CLIMATE OF MINNESOTA

Part XV—Normal Temperatures (1951-1980) and Their Application

Donald G. Baker
Earl L. Kuehnast
James A. Zandlo

AD-SB-2777—1985
Agricultural Experiment Station
University of Minnesota

Climate of Minnesota Part XV:

Normal Temperatures (1951-80) and Their Application

by

D. G. Baker, E. L. Kuehnast, and J. A. Zandlo

INTRODUCTION

This study was made to provide both a climatology of air temperature and basic information relative to the spatial and temporal distribution of temperature and temperature-derived quantities such as growing and heating degree days in the state of Minnesota. This was also the subject of an earlier bulletin in this series: Climate of Minnesota Part III. Temperature and Its Application (Baker and Strub, 1965). There are three important differences between that bulletin and this one: first, this one is based on the temperature normals for the period 1951-1980 instead of 1931-1960; second, all data have been adjusted to a uniform observation time, an improvement that is explained in another section; and third, this bulletin is based on a total of 159 stations, 85 within the state and the remainder along the Minnesota border in adjoining states. Only 65 Minnesota stations were available for the 1965 bulletin.

All data in this bulletin are based on temperatures measured within the standard temperature shelter: a louvered, white, double-roofed, wooden structure whose base stands four and one-half feet above ground. Despite precautions taken to provide adequate ventilation and to guard the thermometers from the effects of radiational heating or cooling, a protection provided by and large with the shelter, there are objections to this data source.

The height of the shelter that houses the temperature sensors is for the convenience of the observer. It represents a compromise between what the climatologist finds desirable and what the agriculturist wishes. Climatologists ordinarily prefer a measurement taken higher so it is less influenced by the immediate surface and is more regional in character. Agriculturists, on the other hand, frequently find that the thermometers are well above the environment in which most organisms live and where the immediate interests of agriculture are found. Large temperature gradients can exist between the height of the temperature shelter and the soil or crop surface. In addition, the housing itself is an artifical environment, often quite unlike that of the natural environment. Nevertheless, the temperature shelter remains the best device yet established for general use in terms of convenience and uniformity of conditions. There are no other long-term statewide standardized temperature measurements available.

The basic data were collected and compiled by the U.S. National Weather Service (NOAA, 1982). We are, therefore, indebted to the National Weather Service and, particularly, to the volunteer weather observers who constitute the great majority of the observers within the National Weather Service climatological network.

METHODOLOGY

Normal Period

The World Meteorological Organization, of which the U.S. National Weather Service is a member, has established a common averaging period so that temperatures between stations can be fairly compared. A 30-year period was determined as being of acceptable longevity. And, recognizing that there are changes with time in both the climate and the stations, the 30-year period is advanced each decade. Currently, the normal period for which the averages are calculated and to which monthly and annual averages are compared is 1951-1980. This period will remain as the averaging or normal period for the 1981-1990 decade, after which the new normal period will become 1961-1990.

As noted earlier, the previous bulletin on Minnesota temperatures was based on the average of the 1931-1960 normal period. Thus, although the mean temperatures for 1951-1980 have not changed greatly from the 1931-1960 period, they are more representative of the current period. One important reason why this is true is that the 30-year averages have often shown marked variations with time as, for example, when a cold period is succeeded by a warm one or vice versa. Although the 30-year average or normal period for worldwide comparisons was established only about 25 years ago, it is interesting to see how one series of 30-year means has varied with time. One unique Minnesota record permits comparisons to be made over an extended period. This record, shown in Figure 1, is a combination of the Ft. Snelling and Farmington 3NW records, began in October 1819 and continues to this day. It has been corrected for errors and certain adjustments have been applied to make it as true a record as possible (Baker et al., 1985).

Figure 1 provides a glimpse of the climatic variation that eastern Minnesota has experienced in the 164 years (1820-1983) represented by the plotted values. Since each plotted value is the mean of 30 years, the temperature variation is greatly smoothed. The smoothing essentially eliminates short-term annual variations, making apparent the major trends that have occurred during the 164-

year record. At first there was a declining trend with the low point reached in the 1859-1888 period. This was followed by a rising trend that reached its maximum in the 1930-1959 30-year period, only to be in turn succeeded by the current declining trend. The range of the 30-year averages has amounted to a surprising 2.8°F. Figure 1 illustrates well that the climate is not stable. Rather, it is dynamic.

In general the current normals are often superior to those representing 1931-1960, since in the late 1930s and the 1940s a number of first order weather stations in the United States were shifted from their original downtown locations to their current airport locations; that is, from typically urban to essentially rural environments. As a result, an artificially induced decrease in the temperature record of these stations can be found at certain locations, since an urban environment is ordinarily warmer (also less humid, less windy, and with less solar radiation) than a rural one. In Minnesota this kind of shift occurred at the first order National Weather Service stations of Duluth and Minneapolis-St. Paul.

At Duluth the weather station was moved from the downtown site to the airport on June 6, 1941, resulting in an altitude change from 1128 to 1428 feet. At the airport the temperature sensors were initially adjacent to the terminal building. On June 22, 1961, they were moved to the present airport runway site.

The move at the Minneapolis-St. Paul airport station was made from downtown Minneapolis to the airport in 1937. Observations, however, were made from roof sites or within a complex of large buildings until January 1, 1960. From that time, observations have been made in an open field along the airport runway.

There is another reason for the improved representativeness with a current normal period. Due to the trends and fluctutations in temperature, some of which are shown in Figure 1, the most recent past usually is a better predictor of the near future than is a longer-term record. That is, even though there is an overall upward trend in the long-term eastern Minnesota record, there are superimposed upon it fluctuations of varying duration. It is these variations that can be more closely followed if the normal period is kept current and is not too long. To be of value, therefore, the normal period should be long enough to be reasonably stable but short enough so that it can be used as a predictor for the near future. For predictive purposes, Sabin and Shulman (1985) found little difference between normals of 10 years and those of longer duration, and Enger (1959) found that in general a 15-25 year temperature normal was the most efficient predictor of the following year. With the eastern Minnesota record for 1820-1983 as the test, it was found that after an 8-10 year period, there was little advantage to be gained in increasing the length of the normal period. Periods tested ranged from 2 to 80 years.

The 30-year normal that has been established as a worldwide standard for climatic comparisons is in effect a compromise between the much shorter periods suitable for equable maritime climates and the longer ones required in highly variable continental climates such as Minnesota experiences. It also is a compromise between the two climatic elements most often measured and compared: temperature and precipitation. A longer time period is required for an adequate sample of precipitation amounts than for temperature stability.

Another reason for the 30-year period is that, although many stations have records of this duration, their numbers decline rapidly beyond 30 years.

Observation Time Selection

A seemingly simple but generally unappreciated factor has limited the value of almost all temperature comparisons that are made between stations, even when they are made over the same time periods. This is the bias introduced when the observation time is not the same. Differences occur because the majority of the National Weather Service climatological observers are volunteers who take their observations at a time convenient for them. For example, the daily observation at one station may be taken at 5 p.m., but at a neighboring station it might be taken at 8 a.m. Although the observations are recorded for the same day, the 24-hour day that each observation represents differs. And neither corresponds to the true calendar day used by the National Weather Service stations such as Duluth, Fargo, Minneapolis-St. Paul, Rochester, or Sioux Falls.

As explained by Baker (1975), the differing observation times create an artificial difference in the mean daily temperature. When mean temperatures are summed over a season, as is the case with growing degree days (GDD) and heating degree days (HDD), variations between stations with different

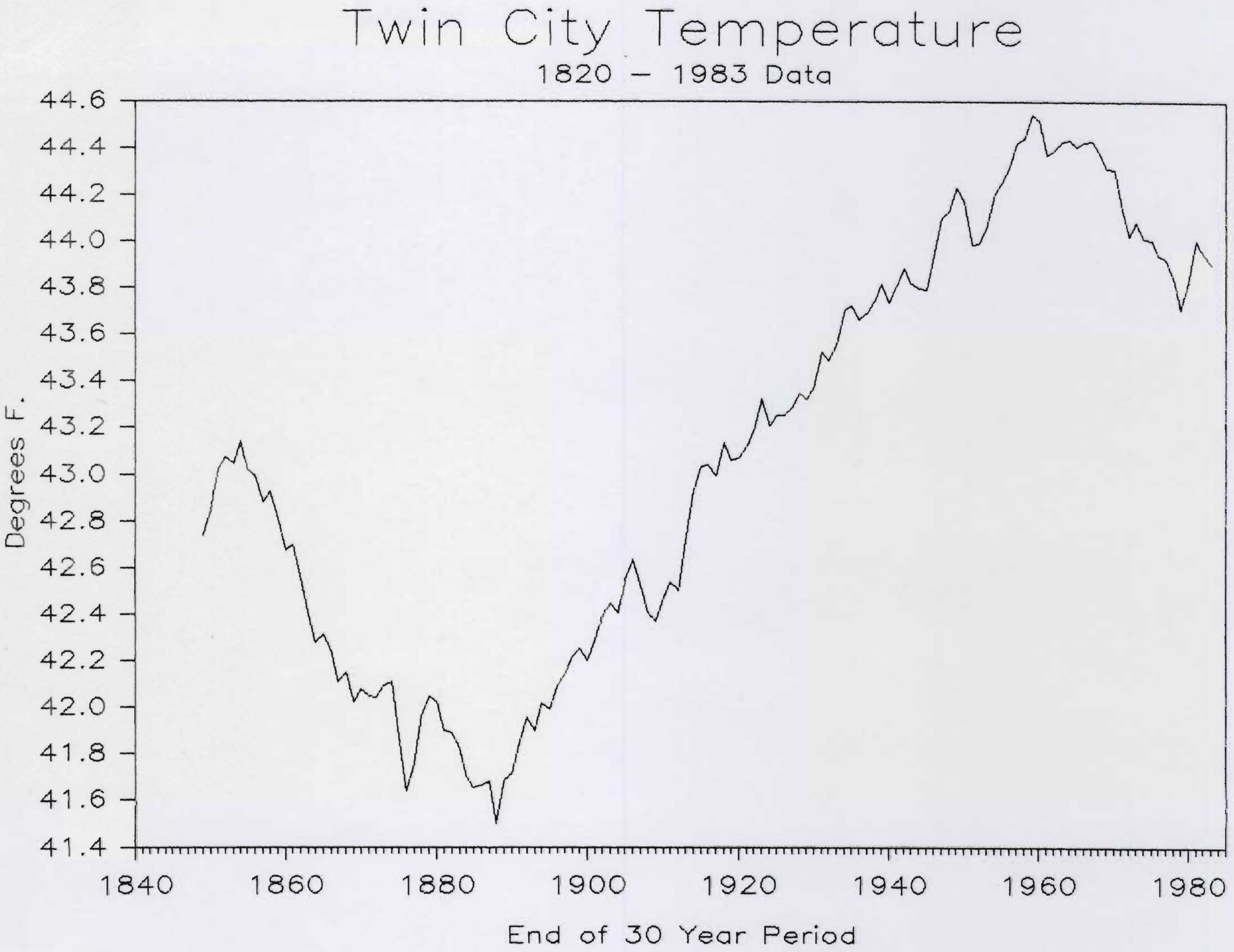

Figure 1.

Thirty-year averages of the eastern Minnesota temperature record, 1820-1983. The averages are plotted at the end of each 30-year period. Data from Baker et al., 1985.

observation times are magnified. Differences in GDD totals due simply to variations in observation time between stations can more than equal some of the proposed hybrid corn varietal differences in GDD totals that the plant requires to reach maturity. For example, a seasonal (May-September) total difference of more than 300 GDD could result at the same site simply because of different observation times as, for example, from 3 p.m. to 6 a.m. This number of GDD is equivalent to about 14 percent of the May-September total GDD across much of southern Minnesota. Resultant errors for seasonal total HDD due to differing observation times can be equally large.

The variation in mean temperatures created by differing observation times has been the subject of several research papers, including those by Bigelow (1909), Byrd et al. (1983), Felch et al. (1972), Mitchell (1958), Rumbaugh (1934), Baker (1975), Schall and Dale (1977), and Weaver and Miller (1970). To our knowledge, however, this is the first time that temperature normals for a large area such as Minnesota have been adjusted to a uniform observation time. The adjustment factors vary from month to month as shown in Table 1. The variation is largely a function of the daily heating cycle, which in turn is a function of day length.

Table 1 contains the observation time adjustments derived by Baker (1975) from his study of hourly temperatures measured over a three-year period at the University of Minnesota St. Paul campus weather station. They have not been published before but were used in a study by Winkler et al. (1981). A recent investigation by Byrd (1985) using New York data makes it appear likely that the adjustment factors are very similar in temperate zone regions of continental climates. Also, the correction values listed in Table 1 agree closely with the Bismarck, N.D., and Columbus, Ohio, values shown by Mitchell (1958) in his Table 1. An analysis of the variation in the time of observation adjustments across the North Central Region (from the Dakotas eastward to Ohio) by Head (1985) indicated that factors do not vary appreciably; as a result the factors shown in Table 1 and derived from the St. Paul campus weather station data can be applied across the state.

Table 1. Correction factors in °F. for adjusting to an 8 a.m. observation time.*

Hour	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	-0.9	-0.8	-0.2	0.0	0.5	0.7	0.3	0.3	0.3	0.1	-0.2	-0.6
2	-0.7	-0.6	0.0	0.2	0.7	0.9	0.4	0.5	0.5	0.2	-0.1	-0.5
3	-0.4	-0.4	0.2	0.3	0.8	1.0	0.6	0.7	0.6	0.4	0.1	-0.4
4	-0.3	-0.2	0.3	0.5	1.0	1.1	0.8	0.9	0.8	0.5	0.2	-0.3
5	-0.1	0.0	0.5	0.9	1.1	1.1	0.8	1.0	1.0	0.6	0.2	-0.1
6	0.0	0.1	0.6	0.9	0.7	0.6	0.4	0.7	1.0	0.8	0.3	0.0
7	0.0	0.2	0.5	0.5	0.3	0.2	0.1	0.2	0.5	0.6	0.3	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	-0.4	-0.5	-0.5	-0.3	-0.3	-0.1	-0.0	-0.1	-0.3	-0.3	-0.4	-0.1
10	-0.9	-1.1	-1.0	-0.7	-0.7	-0.2	-0.1	-0.2	-0.5	-0.5	-0.8	-0.5
11	-1.5	-1.7	-1.4	-1.0	-1.0	-0.5	-0.3	-0.5	-0.7	-0.9	-1.1	-0.8
12	-2.0	-2.2	-1.8	-1.2	-1.3	-0.8	-0.6	-0.8	-1.0	-1.2	-1.5	-1.2
13	-2.5	-2.6	-2.1	-1.6	-1.5	-1.1	-0.8	-1.1	-1.4	-1.7	-1.8	-1.4
14	-2.8	-3.0	-2.3	-1.8	-1.8	-1.3	-1.0	-1.4	-1.6	-2.0	-1.9	-1.6
15	-2.8	-3.1	-2.4	-2.0	-1.9	-1.4	-1.1	-1.4	-1.6	-2.0	-1.9	-1.5
16	-2.7	-3.0	-2.4	-2.0	-1.9	-1.4	-1.0	-1.3	-1.5	-1.8	-1.6	-1.4
17	-2.5	-2.8	-2.3	-1.9	-1.8	-1.3	-0.8	-1.1	-1.2	-1.3	-1.2	-1.1
18	-2.4	-2.5	-2.1	-1.6	-1.4	-1.1	-0.5	-0.7	-0.7	-0.8	-0.9	-0.9
19	-2.2	-2.2	-1.8	-1.3	-1.0	-0.8	-0.3	-0.3	-0.3	-0.7	-0.7	-0.7
20	-2.0	-1.9	-1.7	-1.1	-0.6	-0.7	-0.0	-0.1	-0.1	-0.5	-0.5	-0.6
21	-1.8	-1.6	-1.5	-0.9	-0.4	-0.6	0.1	0.1	0.0	-0.3	-0.4	-0.5
22	-1.6	-1.4	-1.4	-0.7	-0.3	-0.4	0.2	0.3	0.2	-0.2	-0.3	-0.4
23	-1.4	-1.1	-1.3	-0.6	-0.1	-0.3	0.3	0.4	0.4	0.0	-0.1	-0.2
24	-1.1	-1.0	-1.1	-0.5	0.0	0.0	0.4	0.3	0.7	0.3	-0.1	-0.1

* An adjustment between any of the above times is made by determining the algebraic sum of the two correction factors.

The mean temperatures for all stations used in this bulletin were adjusted to an 8 a.m. observation time except as noted. This time was selected for three reasons: it is the common time for the weather data used in agricultural advisories prepared during the growing season by the University of Minnesota's Agricultural Extension Service, it is a fairly popular time for observations (see Table 2), and the adjustment using an 8 a.m. observation results in a temperature close to the midnight or calendar day observation used by National Weather Service first order stations.

Table 2. Time when temperature observations are taken by Minnesota observers as of November 1983 (U.S. Dept. of Commerce, 1983).

Station	Midnight	7 a.m.	8 a.m.	9 a.m.	1 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.	7 p.m.	9 p.m.	Total
Number	15	11	27	4	1	2	11	37	21	8	1	138
Percent	11	8	20	3	<1	1	8	27	15	6	<1	100

DISCUSSION

Factors Affecting Air Temperature

There are a number of factors that determine the temperature of a station. The primary one is the latitude. Other factors, ordinarily all of less importance, serve to modify the general orientation of isotherms (lines of equal temperature) around the globe. These factors include the kind and condition of the surface (oceanic versus continental, for example); the variation in topography, which includes a) the slope and aspect (facing direction) effects, b) the change in pressure, and thus temperature, that occurs in the ascent or descent of a parcel of air about a topographic feature, c) the effect of cold air draining into low areas, and d) the obstruction to air movement that may be brought about by either buildings or natural features like shrubs, trees, and hills; and finally, the degree of urbanization, a factor of increasing importance today.

Latitude and Geographic Location

There is a generally decreasing trend in temperatures from south to north (in the northern hemisphere) that is apparent in almost all temperature maps. It is for this reason that the isotherms are in general oriented east-west around the world. Large-scale departure from a global east-west orientation is due to the proximity to major water bodies (oceans) and to major topographic features (mountains).

