPY # 5

Searching ZIP: B:TEMP.ZIP

Length	Method	Size	Ratio	Date	Time	CRC-32	Attr	Name
251339	Shrunk	96705	62%	01-16-92	15:29	89cf90f5	--w	TMAXBIG.TXT
674991	Shrunk	212908	69%	01-16-92	15:29	e18aede2	--w	TMAXSML.TXT
231963	Shrunk	87663	63%	01-16-92	15:29	8e9b209c	--w	TMINBIG.TXT
611492	Shrunk	197175	68%	01-16-92	15:29	50fef054	--w	TMINSML.TXT
------		------	---					-------
1769785		594451	67%					4

Searching ZIP: B:TEMPDBF.ZIP

Length	Method	Size	Ratio	Date	Time	CRC-32	Attr	Name
402359	Implode	113955	72%	01-17-92	22:54	e20c7e5a	--w	TMAXBIG.DBF
1055051	Implode	244225	77%	01-17-92	22:58	4d6ef0ae	--w	TMAXSML.DBF

335555	Implode	100020	71%	01-17-92	23:09	a091c9ab	--w	TMINBIG.DBF
881191	Implode	218739	76%	01-17-92	23:13	bb69e5df	--w	TMINSML.DBF
-------		-------	---					-------
2674156		676939	75%					4

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