Surface

Air temperature is a reflection of the underlying surface, so major considerations are whether the surface is land or water and whether snow is present. Over land on which vegetation is growing and in the presence of adequate soil moisture the major means by which the available energy at the earth's surface (both solar and horizontally transported energy in the air) is consumed is termed evapotranspiration. A smaller fraction of energy is consumed in heating the air and the soil, and an even smaller amount in photosynthesis. Over open water by far the major amount is consumed in evaporation, only a small amount in heating the air and water, and virtually none in photosynthesis. As a result, in the presence of water bodies during the growing season, air temperature is lower than otherwise, and is often much lower, as in the case of large and deep bodies such as Lake Superior.

The amount of surface occupied by water in Minnesota is very great. There are 15,291 lakes with an area of 10 acres or more. Exclusive of Lake Superior they equal 3,411,200 acres or 5330 square miles. This amounts to 6.3 percent of the surface area of the state (Waters Section, 1968). Within just the three extreme northeastern counties, St. Louis, Lake, and Cook, there are 870 square miles of open water. These are impressive figures. Although it is difficult to assess what air temperature would be in the absence of the lakes, their influence is obviously great.

The land versus water effect is most apparent in Minnesota when Lake Superior and its immediate margin (as at Duluth, Two Harbors, and Grand Marais) is compared with land surfaces at the same latitude but some distance in from the lake. Lake Superior is so large and so deep that its maximum surface temperature occurs in August, at least a month after maximum temperatures have been reached over most land surfaces. For example, the mean monthly air temperature at Duluth airport reaches a maximum of 65.5°F in July. The Lake Superior mean temperature, as measured at 47.2°N and 90.8°W (north and west of the Apostle Islands along a shipping lane), reaches a maximum of 56.4°F in August (U.S. Dept. of Commerce, 1975). The largest difference in temperature between Lake Superior and the air temperatures over land occurs in December. At this time the water temperature near the Apostle Islands averages 24.4°F warmer than the air temperature at the Duluth airport, as shown in Table 3.

The lake effect virtually disappears with the appearance of ice cover, which on Lake Superior is found from about mid- to late January until sometime in April. The effect of Lake Superior on Minnesota temperatures is generally restricted as a result of both the upland found along the north shore of the lake, and the general west to east wind flow. The prevailing (i.e., most common) winds at Duluth, and probably elsewhere along the lake, are from the east. However, the resultant or vector winds (which take into account the wind speed and direction) blow mainly from the north or west (Baker, 1983).

Table 3. Temperature difference between the air and water of Lake Superior in °F.

	Month[1/]									
Location	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Duluth[2/]	38.6	49.4	59.0	65.6	64.1	54.4	45.3	28.4	14.4	46.6
Lake Superior[3/]	35.0	36.5	39.7	48.1	56.4	55.2	47.4	41.9	38.8	44.3
Difference	3.6	12.9	19.3	17.5	7.7	-0.8	-2.1	-13.5	-24.4	2.3

[1/] Data for January-March are not available, but, because of the ice cover during those months, there is probably little difference between surface temperatures at the two locations.

[2/] Measured at the Duluth airport (U.S. Dept. of Commerce, 1979).

[3/] Mean water temperature measured at 47.2°N and 90.8°W (U.S. Dept. of Commerce, Environmental Data Service, 1975), which is near the Apostle Islands and along a shipping lane.

On the scale of the maps shown in this bulletin the other lakes in Minnesota are either too small to create an appreciable influence in the configuration of the isotherms or else the stations are situated so that the lake effect is not apparent.

The snow effect arises largely from the high reflectance of solar radiation from a snow surface compared to all other surfaces. The reflectance of snow ranges from about 90 percent or more on fresh snow to about 40-50 percent on aged and dirty snow. Almost every other natural surface reflects 25 percent or less, and, except at low sun angles, the reflectance from still water is only about 5 percent of the incident solar radiation.

Topography

As already noted, a feature that interrupts the natural east to west orientation of the isotherms is topography. The effects of topography can be diverse and complicated. One effect is the result of the forced ascent or descent of air as it passes over a topographic feature. On moving up a slope the air enters a region of lower air pressure and thus expands. The expansion results in a cooling of the air at a constant rate equal to 5.5°F for each 1000 feet (or 10°C per 1000 m) rise in elevation as long as condensation does not occur.

Upon descent the air is compressed and it warms at the same rate, 5.5°F per 1000 feet or 10°C per 1000 m decrease in elevation. This process is known as adiabatic cooling when air is forced to ascend and adiabatic heating when air descends. On the lee or downwind side of certain topographic features, the downslope or adiabatic heating can be dramatic. The associated warm winds have been given names that are particular to certain parts of the globe: chinook on the east side of the Rockies, foehn in the Alps, and Santa Ana in southern California near Los Angeles.

There are several topographic features of sufficient size to induce the degree of adiabatic heating and cooling required to be apparent on a scale like that used for the maps in this bulletin. They are shown in Figure 2. One of the most prominent of these is Buffalo Ridge, also known as Coteau des Prairies, which is oriented northwest to southeast in the southwestern corner of the state. A "tongue" of cold air extending southeastward from South Dakota coincides with the ridge. It is due to winds being forced to move up and over the ridge with the air cooled as it rises. The elevation change from southwest of Buffalo Ridge to its crest is about 800 feet (250 m); from the ridge crest northeast to the Minnesota River valley the drop in elevation is about 1000 feet (310 m). The maximum effect of the ridge occurs, of course, when winds blow at right angles to its alignment. For example, with southwest winds forced to rise over the crest, a decrease of about 4.5°F (2.5°C) can be expected from the base to the top of Buffalo Ridge and about a 5.5°F (3.1°C) increase in going downslope from the ridge top to near the Minnesota River valley. Thus, a tongue of warm air is located on the north side of the ridge (on the downslope side for southwest winds) and is parallel to but about 35 miles (58 km) northeast of the center line of Buffalo Ridge. Since southwest winds are common during the summer months, this elevation effect is most apparent at that time of year. But, because the wind blows from other directions as well, the ridge effect found on the monthly normal maps is less than the temperature change examples just given.

Another area of high terrain is found east of the Red River valley and is known as the Alexandria Moraine. It is shown in Figure 2 also. It begins south of Alexandria and continues northward through the Itasca State Park area. From the Red River valley floor to Itasca State Park the elevation increases about 800 feet (250 m); the eastern and usually downwind side of this highland falls only about 400 feet (125 m). Although a distinctly cooler area is associated with the Itasca State Park region, as shown in the temperature maps, the downslope warming east of this highland is not as apparent as in the case of Buffalo Ridge. This is so because of the lesser elevation difference and the greater irregularity of the Alexandria Moraine highland. The adiabatically warmed area (due to the air moving downslope) is oriented approximately northeast to southwest and extends from extreme southeastern Ottertail County through parts of Todd, Wadena, Cass, Aitkin, and Itasca counties and into St. Louis County. This feature also is apparent in the temperature maps.

As already noted, there is a general increase in elevation from the Red River valley eastward, with the highest elevation located in the Itasca Park area (Figure 2). There also is an appreciable elevation increase in eastern North Dakota that begins about 30 miles (50 km) west of the north-south oriented Red River. As a result of the downslope warming to the west of the Red River in North Dakota and the upslope cooling that occurs to the east of the river (with westerly winds), there is a marked "tongue" of higher temperatures extending northward in the Red River valley area; it is shown in all the maps. It is especially noticeable in winter when westerly winds are most prevalent.

The elevation change from the highlands west of Lake Superior down to the lake level varies from about 500 to 1200 feet (155-375 m) along the north shore (Figure 2). With downslope winds (most effective with winds from the northwest) the temperature increase would be considerable. The effect, however, is certainly not observable on the monthly normal maps. During the summer months it is largely negated by the cool water temperatures of Lake Superior; in early winter when the lake is still ice-free the effect is masked by the warmer than land temperatures.

Topographic features also can restrict air movement, serving to keep the air warmer than otherwise under one set of circumstances and cooler than otherwise at other times. Valleys frequently show this feature. The warming effect is dominant if a good southern exposure to the sun is afforded. The isotherm configurations in the Mississippi River valley (at Red Wing and Winona) are due esentially to this feature and show temperatures to be higher than expected for their latitudinal position in the state. The warmer temperatures in the Mississippi valley just noted also may be due to the somewhat higher atmospheric humidity in the immediate area. This influence, however, probably is minor.

The valley effect certainly occurs in other parts of the state such as in the St. Croix and Minnesota river valleys, but due to the scale involved as well as to the location of stations, it is not generally apparent elsewhere on the maps.

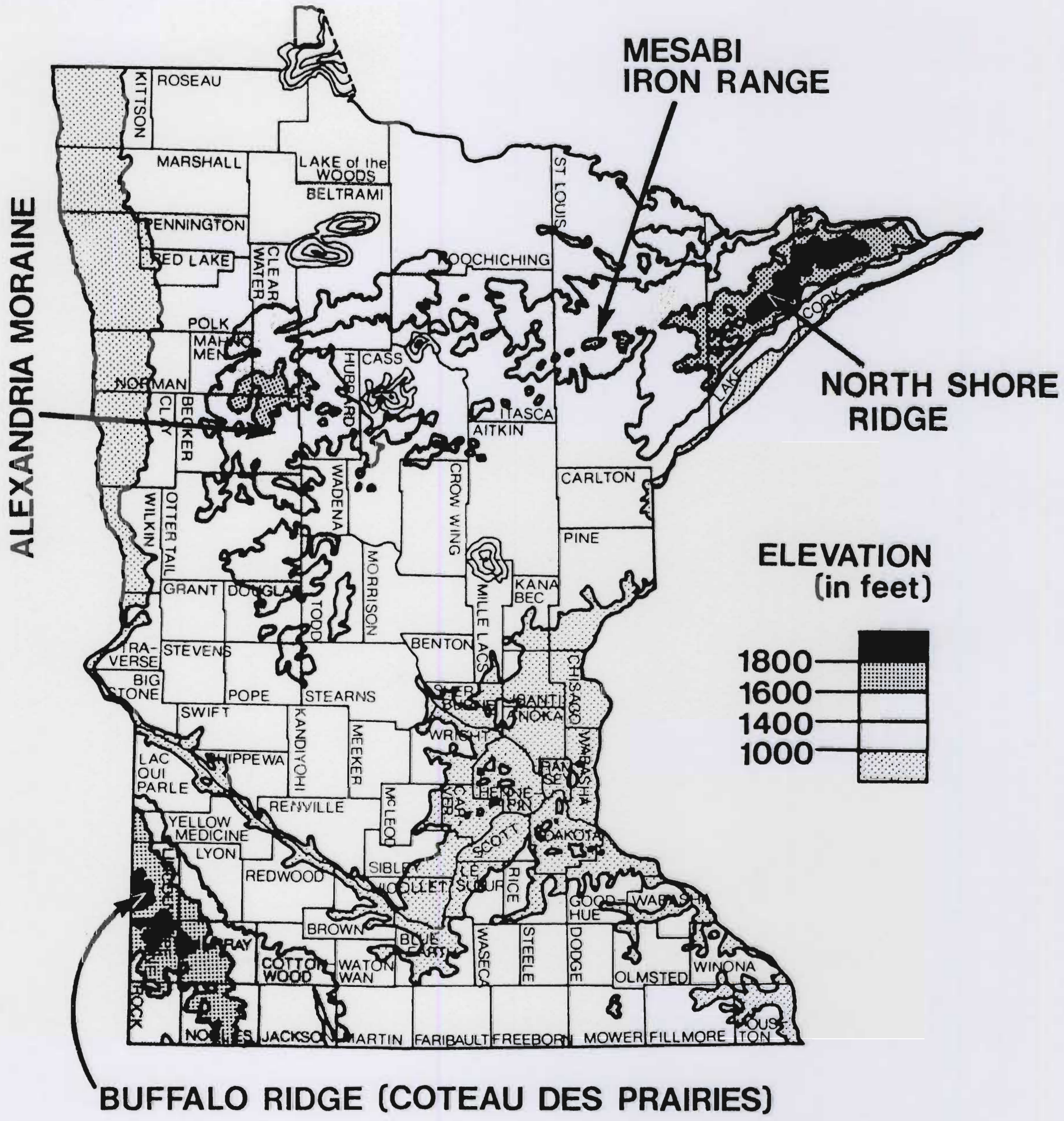

Figure 2.

Topographic map of Minnesota.

Topographic influence upon air temperature also includes the effect of cold air drainage. Under conditions of light winds, dry air, and cloud-free skies the earth loses heat rapidly at night and the coldest air forms and collects at the surface of the earth given the opportunity. The colder and thus denser air will move downslope under the influence of gravity and collect in low spots. This condition can dramatically affect vegetation; such places are often termed "frost pockets." Any influence due to adiabatic heating as the air moves downslope is ordinarily negligible because the movement is usually over short distances and because the air is relatively cold to begin with. As a result of air drainage, temperatures at some stations may be colder than expected, although this effect may not occur frequently enough to be observed in long-term averages such as the 30-year normals dealt with here.

Urbanization

Even in Minnesota, urbanization has been such that its effect is evident in certain local climates. Probably the major urbanization factor is the alteration of the surface; the heat generated within an urban community is of secondary importance. The areal extent of the roads, parking lots, roofs of houses and buildings, and other "artificial" surfaces provides a surface that usually absorbs more solar radiation than does a vegetation covered surface. The lower reflectance or albedo is credited particularly to the vertical extent and canyon-like character of a city, which results in multiple reflection and a greater likelihood of absorption, and during winter also to a combination of dirtier snow and earlier snow removal (Munn, 1966). In addition, these urban surfaces increase the rate at which precipitation is removed from the urban area. As a result, instead of a large portion of the absorbed solar energy being consumed in evaporation, as in rural areas, a greater share is available to heat urban surfaces and the air.

Temperature measurements in most urban areas are made at airport sites, so the full effect of urbanization may not be evident. Even at airport sites, however, the effect of the adjacent urban area can be found. The Twin Cities of Minneapolis and St. Paul have reached the point where their effect can be measured (Winkler et al., 1981).

Monthly, Seasonal, and Annual Mean Temperatures

Monthly Mean Temperatures

The monthly, seasonal, and annual mean temperatures are shown in Figures 3-23 and Appendix Table 1. The maps depicting the monthly mean temperatures all exhibit similar features that are controlled essentially by latitude, topography, lake effect, or urbanization or by some combination of these factors.

Temperature Variation. The temperature gradient shows a maximum intensity in January with a difference of 16°F between the northwestern and southeastern corners of the state. It is nearly as great in June because Lake Superior depresses the temperatures so much along its margin. The least difference across the state occurs in September and October with only 8° and 7°F, respectively, separating the northern and southern boundaries.

Both the relative and absolute variation in temperature at a given station is greatest in the winter. Table 4 shows the absolute variation in terms of the standard deviation. The lowest values are generally found in July and August and the highest in January. At most stations the summer

Table 4. Standard deviation of 1951-1980 normal monthly temperatures at selected stations.

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Duluth	4.87	4.74	4.58	3.50	3.08	2.13	2.28	2.58	2.69	3.90	3.77	4.89
Fargo	5.85	6.05	6.24	4.20	3.85	2.85	2.56	2.87	3.04	4.01	4.40	5.80
International Falls	5.86	5.35	5.48	3.73	4.14	2.88	2.52	2.62	2.50	3.82	4.16	5.77
LaCrosse	5.51	5.23	4.87	3.47	3.45	2.64	2.54	2.32	2.44	3.97	3.62	4.81
Minneapolis-St. Paul	5.35	5.33	5.32	3.87	3.51	2.68	2.85	2.50	2.88	3.80	3.55	5.00
Rochester	6.02	5.80	5.24	3.62	3.40	2.78	2.68	2.23	2.16	4.01	3.71	5.23
St. Cloud	5.12	5.16	5.67	3.74	3.37	2.61	2.38	2.40	2.58	3.74	3.74	5.28
Sioux Falls	5.77	6.05	6.00	3.57	3.30	3.10	3.07	2.57	2.95	3.69	3.69	4.82

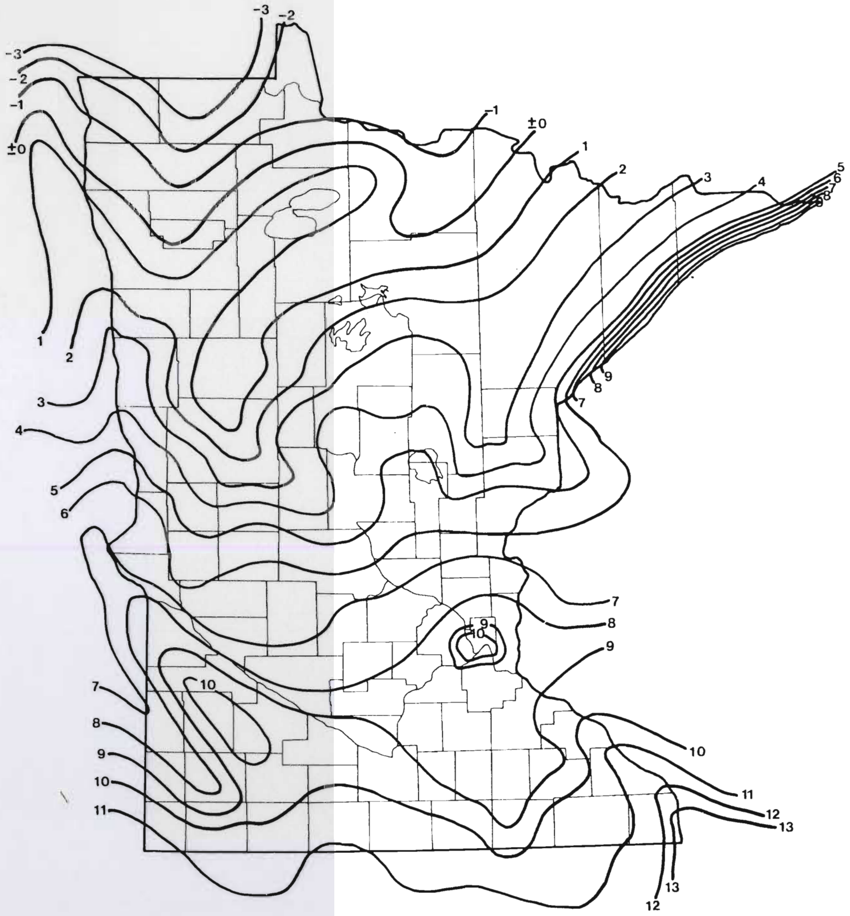

Figure 3.

January normal temperatures, °F.

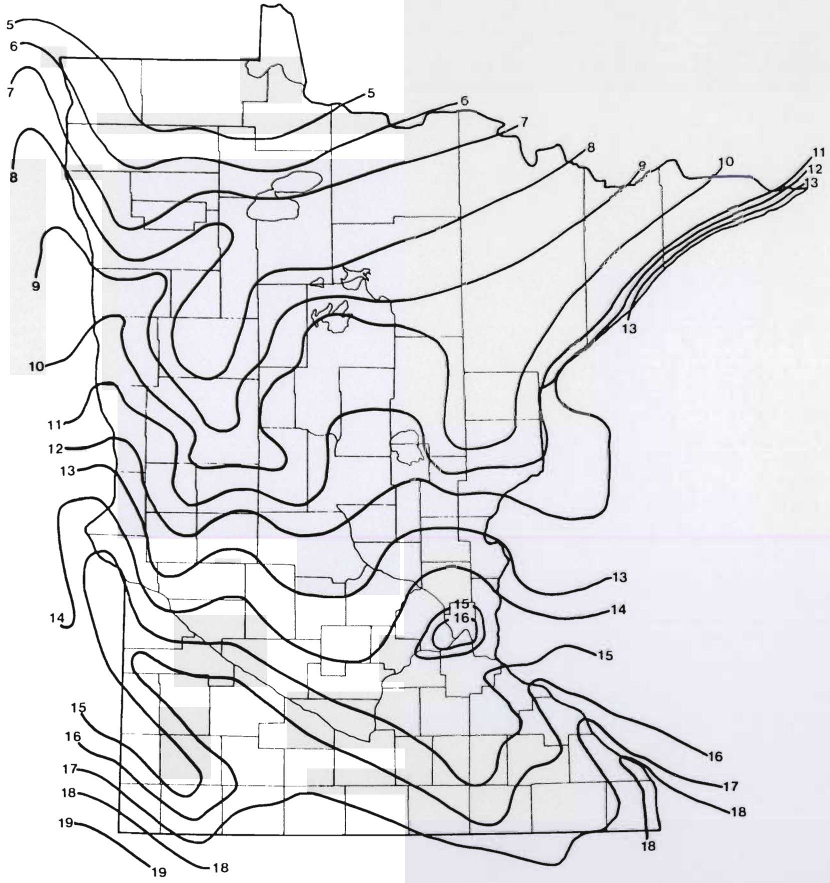

Figure 4.

February normal temperatures, °F.

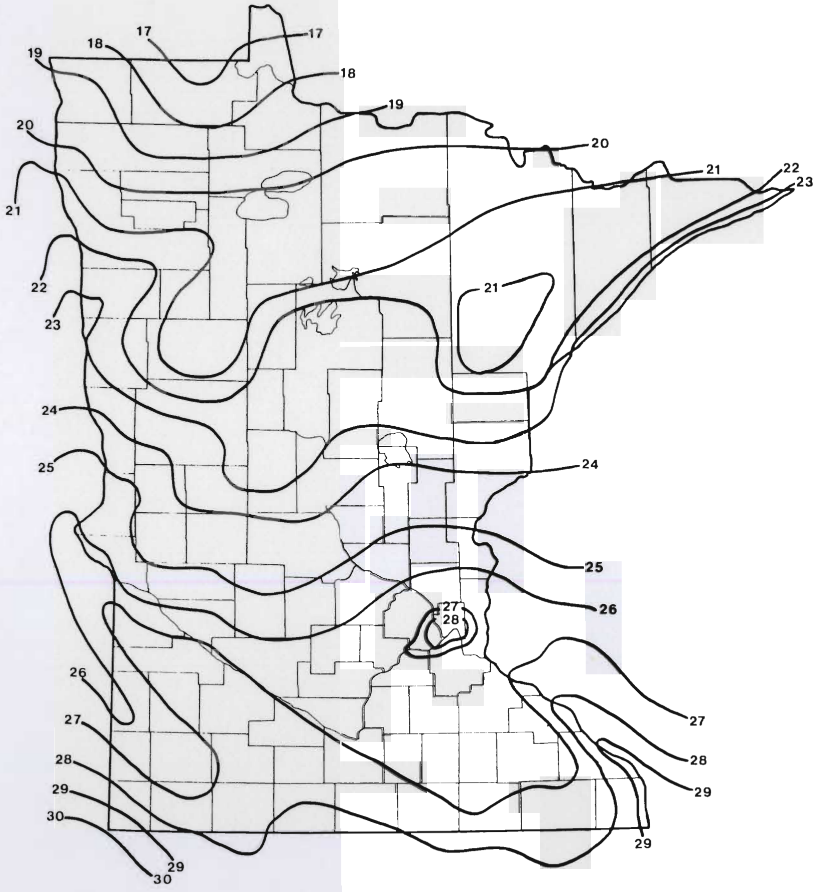

Figure 5.

March normal temperatures, °F.

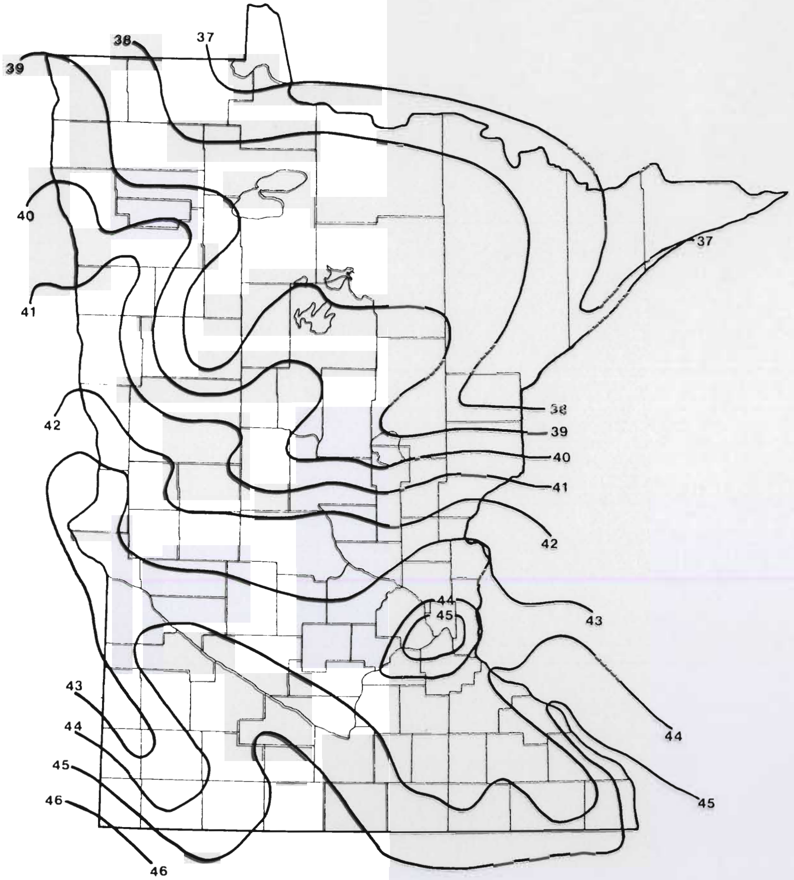

Figure 6.

April normal temperatures, °F.

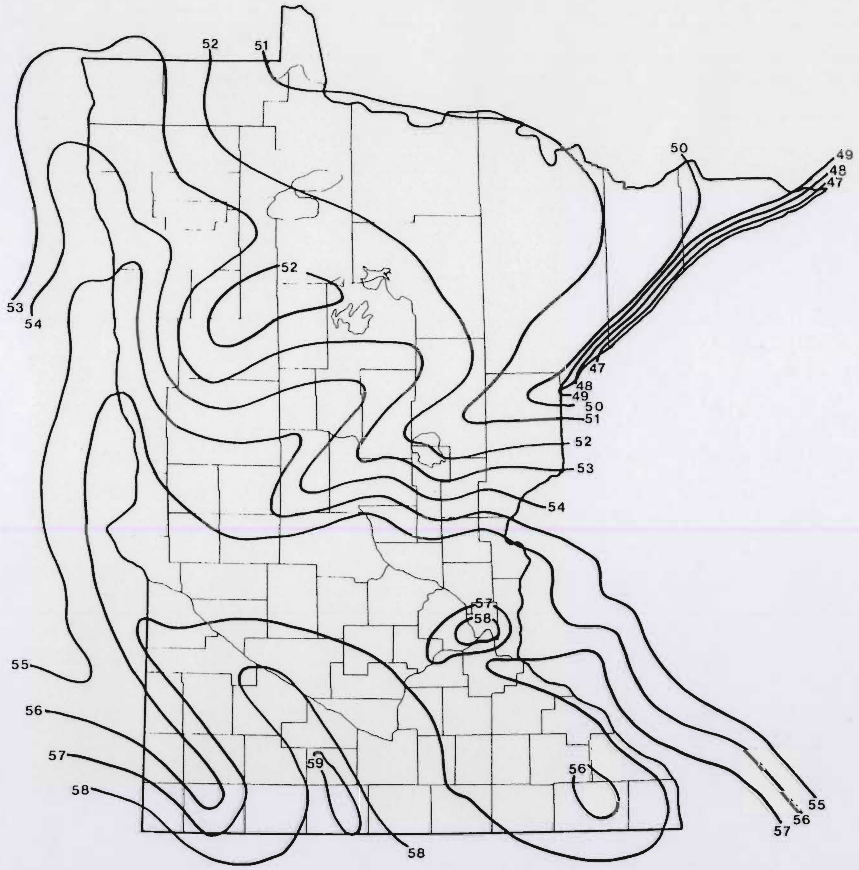

Figure 7.

May normal temperatures, °F.

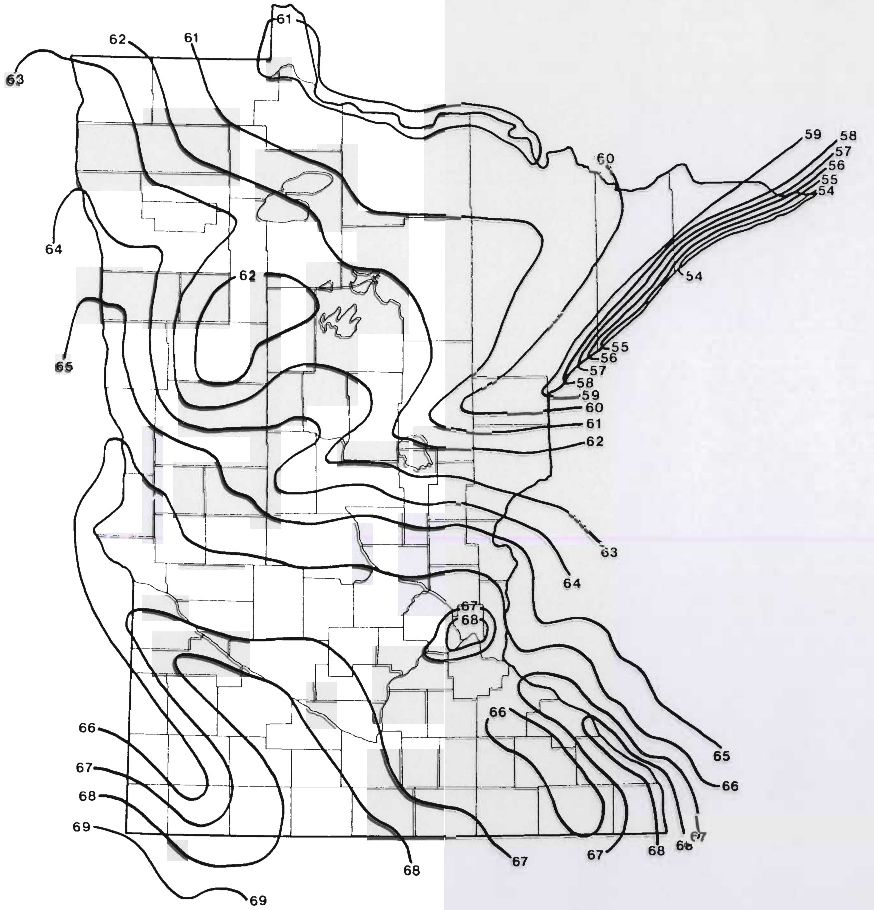

Figure 8.

June normal temperatures, °F.

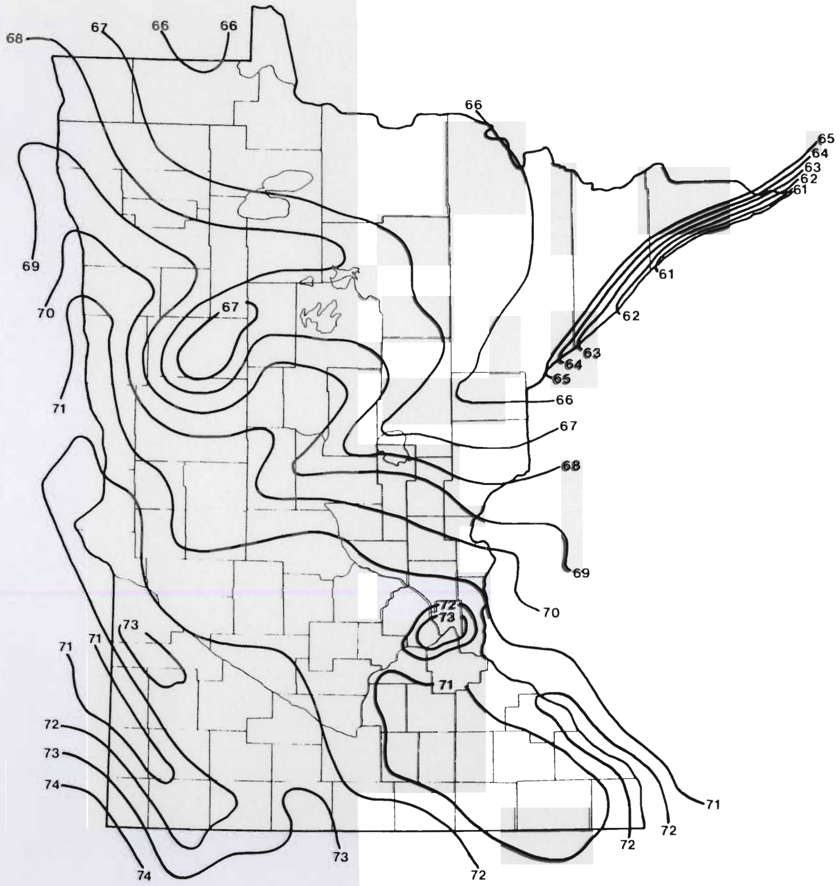

Figure 9.

July normal temperatures, °F.

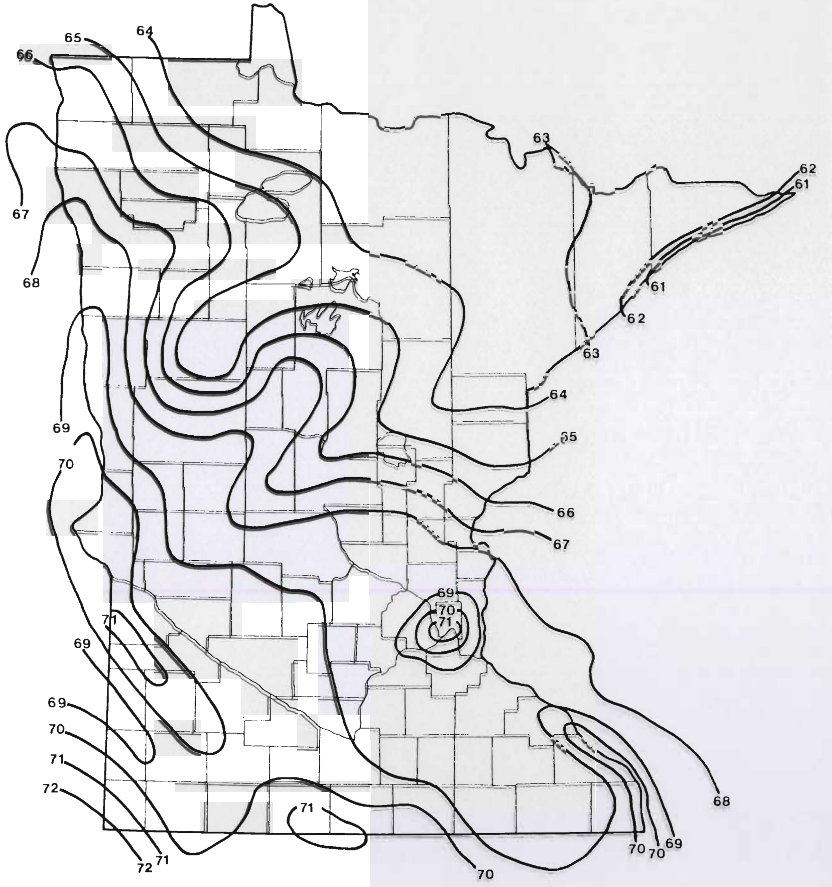

Figure 10.

August normal temperatures, °F.

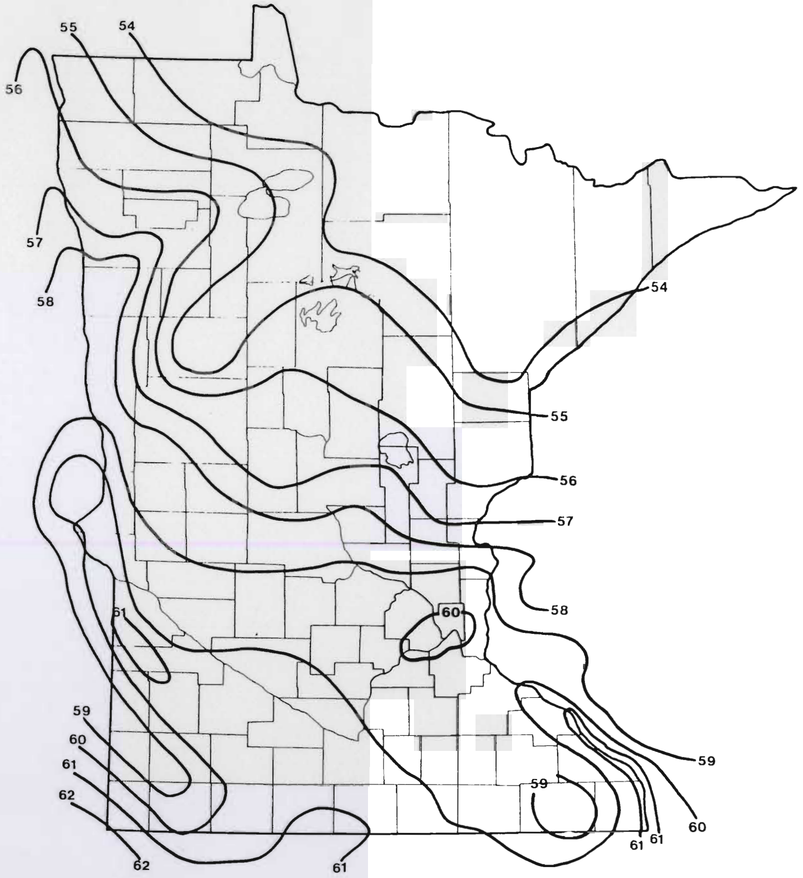

Figure 11.

September normal temperatures, °F.

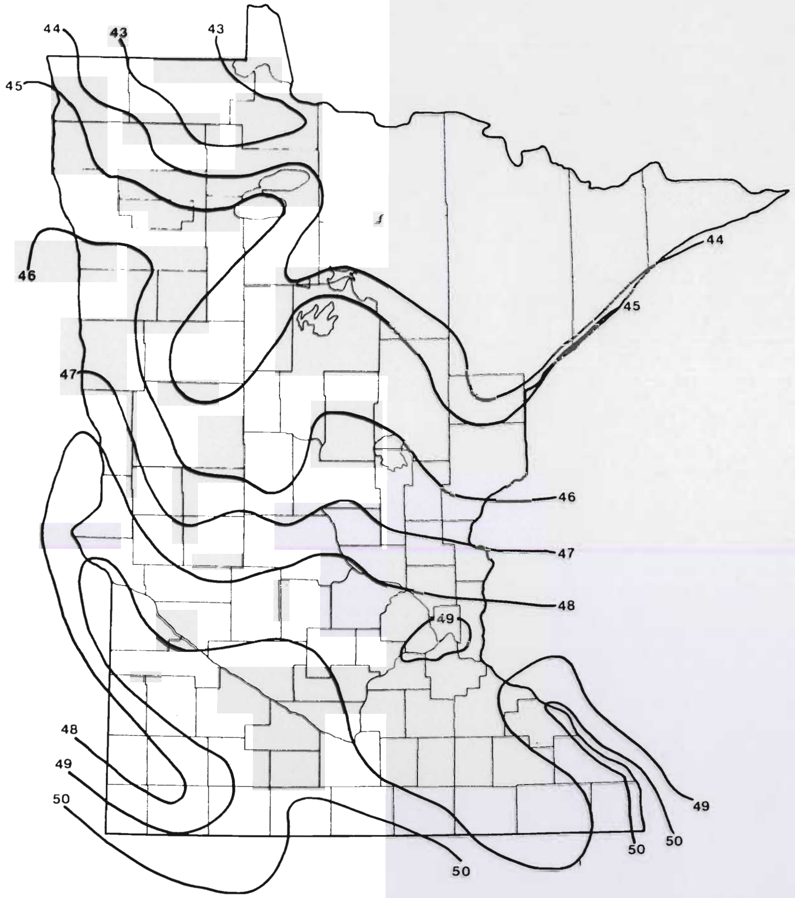

Figure 12.

October normal temperatures, °F.

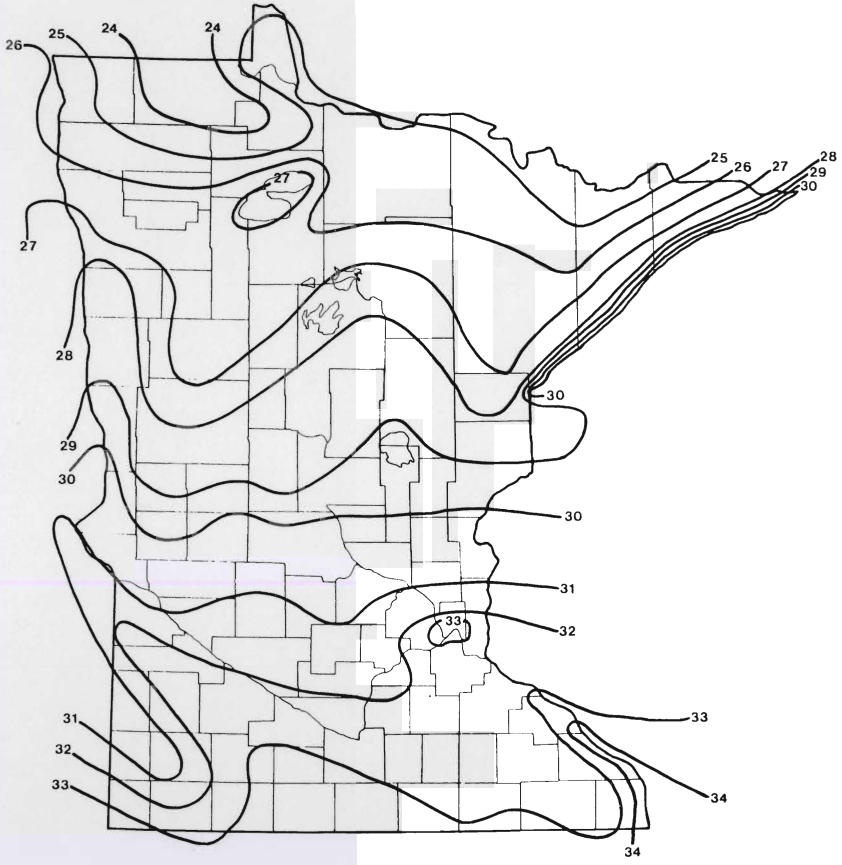

Figure 13.

November normal temperatures, °F.

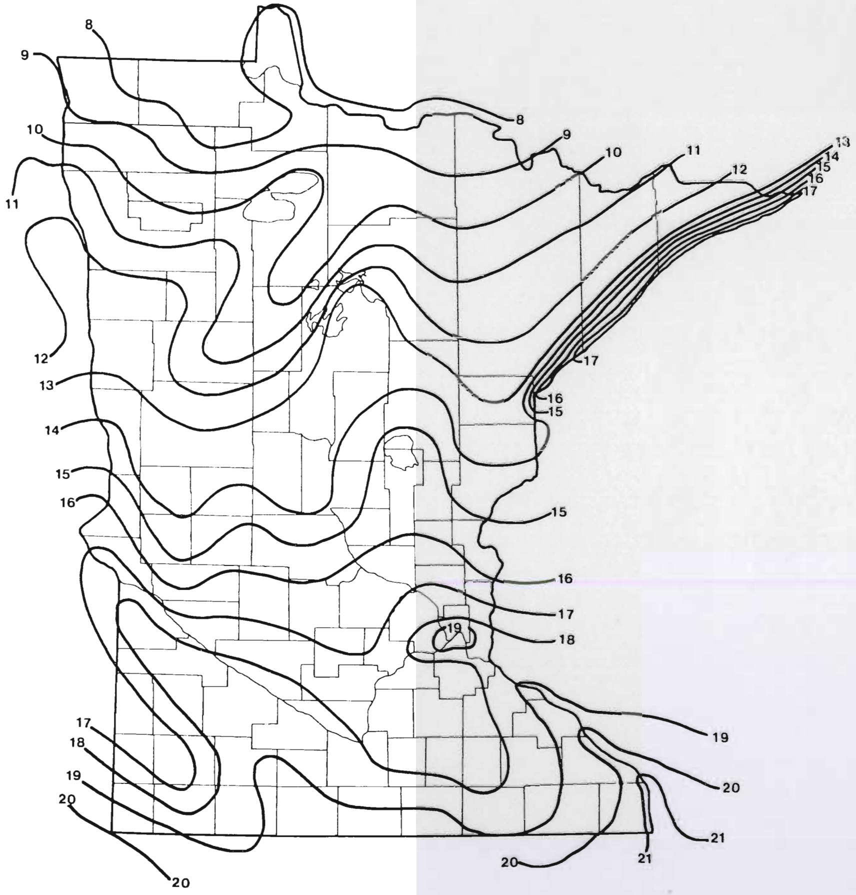

Figure 14.

December normal temperatures, °F.

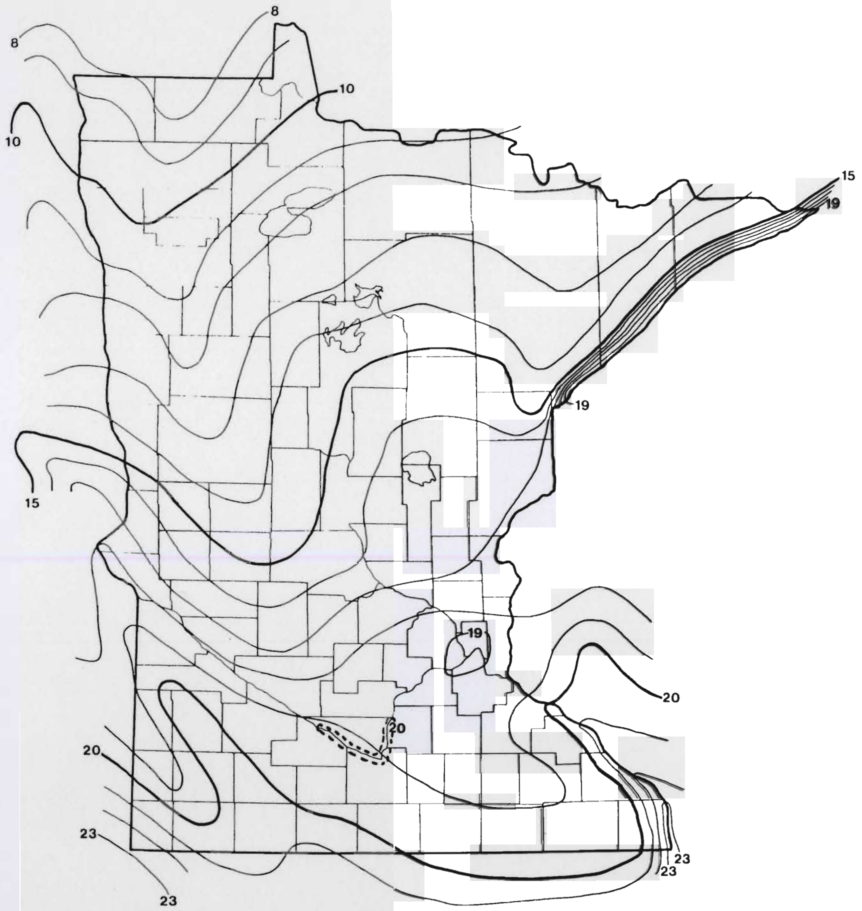

Figure 15.

January normal maximum temperatures, °F.

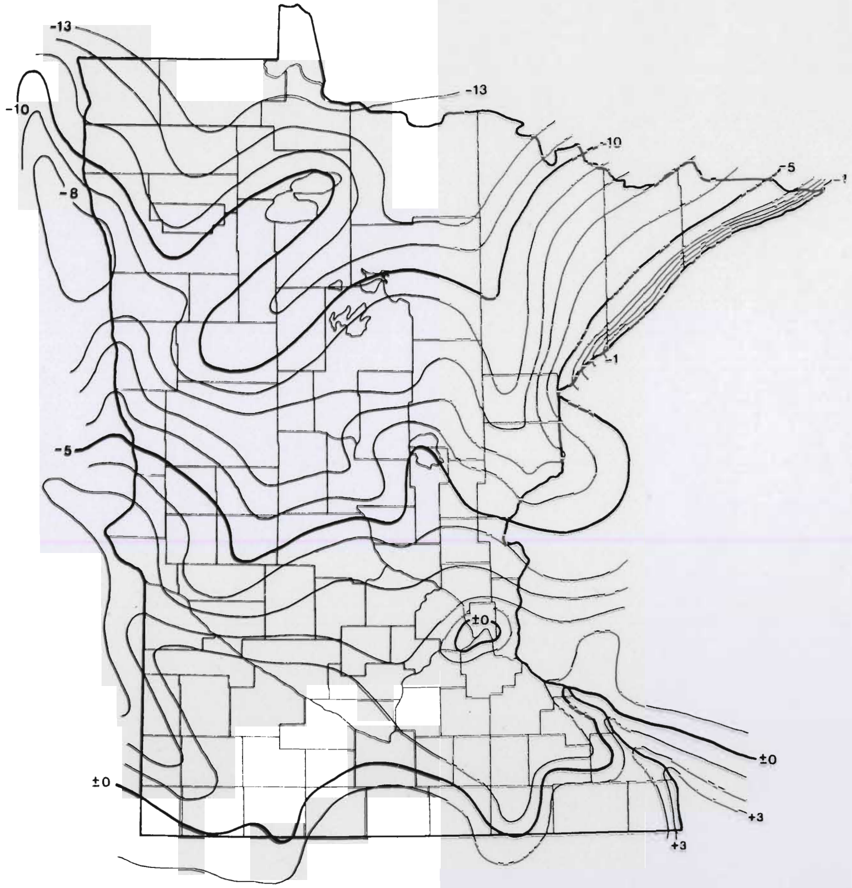

Figure 16.

January normal minimum temperatures, °F.

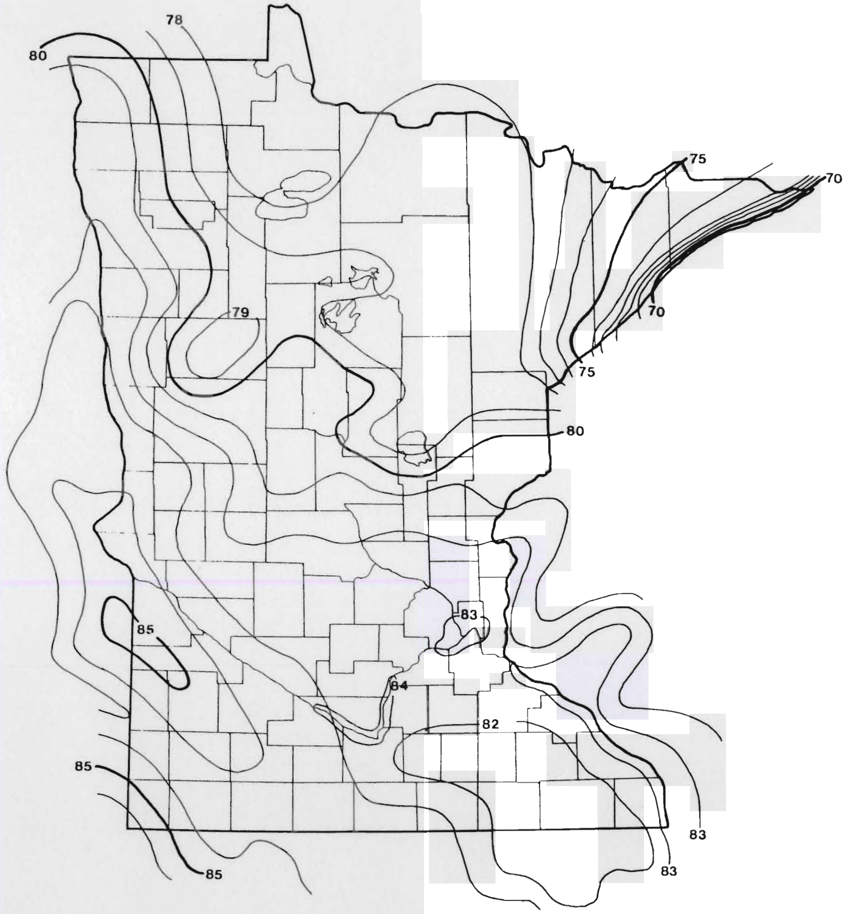

Figure 17.

July normal maximum temperatures, °F.

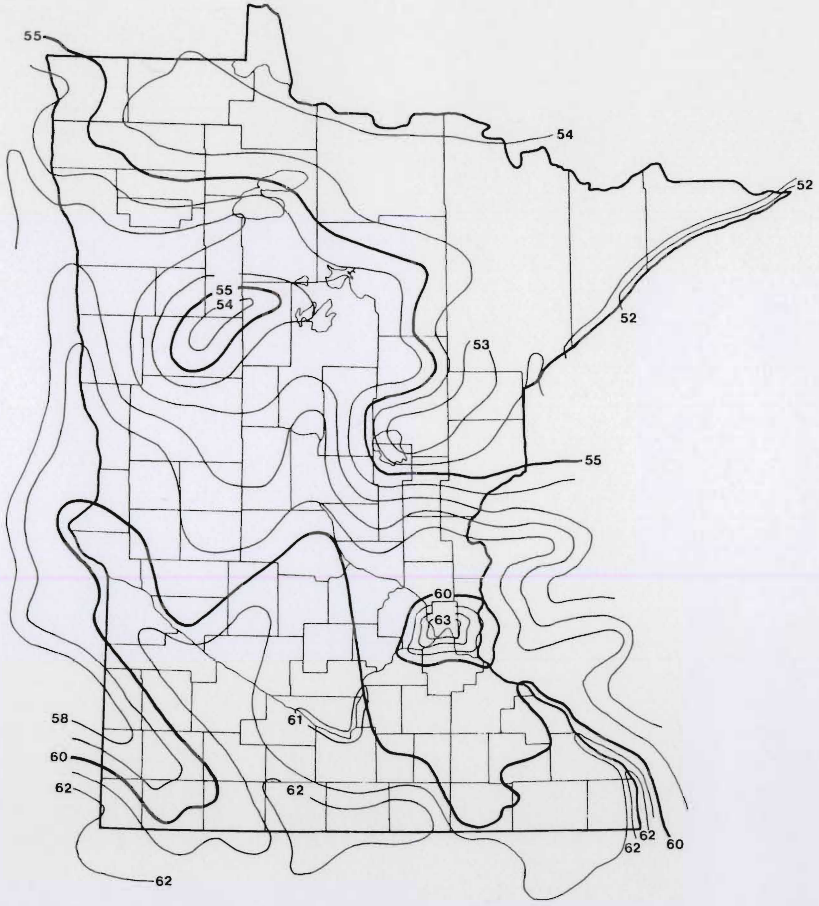

Figure 18.

July normal minimum temperatures, °F.

variation is about half that of winter. The temperature variation exhibits the continentality of the Minnesota climate: a large annual range coupled with high variability of the temperature. Variations in the daily temperatures show a similar seasonal difference; they are about two to two and one-half times greater than the monthly values shown in Table 4.

The probability that a monthly mean temperature will fall within a certain temperature range can be calculated from the mean temperatures in Appendix Table 1 and the standard deviations in Table 4. Since 68 percent of the temperatures will fall within ±1 standard deviation, 95 percent within ±2 standard deviations, and 99 percent within ±3 standard deviations, the probability of a given temperature range can be estimated readily. For example, from Appendix Table 1 the July mean at International Falls is 66.1°F and from Table 4 the July standard deviation is 2.52°F. Thus, there is a 68 percent probability that the temperature will be between 63.6 to 68.6°F, 95 percent probability of a range within 61.1° to 71.1°F, and 99 percent probability that 58.5 to 73.7°F will include the expected July mean temperature.

In Table 4 the smaller deviations at Duluth are a consequence of the lake effect; the greater winter than summer variation at all stations is an indication of greater climatic instability during winter. This instability is a result of the variable snow cover and, in particular, a result of the greater temperature difference during the low sun (winter) period.

January and July Maximums and Minimums. The average extremes that can be encountered are shown in the mean maximum and minimum temperature maps for January and July (Figures 15-18). The most dramatic of the four maps are those showing the mean minimums (Figures 16 and 18). This is so because the minimum temperature most often occurs in the early morning hours at about sunrise, when wind speed usually is at its lowest for the day. With relatively still air and thus little atmospheric mixing, the diverse underlying surfaces can have their greatest influence. In contrast, maximum temperature most often occurs during the afternoon, when the wind reaches its maximum speed for the day (Baker, 1983). Increased air motion results in greater atmospheric mixing, which in turn decreases any temperature differences created by different surfaces. A good example is the increased intensity of the urban heat island produced by the Twin Cities. It is obvious in both the January and the July minimum maps, whereas on the two maximum temperature maps (Figures 16 and 18) it is barely evident. Similarly the temperature differentials in the Mississippi valley in the extreme southeast and along the Alexandria Moraine in the northwest are much more evident on the July minimum map than they are on the July maximum map.

The temperature differential along the margin of Lake Superior is greater on the July maximum map than on the July minimum map (Figures 17 and 18). As described earlier this is due to the difference between land and water heating characteristics. Because of these characteristics, the land warms faster than the water does, and the difference between land and water is accentuated due to the longer warming than cooling period in July (longer days and shorter nights). Comparing the July minimum map (Figure 18) with Table 3, the land minimum air temperature along the margin of Lake Superior averages only about 4-5°F higher than the water temperature in that month.

On the same July minimum map (Figure 18) there exists a steep temperature gradient in a 50 mile zone about half way between Duluth and the Twin Cities. The gradient equals about 1°F per 10 miles. Since there are no sharp topographic or surface differences that occur in this area, the explanation must rest upon other features. An important one may be an outflow of cool air from the Lake Superior basin southwestward. Although this movement of the air is unusual due to the generally eastward movement of the weather systems, it must occur frequently enough to set up the observed temperature gradient. Given proper air movement from the lake, there are no obstacles to halt its flow southwestward into the St. Louis River valley. Except, however, for the Duluth station, which shows a prevailing east wind in May, June, and August, there are no other station records available between Minneapolis-St.Paul and Duluth to confirm the southwestward transport of cool lake-derived air. An example of a situation in which this did occur is discussed in the following section.

Annual and Seasonal Mean Temperatures

The temperature distributions for the four seasons and the annual period are shown in Figures 19-23. Each is similar in terms of the several high and low temperature areas depicted: the heat island of the Twin Cities, the warm Mississippi valley in the southeast, the Lake Superior influence in the northeast, and the cool highlands associated with the Buffalo Ridge in the southwest, the Alexandria Moraine in the northwest, and the North Shore Ridge paralleling Lake Superior.

The 14°F winter gradient between the northern and southern borders of the state is a maximum for the four seasons. The least gradient occurs in the summer, when there is only an 8°F difference if

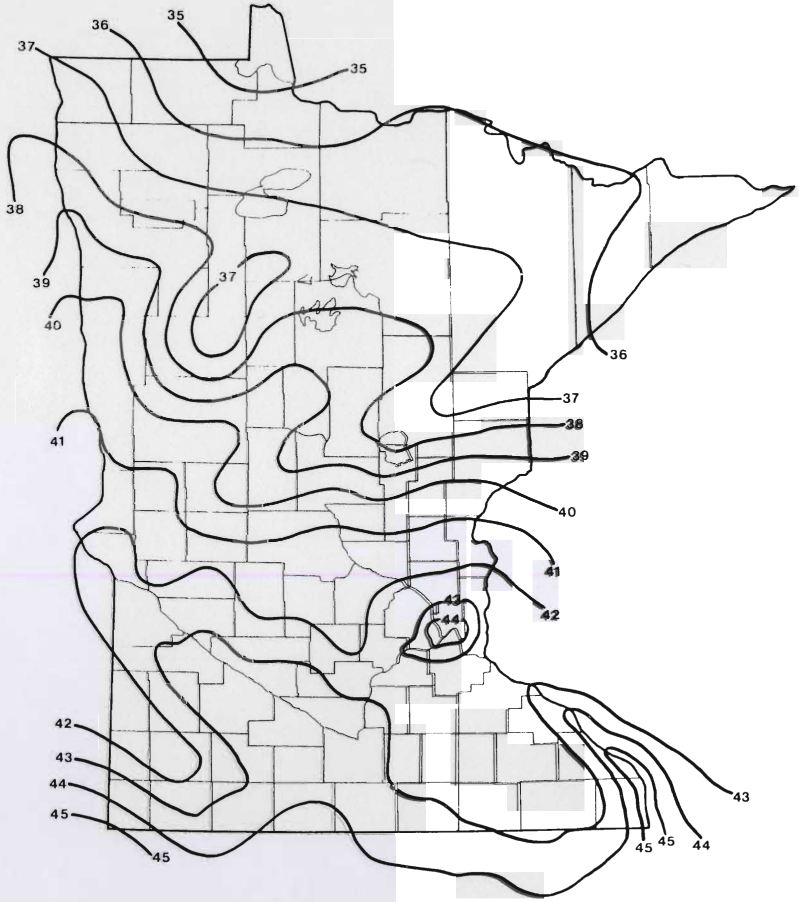

Figure 19.

Spring (March-May) normal temperatures, °F.

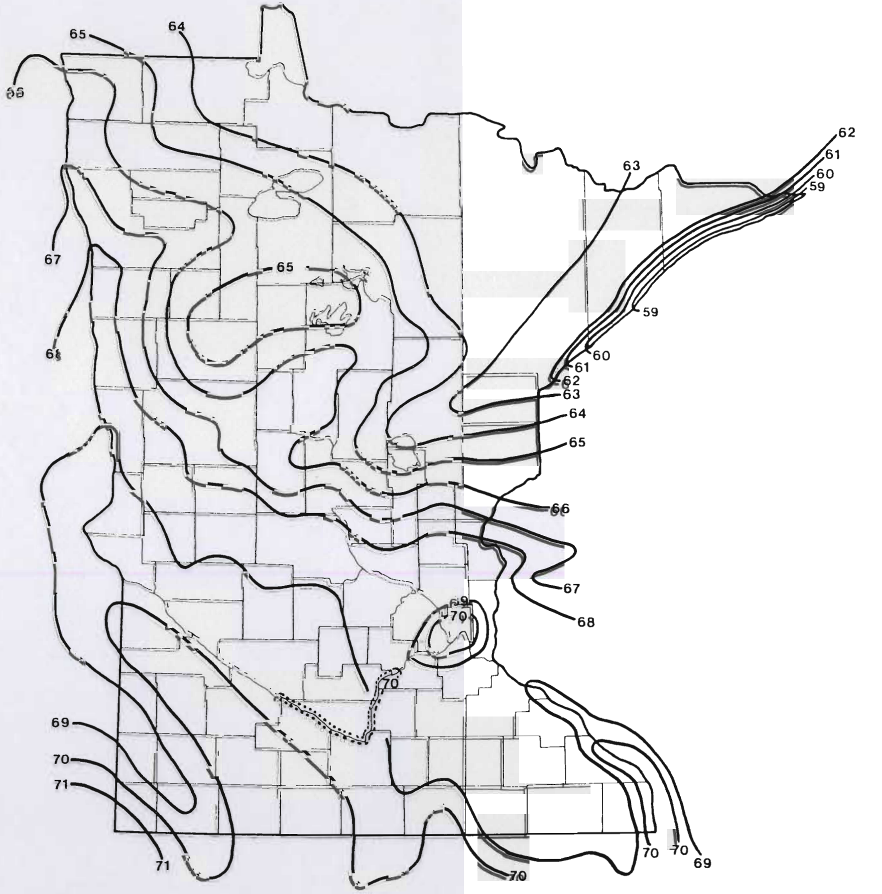

Figure 20.

Summer (June-August) normal temperatures, °F.

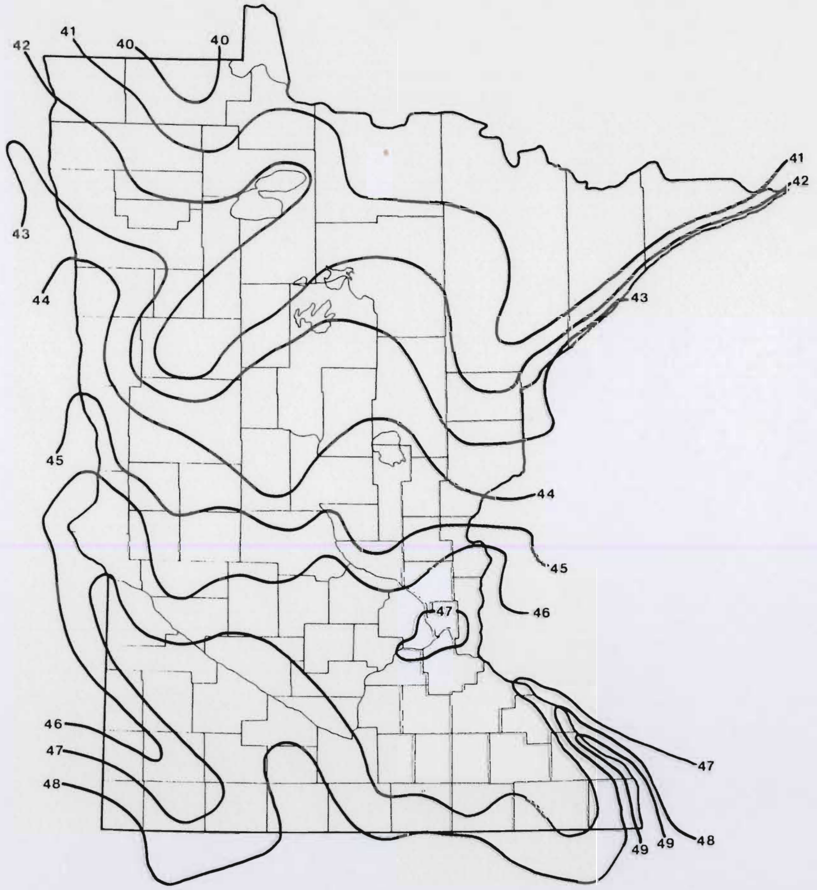

Figure 21.

Fall (September-November) normal temperatures, °F.

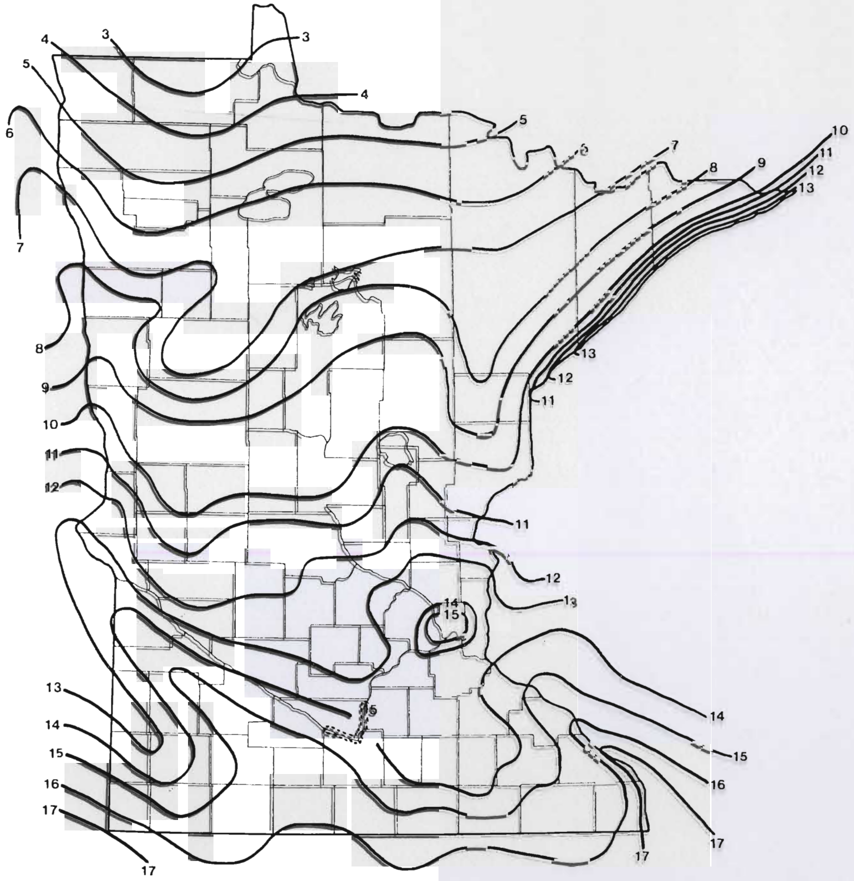

Figure 22.

Winter (December-February) normal temperatures, °F.

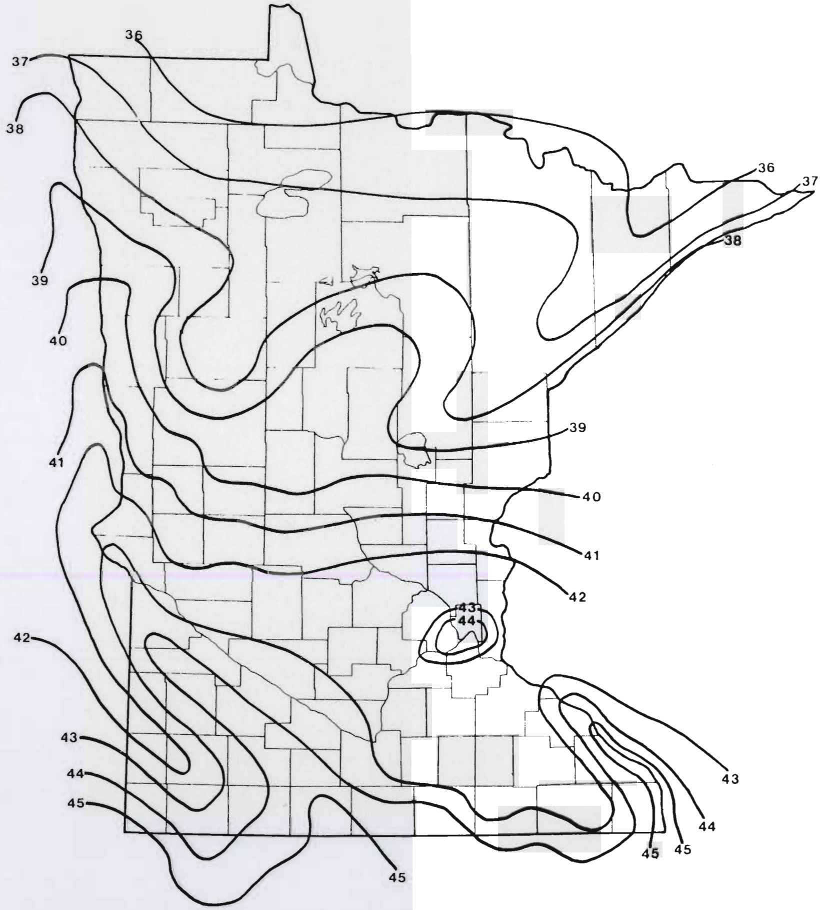

Figure 23.

Annual normal temperatures, °F.

the cool lakeshore temperatures of Lake Superior are excluded. The fall differential between the corners of the state is only 9°F even when the Lake Superior effect is counted. The spring difference across the state is 10°F; during this season the lake-land difference is at a minimum.

The summer mean temperature map (Figure 20) shows several features that distinguish it from the annual map (Figure 23). An obvious difference is the general northwest to southeast orientation of the isotherms, which arises from a combination of factors. The primary factors are the path of the storm centers and the presence of Lake Superior. The main position of the polar front is essentially north of Minnesota. The weather systems from Canada still move southeastward, but they are displaced farther north. Thus warm air intrusions from the south are more frequent in western Minnesota, whereas the southeast directed storm path plus the cool lake serve to "tilt" the isotherms into a more northwest-southeast orientation. Both air mass analysis (Bryson, 1966) and resultant wind analysis indicate that such an orientation is to be expected (Borchert, 1948; Baker, 1983). The presence of Lake Superior, a large, cool air source in the summer, in combination with the upland immediately to the west of it forces isotherms far south in northeastern Minnesota. This effect is particularly noticeable because there is nothing comparable in the northwestern corner of the state. The influence of these climatic parameters and the general isotherm orientation also help to explain a similar orientation of the native vegetation zones of the state.

With respect to local summer features, the cool area associated with the Alexandria Moraine shown in the annual map (Figure 23) is enlarged eastward in summer to include Leech, Cass, and Winnibigoshish lakes. The summer coolness of this area is due both to the higher elevations present and to the lakes themselves, which are numerous, constituting about 215,000 acres or nearly 336 square miles.

Another special summer feature is the cooling effect created by the apparent funneling of Lake Superior air across parts of eastern Minnesota that lie southwest of the lake. As noted earlier the Great Lakes, and Lake Superior in particular, present during the summer a surface that is much cooler than adjacent land surfaces. During May-August the southern part of Lake Superior averages about 12°F (6.7°C) cooler than the air over land. Thus any weather system that is located in such a position as to cause a westward movement of the cool air from Lake Superior toward Minnesota during May-August (such as a high pressure system centered to the north or northwest of the lake, or a low pressure system to the south of Lake Superior) will move the surface air in an easterly direction. As the air moves westward it is channeled southwestward, due to the North Shore Ridge along the northern margin of Lake Superior, with the outlet being the low terrain southwest of Duluth-Superior. Occasionally the cool air of the Lake Superior basin reaches Mille Lacs Lake; such an occurrence appears to reinforce the flow of cool air. The advection or transport of the cool lake air into parts of eastern Minnesota probably reaches a peak in May and June when the combination of the frequency of winds from the east, as measured at Duluth, and the temperature differential between land and water is at a maximum.

These cold air intrusions within a relatively narrow band through Carlton County and lower Aitkin County can have such a profound effect upon crops that chances for a thriving agriculture are greatly reduced. The lowered temperatures reduce the seasonal total of growing degree days and may also increase the risk of late spring and early fall frosts.

That this differential between the lake and the land can be dramatic is demonstrated by conditions experienced by one of the authors on a drive from St. Paul to Two Harbors, about 175 miles north-northeast of St. Paul, via Hinckley and Duluth on July 9, 1983. A large high pressure was located between Lake Superior and Hudson Bay, producing winds that blew from east to west across the lake. A weather front or major discontinuity between the lake air, 62°F (16.7°C) at Two Harbors, and land air, 80°F (26.7°C) at St. Paul, began at Willow River. Between there and Cloquet, a distance of 24 miles, the temperature dropped 12°F (6.7°C). Within this temperature discontinuity clouds were low and constituted a complete cover, while it was partly sunny both to the north and to the south of this zone. With a somewhat stronger general circulation or wind flow, the cool air would soon be carried southwestward into east-central Minnesota.

Temperature Profiles

To determine a quantitative measure of the two major causes of the temperature variation observed, latitude (northward displacement) and altitude (excluding the important but essentially localized effect of Lake Superior), a multiple linear regression equation was calculated for two south to north profiles. The results are shown in Table 5. The latitude effect is shown in terms of the horizontal distance northward from the Iowa border. Due to the large effect of Lake Superior the data in Table 5 for the south to north temperature profile across eastern Minnesota are only for that portion running from the Iowa border to Duluth.

Table 5. Temperature changes associated with an increase in elevation and an increase in distance from Iowa to the Canadian border (compare with Figures 24 and 25).

Location	Period	Elevation Effect in °F per 100 Feet	Distance Effect in °F per 100 Miles
South to north (western Minnesota, see Figure 24)	July	-0.44	-2.27
	Summer	-0.42	-2.17
	Winter	-0.48	-4.23
	January	-0.45	-4.39
South to north (eastern Minnesota, see Figure 25)	July	-0.65	-2.72
	Summer	-0.64	-3.02
	Winter	*	-2.86
	January	*	-2.83

* No apparent effect due to change in elevation.

As shown in Table 5, the temperature gradient in winter is greater than in the summer in the western temperature profile. This is a feature common to most parts of the world. But the seasonal difference in the eastern profile shows a greater contrast in summer than winter because the lake effect that is present in summer is at least partially eliminated in winter due to ice cover. In summer Lake Superior air is very cold compared to land temperatures. Since some of this cold air occasionally "spills out" of the immediate area and is moved to the southwest, the result is that a larger than expected summer temperature differential can develop between the Iowa border and Duluth.

The temperature decrease introduced by an increase in altitude is another interesting feature evident in Table 5. The decrease is about 0.1°F less than the theoretical value for adiabatic cooling (0.55°F per 100 feet) associated with rising air in the western Minnesota profile. The values shown for the two profiles in Table 5 seem reasonable. The indicated changes of -0.65 and -0.64°F in July and summer, respectively, in the eastern profile are greater than the predicted rate. The explanation must rest with the fact that the change in elevation, which occurs principally in the Twin Cities area, is confounded with the urban heat island effect. Both features act to make the Twin Cities area warmer than the surrounding area. The combination of the warm Twin Cities temperatures and the lake-influenced cool temperatures of Duluth serves to produce a temperature change greater than the elevation-induced decreases.

The two temperature and altitude profiles associated with Table 5 that extend south to north across the state are shown in Figures 24 and 25. In each case the associated elevation profile is depicted at the base of the figure. The temperature profiles shown are for the temperature normals of four periods: July, summer (mean of June, July, and August), winter (mean of December, January, and February), and January.

A general decreasing trend in temperatures from south to north is the most evident feature in Figures 24 and 25. The northward rate of temperature decrease, ordinarily greater in winter than summer, is modified by several factors, with variation in elevation being the most important and obvious one. The marked temperature decrease at Pipestone (Figure 24) can be explained by its position on Buffalo Ridge, some 320 feet (98 m) higher than Sioux Falls to the south and 570 feet (174 m) higher than Marshall, located to the north-northeast.

Of major importance in northeastern Minnesota is Lake Superior (Figure 25), as evidenced by the temperatures at the two lakeside stations, Two Harbors and Grand Marais. The effect of the lake is present in the winter and January profiles of these stations. The relatively high temperatures are the result of the lake being ice-free, particularly in December and early January, while nearby land surfaces are considerably colder and usually are snow covered.

Another factor whose influence probably is evident in the eastern Minnesota transect from south to north is the urban effect of the Twin Cities (Figure 25). Due to the urbanization and industrialization of the Twin Cities, with the attendant heat production and heat absorbing building materials of the city, a marked increase in temperature frequently can be observed. In this temperature profile of eastern Minnesota the urban effect, or "heat island," is added to the warming effect due to the decrease in elevation at the Minneapolis-St. Paul airport station. Although the

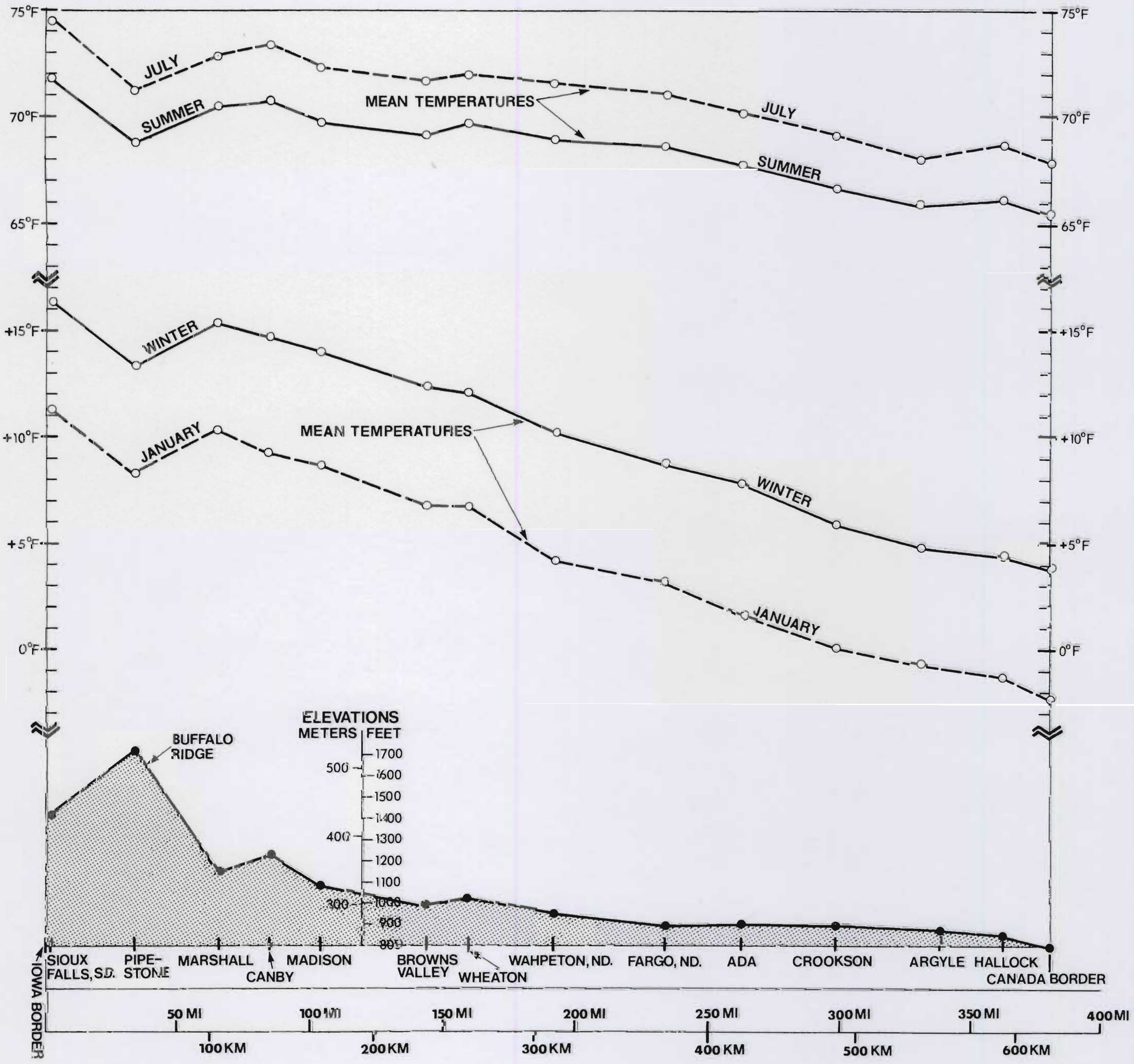

Figure 24.

South to north temperature (July, summer, winter, and January) and altitude profiles across western Minnesota from Iowa to the Canadian border.

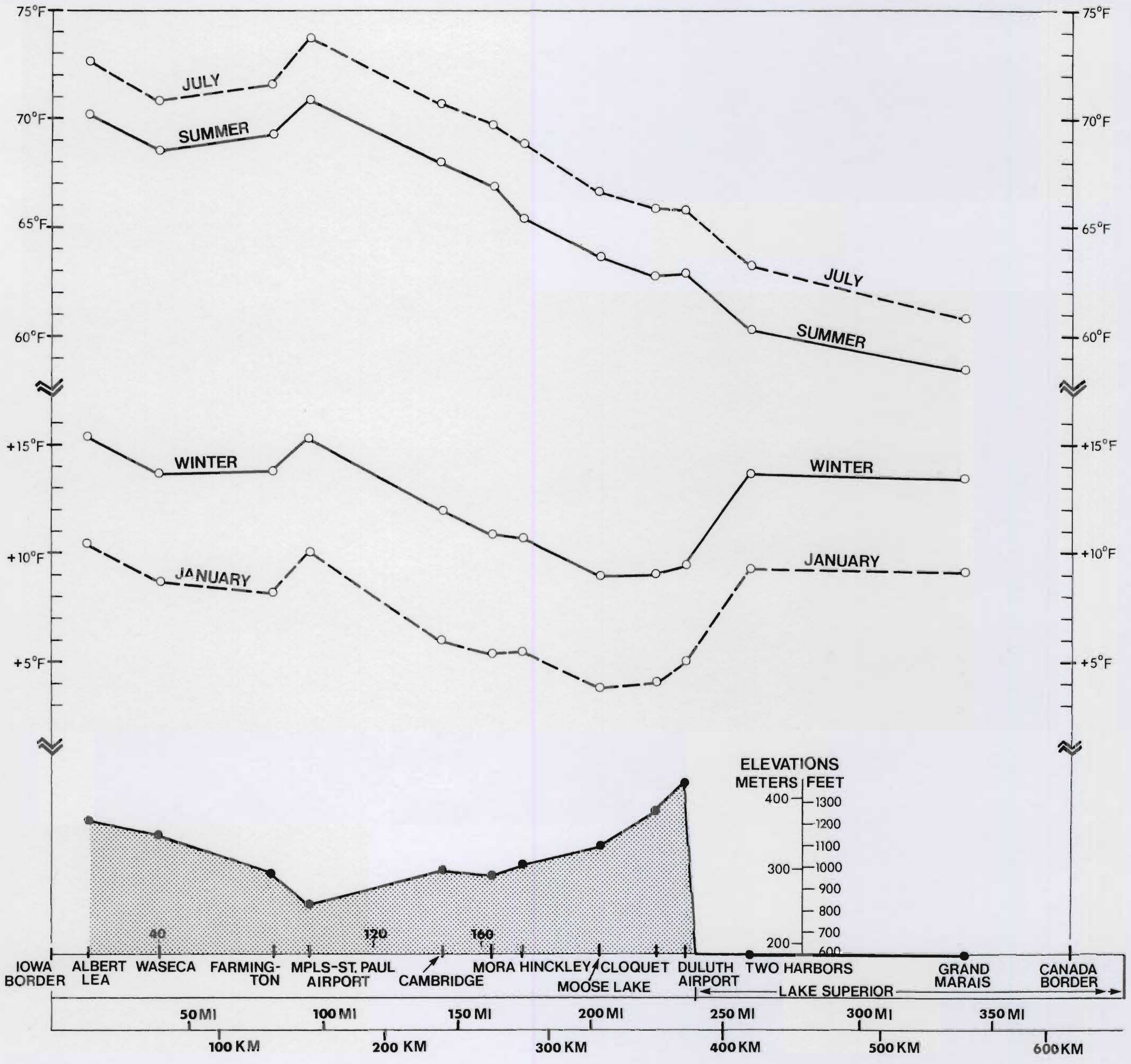

Figure 25.

South to north temperature (July, summer, winter, and January) and altitude profiles across eastern Minnesota from Iowa to the Canadian border.

airport is not in the heart of the heat island (Winkler et al., 1981), the temperatures, which are higher than those at Farmington just to the south of the Twin Cities, cannot be attributed just to the decrease in elevation.

Two additional temperature and altitude profiles are shown in Figures 26 and 27. Both show west to east profiles, with the former across the northern part of the state and the latter across the south.

The profiles across northern Minnesota (Figure 26) show the marked seasonal effect typical of large bodies of water, an effect that is out of phase with the land. In July and summer there is a general decrease in temperature as the lake is approached, whereas in winter and January there is a general increase. The elevation effect is sharpest between Itasca Park and Park Rapids in July and summer. The large topographic change along the western and eastern sides of the Red River valley is hardly apparent in the temperature profile, probably because the winds do not commonly blow at right angles to this depression.

Across southern Minnesota there is a marked decrease in elevation from west to east (Figure 27). Except at Waseca and the Mississippi River valley, however, there is virtually no corresponding temperature variation. The altitude and distance effects upon the two west to east profiles are shown in Table 6. The major change found in the northern and southern transects is that in moving west to east across the state, temperatures decrease in summer and July but increase in winter and Jaunary. This is partially due to Lake Superior, since it is still open in December and a part of January. A part of the decrease in temperature also is due to the fact that centers of the Canadian cold air masses usually enter North Dakota or northwestern Minnesota first. As a result, by the time an air mass reaches eastern Minnesota, some amelioration in the air temperature has taken place. For these two reasons, then, temperatures in the eastern portion of the transects are somewhat warmer in the winter and cooler in the summer.

Table 6. The temperature changes associated with a change in elevation and increase in distance from the Dakotas to the Wisconsin border (compare with Figures 26 and 27).

Location	Period	Elevation Effect in °F per 100 feet	Distance Effect in °F per 100 Miles
West to east (northern Minnesota, see Figure 26)	July	-0.44	-1.41
	Summer	-0.38	-1.67
	Winter	-0.33	1.10
	January	-0.43	1.54
West to east (southern Minnesota, see Figure 27)	July	-0.31	-0.89
	Summer	-0.31	-0.90
	Winter	-0.21	0.11
	January	-0.19	0.22

* Superior, Wisconsin, is not included.

Other factors, usually minor and very local, do play a part in modifying the temperatures from what might be expected. Such factors usually are unique to a given station. As noted earlier they include the location of the temperature shelter housing the instruments relative to nearby obstructions to air movement and to minor and localized variations in both topography and surface.

The Application of Temperatures

Degree Days

An interesting and frequently useful means of predicting certain physical or biological events is through the application of degree days. The basis for success is that within a given temperature range many biological and physical systems react directly to a temperature increase or decrease. That is, once a certain base or threshold temperature has been reached the rate of change of the system under consideration closely approximates the summation of the temperature. Depending on the application, the temperature threshold can be reached with either rising or falling temperatures.

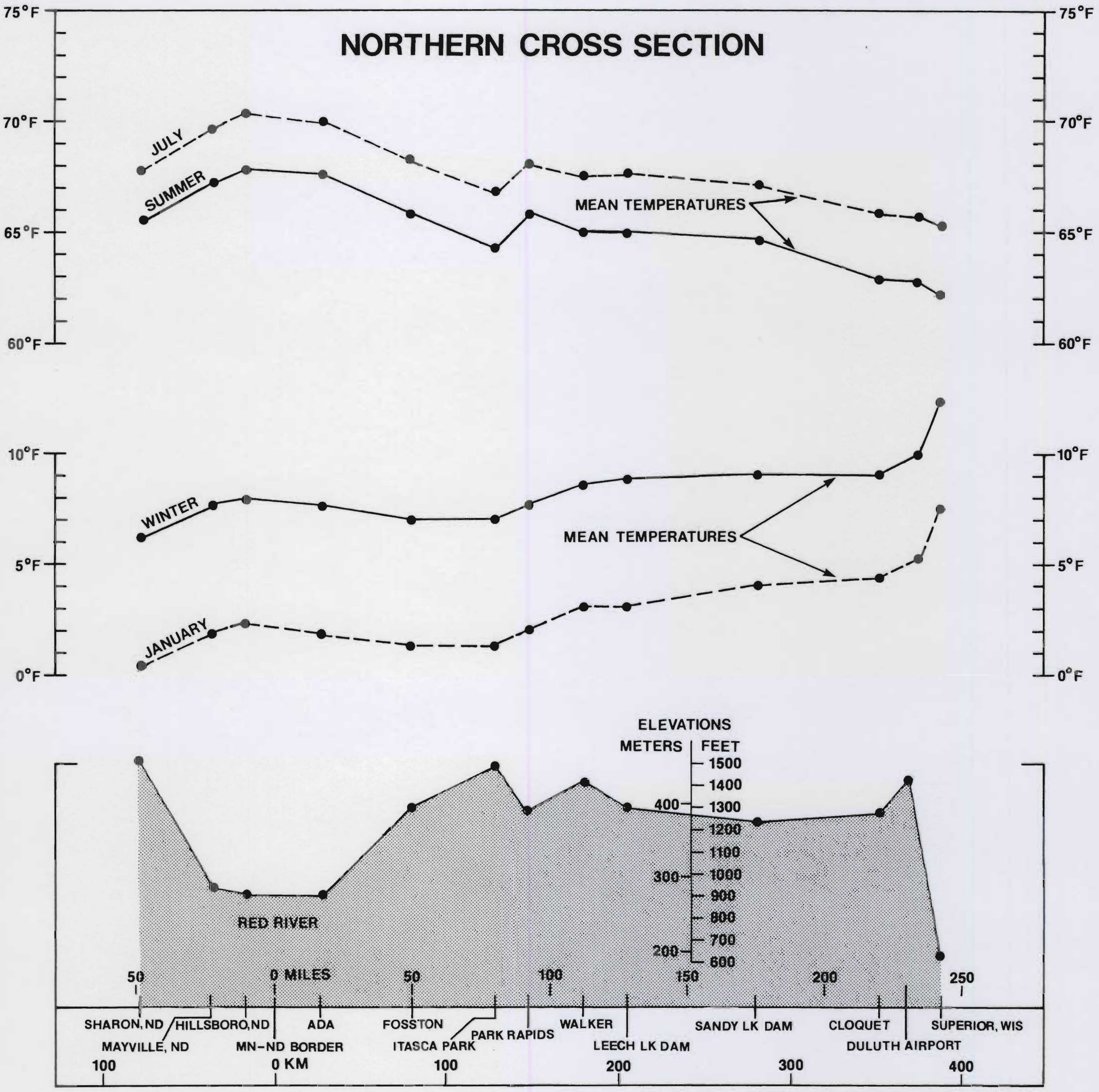

Figure 26.

West to east temperature (July, summer, winter, and January) and altitude profiles across northern Minnesota from Sharon, N.D., to Superior, Wis.

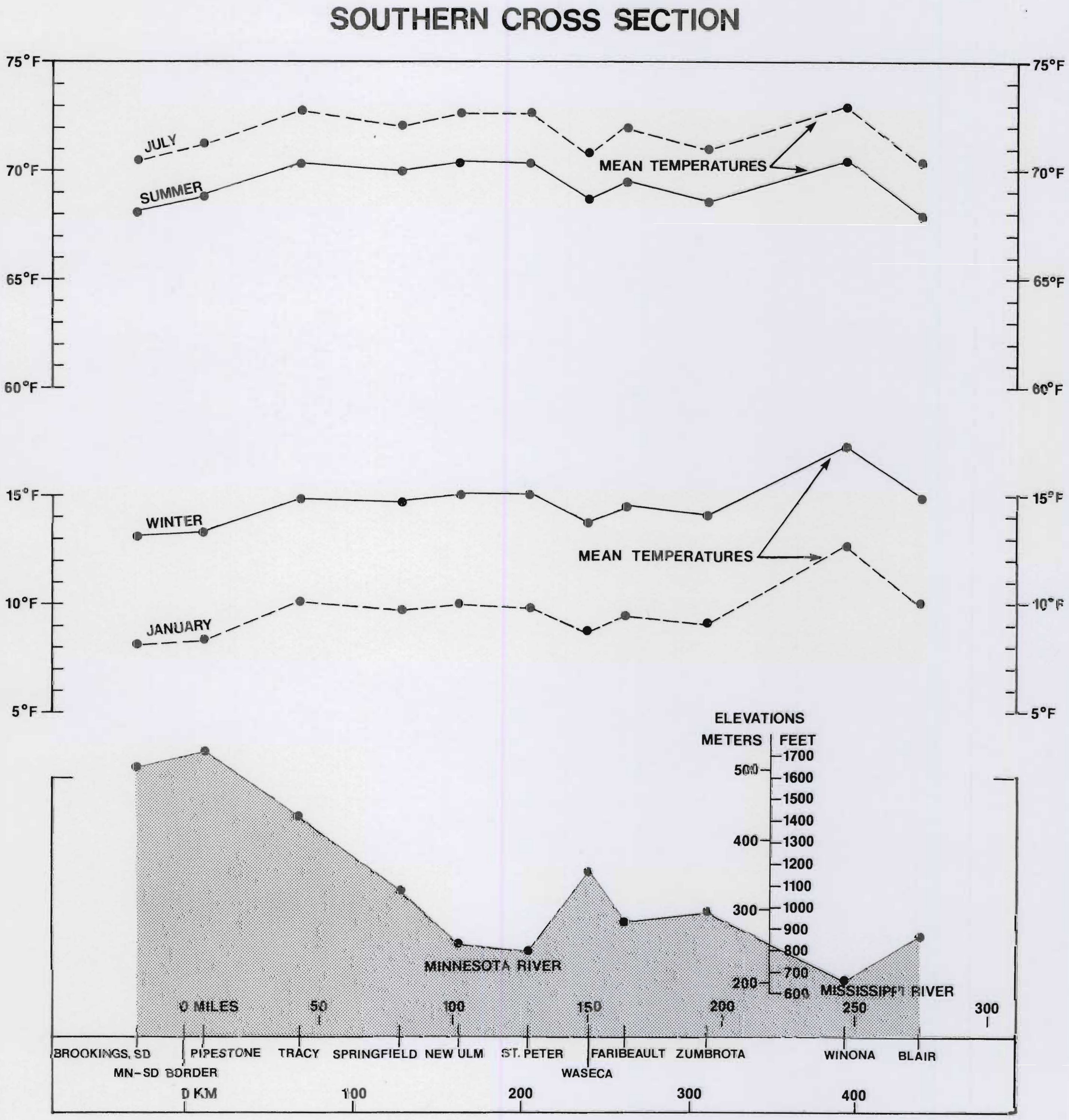

Figure 27.

West to east temperature (July, summer, winter, and January) and altitude profiles across southern Minnesota from Brookings, S.D., to Blair, Wis.

For application to biological systems, such as the growth and development of crops, the threshold or base temperature is reached with rising temperatures. The calculation for this kind of degree days (DD) is:

$$DD = \Sigma (\bar{T} - T_b)$$

$\bar{T}$ = the average daily temperature, which is one-half of the sum the daily maximum and minimum temperatures.

T_b = the base or threshold temperature; the temperature that must be exceeded before growth or development commences.

Σ = the symbol indicating that the difference between $\bar{T}$ and T_b is to be summed day by day; negative values are not counted.

Occasionally, hourly temperatures are used in place of the average daily temperature $\bar{T}$ (Lana and Haber, 1951). The degree day total or, more correctly, the total of the degree hours assigned to a particular event or stage, then has to be revised accordingly.

For expediency the formula sometimes is altered to:

$$DD = \Sigma[(\bar{T}m - T_b) \times N]$$

$\bar{T}m$ = average monthly temperature; T_b = base temperature; N = number of days in the month; Σ indicates that the value obtained within the brackets is to be summed.

Degree days also can be calculated when the base temperature is reached with descending temperatures. This kind of degree day usually finds frequent application in physical systems and is used, for example, to estimate fuel consumption or the freezing rate of soil. It also can be applied to biological systems in which insects or plants require a certain number of chill units before development can proceed. It is discussed in detail in a following section. The calculation method is similar to the degree days just described except that the mean temperature ($\bar{T}$) is subtracted from the base temperature (T_b), with the daily differences summed as usual. Symbolically the formula is:

$$DD = \Sigma (T_b - \bar{T}).$$

Degree days in this bulletin were computed from the monthly temperature normals rather than from daily temperatures. Ordinarily such a method is not recommended because daily variations are then masked. Thom (1954), however, developed a method that permits the use of monthly normals by taking daily variations into account. Thom's method, which permits an estimation of monthly totals of degree days based on the mean and standard deviation of the monthly temperatures, was modified and improved by Zandlo (1985) for computer use. Zandlo's method was used to calculate the monthly totals of degree days required for determining the several kinds of degree days shown in this bulletin.

Growing Degree Days (GDD). Because of the relative ease with which degree days can be calculated (see the two formulas for DD above) and because so many things are temperature regulated, degree days can be applied to a number of biological and physical events. The most obvious and earliest application was to the development of agricultural crops. The concept of degree day is not a new one; it was suggested as early as the late 18th century by Reaumur (Went, 1957), a French scientist who also developed the thermometer and temperature scale that bear his name. It was another Frenchman, de Candolle, who in 1855 first subtracted a minimum temperature from the daily average (Went, 1957). This minimum, now termed the base or threshold temperature, was presumably the temperature level below which no growth occurred. Besides being known as GDD and thermal time, degree days also are referred to as day degrees, heat sums, and the remainder index.

An example that applies GDD to sweet corn can be used to explain this method more clearly. If $\bar{T}$, the average temperature for the day, is 80°F and T_b is 50°F, the base temperature frequently used for sweet corn, then the total GDD for this day equal the difference between 80° and 50°F or 30 GDD. The accumulation of about 1750-2000 GDD from planting to harvest (canning) time usually is required for sweet corn varieties grown in Minnesota.

Of course, canning companies, which are the most frequent users of this method, do not depend on this method alone to determine proper harvesting time. After a certain sum has been reached during a season, field inspections are greatly increased; the decision to harvest is based on these inspections. As one canning company official stated, "The growing degree day method is a yardstick, not a micrometer."

Canning companies frequently use the GDD method for another practical purpose: to schedule plantings so that harvest does not occur within too brief a period and overload the canning facilities. Because temperatures for the growing period are unknown at planting time, schedules are based on GDD calculated from the normal or average temperature for the area. At least one canning company even uses this method to estimate root growth of corn for determining when to cease cultivation.

Within usually acceptable limits, a certain number of GDD can be allotted to various stages of growth and development for plants (as used by Baker et al., 1984), for example, or for insects. In other words, rate of development and rate of growth are closely tied to environmental conditions, particularly temperature. Indeed, the accumulation of degree days frequently is superior to number of calendar days as a measure of growing time. For example, we can all remember occasions when plant growth virtually ceased during low temperature periods only to resume when temperatures rose. The degree days that elapse during such low temperature periods are few in number, while the calendar days continue to increase. Consequently, the use of degree days to indicate the passage of "time" and to replace calendar days is now fairly common. Applied in this manner, degree days have been termed "thermal time."

An area of temperature application that has yet to be comparably exploited is insect development. Nevertheless, according to Lablans, et al. (1980), the influence of temperature is so important with respect to certain insect populations that it should be used in mathematical models as an essential variable that drives populations, a so-called forcing function. They also state that with "adequate food and tolerable humidity" the growth rate of insects is mainly a function of two things: temperature and the genetic constitution of the individual.

The application of degree days has been tested in entomological studies. Results indicate that insects do not follow a linear development or growth rate, an accepted part of degree day use. Rather, insect growth rates are better described by curvilinear equations (see, for example, studies by Berkett et al., 1976, and Tanigoshi et al., 1975a and 1975b). Inspection of several studies, however, indicates no great loss of accuracy if a linear equation is accepted instead of the curvilinear one. For example, Berkett et al. (1976) found in the regression of temperature against the rate of apple budmoth development that the nonlinear model resulted in $R^2 = 0.90$ compared to $R^2 = 0.82$ using a linear degree day model. The linearity of degree days in modeling insect development usually can be considered acceptable when it is understood that the application normally will be in the uncontrolled environment of the field and that the temperature data source may be several miles away. In other words, laboratory accuracy cannot be expected under field conditions.

The temperatures of greatest concern to entomologists often have been temperatures in the range marking the zone of essentially linear insect development. The determinations have been made under constant rather than varying temperatures as in the field. As a result, threshold or base temperatures have yet to be fully established under field conditions. Some can be cited directly or estimated from certain studies. The degree days are calculated and the T_b's are used as previously described for plant GDD.

Baker et al. (1984) found that for the European corn borer the T_b ranges from 37°F for first instar larvae to about 44°F for fifth instar larvae. These temperatures explain a commonly observed phenomenon: corn borer larvae are active during periods too cool for active corn growth, for which 50°F is the generally accepted base temperature.

In a study on developmental rates of the tufted apple budmoth, Berkett et al. (1976) found there was still a 1 percent development rate per day at the lowest temperature used in their study. From their temperature versus rate curve, the T_b can be estimated as between 55-60°F, since at 60°F development from egg hatch to adult emergence requires about 100 days.

Extrapolating to zero the various developmental curves shown in a study on the McDaniel spider mite by Tanigoshi et al. (1975a), the estimated T_b is about 40°F. This or a slightly lower temperature is probably the T_b for the pear psylla also, since more than 100 days are required at 50°F for its development from egg to adult (Asquith et al., 1980).

Base temperatures suggested for the alfalfa weevil and grasshopper are 48° and 50°F, respectively (Ruesink, 1981). With these base temperatures Ruesink found that the best spray date for the weevil occurred in Illinois after about 450 GDD had accumulated and that nearly 25 percent of the grasshopper hatch occurred by 500 GDD. For the northern corn rootworm the T_b is approximately 44°F. The egg hatch begins in Illinois at about 800 GDD, peak larval feeding begins at 1350 GDD, and adult emergence commences at about 1850 GDD (Ruesink, 1981).

For some other insects, notably the black cutworm, the green cloverworm, and the bean leaf beetle, GDD are accumulated following an observed initial event. Following that event, GDD are then summed with the T_b equal to 50°F for each of the three insects. The initial event for the black cutworm and green cloverworm is the moth flight, whereas for the bean leaf beetle it is the time of planting (Ruesink, 1981).

Despite concern over the proper base temperature, predictions of various developmental stages for a number of economically important insects can be made using a general base of 50°F. This temperature probably is a close approximation of the correct T_b for many insects as well as for a number of host plants. In addition, degree days do not accumulate fast at low temperatures. Table 7 is composed of a number of events for which the indicated degree day totals with a T_b = 50°F have given acceptable results in Michigan.

In general, adult mosquitoes do not actively breed when the monthly mean temperature is less than 60-65°F. They seem to be best suited to monthly mean temperatures in the range of 70-77°F (Landsberg, 1969). Of course, adequate moisture is a necessity, and low wind speeds are also a favored condition.

A 1970 study by Trpis and Shemanchuk indicated that a more precise T_b for a mosquito common to Minnesota (*Aedes vexans*) was 47°F. Under laboratory conditions 120 GDD were required for development from egg hatch to pupation and an additional 58 GDD were required to reach the adult stage. Krafsur et al. (1985) found the face fly of cattle (*Musca autumnalis* De Geer, Duptera: Muscidae) to have a T_b of 54°F and that 126 degree days were required for the laying of the first spring eggs.

Table 7. Total GDD (T_b = 50°F) required for the indicated stage or event under Michigan environmental conditions (after Gage and Smitley, 1985).

Total GDD	Pest	Host	Stage/Event
	VEGETABLES		
569-834	European corn borer	Corn	First larvae
1527-1700	European corn borer	Pepper, tomato	First egg masses
	FIELD CROPS		
569-834	European corn borer	Corn	First larvae
1059-1266	Western corn rootworm	Corn	First adults
	FRUIT		
14-43	Pear psylla	Pears	First eggs
22-70	Tentiform leafminer	Apples	First adults
25-78	Redbanded leafroller	Apples	First adults
73-177	Oriental fruit moth	Stone fruits	First adults
142-183	Obliquebanded leafroller	Apples	First larvea
201-340	Codling moth	Apples	First adults
223-326	White apple leafhopper	Apples	First nymphs
356-480	Lesser peachtree borer	Peaches	First adults
460-662	Cherry fruit fly	Cherries	First adults
	ORNAMENTALS		
142-183	Obliquebanded leafroller	Many	First larvae
167-228	Redbanded leafroller	Many	First larvae

A mean daily temperature of 70°F also can be taken as the threshold temperature of summer days, and the accumulation of degree days above 70°F can be considered a measure of what might be termed the "intensity of summer".

Some typical values of T_b and total GDD calculated from planting to maturity or harvest are shown in Table 8. Often the GDD values established for crops or insects within one state or region are not acceptable elsewhere. The major factor limiting the application of GDD to crops apparently is day length. Weather, soil fertility, and varietal differences also may play a part (Katz, 1952). Thus errors made with an east to west transfer of the GDD totals are not as serious as with a north to south transfer, which introduces the day length factor. Experience is the best method for determining whether a given set of GDD values is suitable for a particular area. GDD do not work well with soybeans because their development is much more closely tied to day length than is the development of crops like corn.

Table 8. Values frequently assigned to base temperature (T_b) and total GDD required to reach maturity for selected crops or indicated stage for insect development.

Crop	T_b (°F)	Total GDD, planting to harvesting
	CROPS	
Peppers, chili	60	-------------
Corn, field	50-55	2200-2600 (T_b = 50°F)
Corn, sweet	49-50	1750-2000 (T_b = 40°F)
Soybeans	50-55	2000-2400 (T_b = 50°F)
Tomatoes	50-53	-------------
Beans, lima	50-53	-------------
Snapbeans	50	-------------
Barley	40-43	2000-2400 (T_b = 40°F)
Flax	40	1900-2200 (T_b = 40°F)
Oats	40-43	2100-2500 (T_b = 40°F)
Wheat, spring	40-43 (or 32)	2000-2400 (T_b = 40°F)
Asparagus	40	-------------
Peas, canning	40	1200-1800 (T_b = 40°F)
Native vegetation	32	-------------
	INSECTS	
Mosquito (adult activity)	60-65	-------------
(larval development)	47	Egg hatch to adult stage 178 GDD
Stethorus punctum (mite predator)	65	-------------
Tufted apple budmoth	55-60	-------------
Face fly	54	First eggs 126 GDD
Grasshopper	50	Grasshopper hatch 500 GDD
Metaseivlus occidentalis (mite)	50	-------------
Alfalfa weevil	48	Suggested alfalfa weevil application 450 GDD
Corn rootworm	44	Corn rootworm egg hatch 800 GDD
McDaniel spider mite	40	
European corn borer	37 increasing to 44	Instar 1 to instar 5

Threshold values other than those shown in Table 8 are sometimes used. For example, recent work seems to indicate that a temperature lower than the indicated 40°F may be more appropriate for spring wheat (Baker and Gallagher, 1983; Davidson and Campbell, 1983). Both investigations concluded that 32°F is a more correct base or threshold temperature. Note, however, that the total GDD accumulated will not vary greatly from the figures shown in Table 8 with a base temperature of either 32° or 40°F.

Although GDD are a very useful and practical guide, they are not a research tool. It is questionable whether seeking improvement in this method deserves further effort. As Went (1957) stated, it is amazing that this method works as well as it does, since growth is not a straight line function with temperature as the formula indicates. Admittedly, this method is a tempting one; knowing only the base and maximum and minimum temperatures, any stage of plant development supposedly can be estimated.

In Minnesota, success in applying this method to plant development and growth is greatest when it is limited to the period from spring planting until early July because soil moisture normally remains adequate only through this period. After early July soil moisture reserves and precipitation ordinarily cannot meet the evapotranspiration demands of crops. So proportionally less energy is expended in evapotranspiration and more is available for heating the air and soil. The resulting high air temperatures, and the corresponding increase in GDD, seemingly indicate a proportional increase in plant growth. But, as experienced growers know, the high temperatures that develop often exceed the optimum levels and growth can even be retarded. To apply the method more satisfactorily a correction factor can be introduced to reduce the accumulated GDD to correspond more closely to actual growth and development during high temperature periods. If sufficient soil moisture is provided by precipitation or irrigation, however, the available energy is more uniformly divided between evapotranspiration and heating the air. In this case the expected relationship between the plant and temperature will continue to hold.

Total annual GDD were calculated using base temperatures of 32°F and five-degree increments from 40° to 70°F. Eight different base temperatures were chosen because of the wide variety of uses to which degree days can be applied. Of course, not all of them are related to agriculture. Table 8 shows that even for the relatively limited kinds of crops grown in Minnesota there is a wide range of base temperatures to be applied that extend from around 32°F for many native plants, and perhaps wheat, to 60°F for peppers. Insects run the gamut from 37° to 70°F. The accumulation of temperatures above the 65°F base is used for cooling degree days (CDD) and 70°F is used for certain mosquitoes and as a measure of summer days.

Annual total degree days for various T_b's are listed in Appendix Table 2; in Appendix Table 3 the mean first and last date of occurrence of related temperatures are given along with duration between the dates.

The number of degree days that normally accumulate at 10-day intervals throughout a season are given in Appendix Tables 4-10. These tables permit a determination of the rate at which the degree days normally accumulate. They are especially useful in comparing a particular year with the tabled value to see if the season is in advance, behind, or equal to the normal season.

Detailed information with respect to four common and useful DD is provided in Appendix Table 3: GDD with base temperatures of 32°, 40°, and 50°F in addition to HDD (heating degree days) below 65°F. Information in this table includes the date when the average daily temperature first exceeds the indicated T_b in the spring, the last date when the same base temperature normally occurs at the end of the season, the duration between these two dates, and the total degree days accumulated between the same dates for a normal season. Figures 30-31 illustrate the first date when the normal daily temperature reaches the base temperatures of 40° and 50°F.

A 40-year record of phenological observations compiled by Prof. A. C. Hodson (Hodson and Kuehnast, 1981) in the Minneapolis-St. Paul area showed a marked coincidence between elderberry bud opening and the blooming of soft maple, April 3 and 5, respectively, and the mean date of occurrence of a 40°F average temperature, April 5, as shown in Appendix Table 3. In the same record the apple tip green stage was found to average about April 23, coinciding with the first occurrence of a mean daily temperature of 50°F, April 22, at Minneapolis-St. Paul (Appendix Table 4). These events also can be tied closely elsewhere around the state to the accumulation of a set number of degree days from the nearest weather station.

A remarkable feature in terms of the warming of the state is evident from comparing Figure 28 with Figures 30 and 31. A great many more calendar days are required for all of the state to reach a mean daily temperature of 50°F than is required to reach either 32° or 40°F. Table 9 summarizes the differences between the four corners of the state. That the greatest interval exists between the southeast and northeast corners can be attributed to the effect of Lake Superior. That the temperature intervals (32° to 40° and 40° to 50°) are not equal is a minor factor.

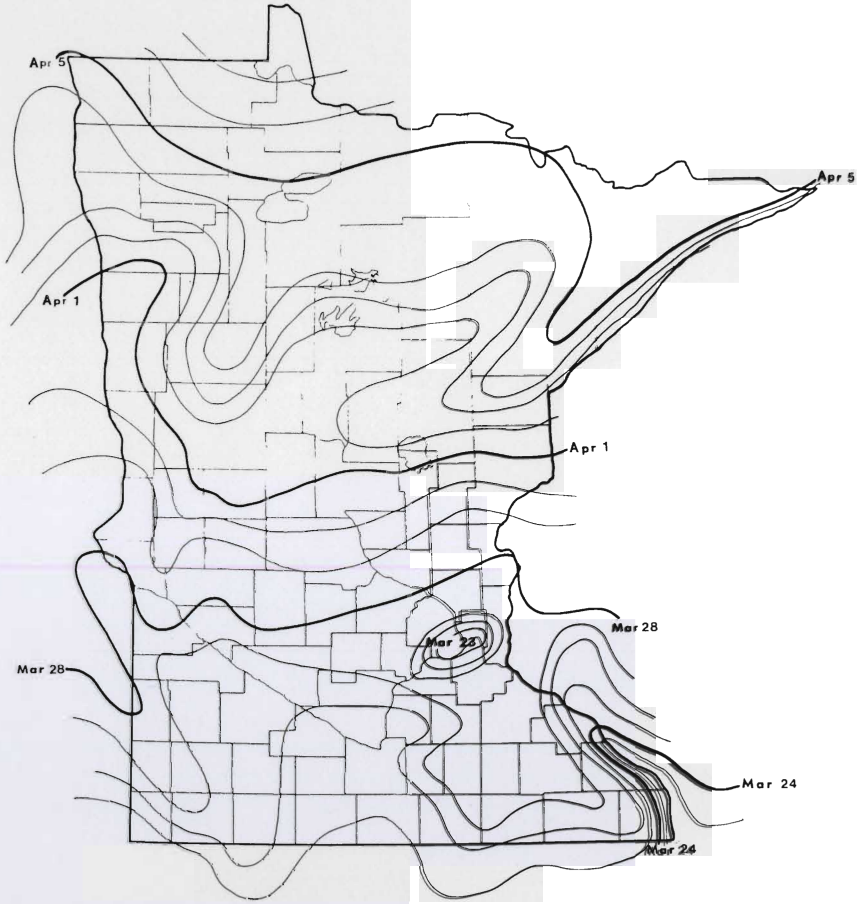

Figure 28.

Date of the first 32°F normal daily temperature.

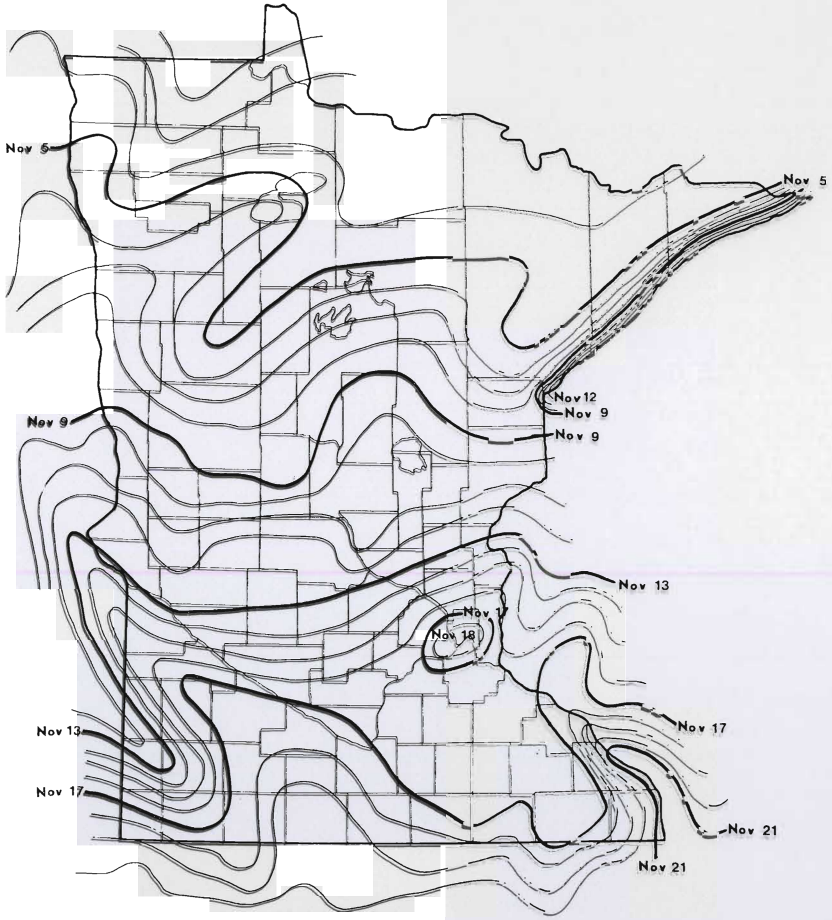

Figure 29.

Date of the last 32°F normal daily temperature.

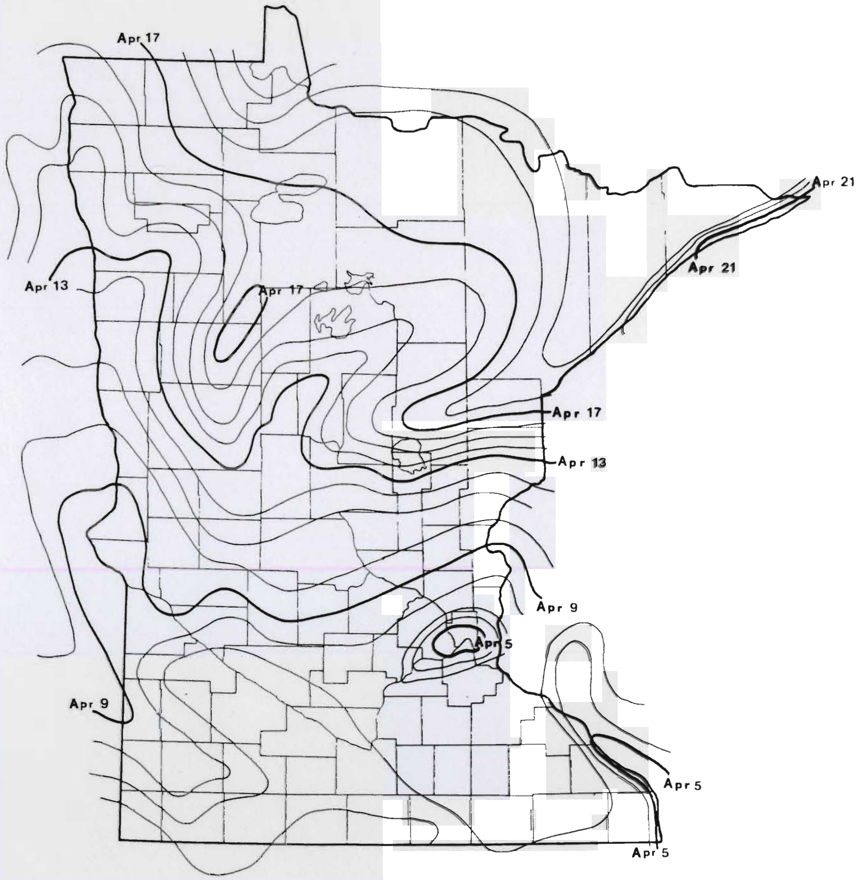

Figure 30.

Date of the first 40°F normal daily temperature.

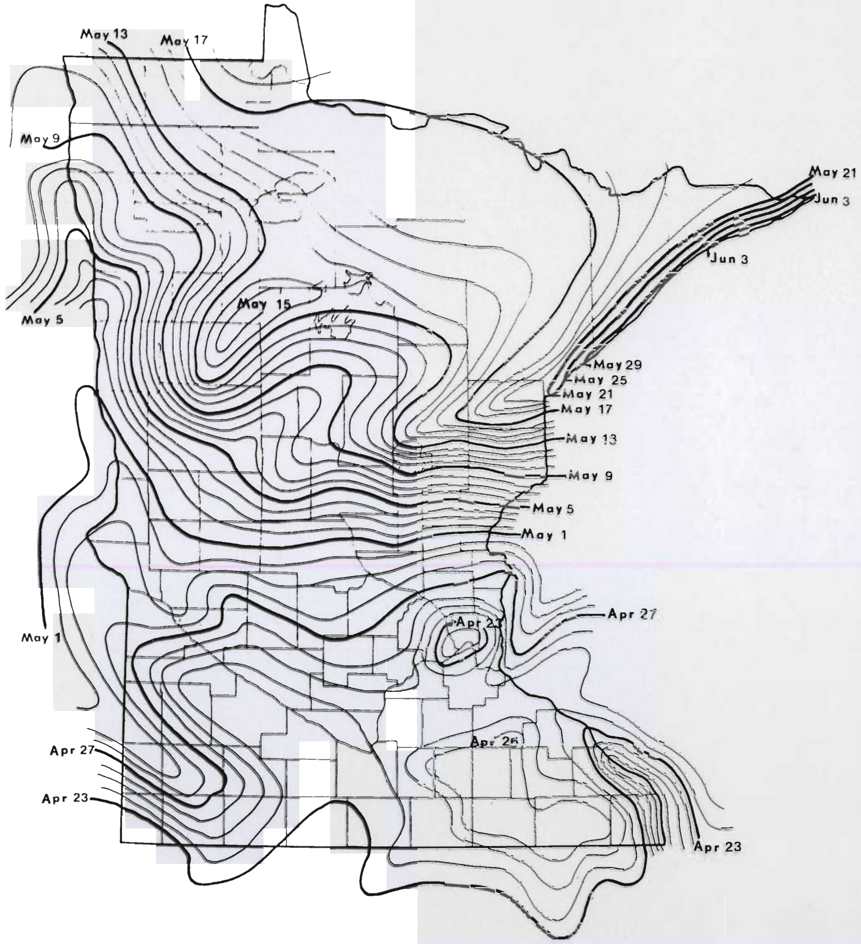

Figure 31.

Date of the first 50°F normal daily temperature.

Table 9. Interval in calendar days required for a mean daily temperature of 32°, 40°, and 50°F to be reached across the state.

Corner of State	Interval 32°F	 40°F	 50°F
From the southeast to the northwest corner	12	11	20
From the southeast to the northeast corner	11	16	44
From the southwest to the northwest corner	11	10	17
From the southwest to the northeast corner	10	15	41

As evident from Table 9, the rate of temperature increase once 40°F is reached differs dramatically between the northeastern and southern parts of the state.

The next set of maps (Figures 32-39) have been drawn to show the distribution of the various degree day annual totals across the state. Each of the maps shows the now familiar configuration of the isolines (lines of equal value): distortions of the isolines created by Lake Superior, the urban effect of the Twin Cities, the Mississippi valley in southeastern Minnesota, and the topographic effect of the three major uplands in the southwestern, northwest-west central, and northeastern parts of the state.

Profiles of the annual total number of GDD, T_b = 50°F, from the Iowa border northward across western and eastern Minnesota are illustrated in Figures 40 and 41. The major difference between the two figures is the sharper and more continuous GDD decrease that begins in eastern Minnesota a short distance north of the Twin Cities. In the second 100 miles north of the Iowa border the contrast between the western and eastern transects of the state becomes great. In the east between St. Paul and Moose Lake the GDD decrease from 2400 to 1530. In western Minnesota over the same distance and latitude, from 10 miles south of Willmar to Wadena, the GDD decrease from 2240 to 1880. This is a difference of only 360 GDD per 100 miles compared to a 870 GDD decrease along the eastern transect. By the time Cloquet is reached, there are only about 1400 GDD that will have accumulated by the end of a normal season, hardly enough for even the production of fodder corn.

Melting Degree Days. The summation of temperatures above 32°F has application in both the biological and physical realms. As noted earlier, 32°F has been suggested as the base temperature for spring wheat, and it may be an acceptable base temperature for the initiation of growth of some native vegetation. When applied to the physical realm these degree days are often termed melting degree days (MDD) or thawing degree days (TDD) and are used in various formulations to estimate the thawing rate of the snow pack or of the soil. The first and last dates and the duration of melting degree days are shown in Figures 28-29 and Appendix Table 3. Totals for selected dates during a normal season are listed in Table 14.

Cooling Degree Days. The purely physical applications for which degree days have been used are related to energy consumption and freezing rates. In many parts of the United States a good correlation exists between the energy consumed in cooling homes and buildings and cumulative degree days. Cooling degree days (CDD) were developed for this application. They are defined as:

$$\text{CDD} = \Sigma\ (\bar{T} - T_b)$$

The calculation is the same as with GDD. The base temperature (T_b) usually assigned is 65°F because it is when air temperature averages just above 65°F that electrical energy begins to be consumed for air conditioning. Normal total values at regular intervals during the year are listed in Appendix Table 9 and total annual distribution is shown in Figure 38.

Heating Degree Days. Another use of degree days, one that has been used by utility and power companies, is heating degree days (HDD). The calculation is:

$$\text{HDD} = \Sigma\ (T_b - \bar{T})$$

Here T_b usually is assigned the value of 65°F. Only positive values are summed, and the HDD season begins July 1 rather than January 1. Totals at periodic intervals are listed in Appendix Table 11 and annual totals are illustrated in Figure 42.

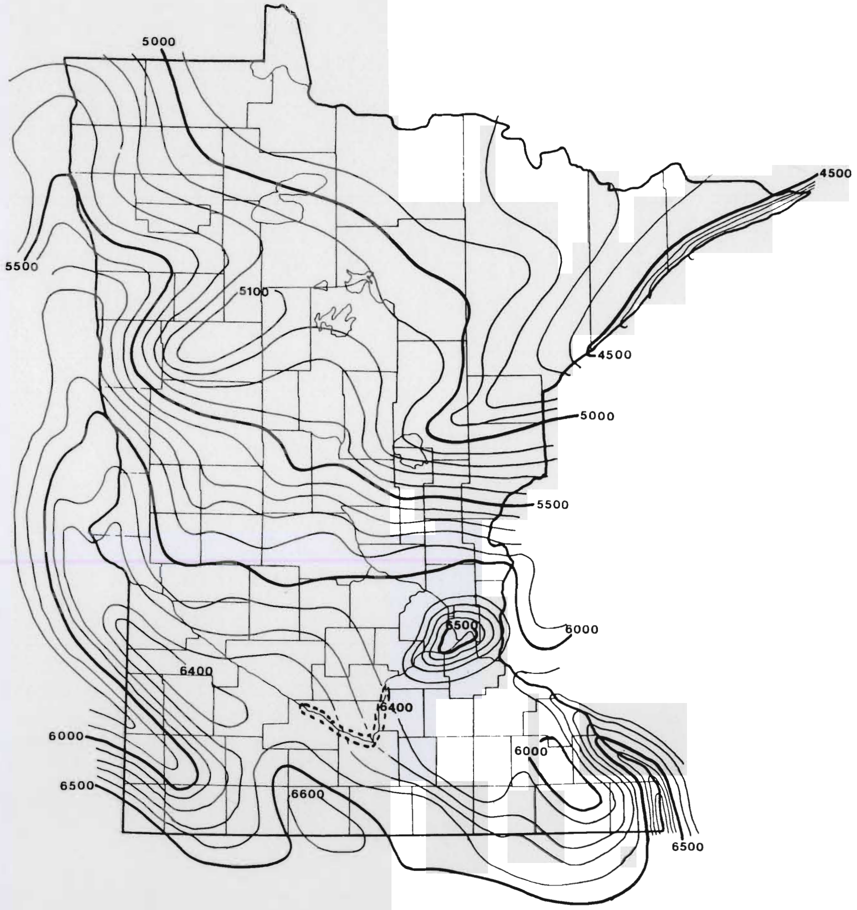

Figure 32.

Normal total annual melting (growing) degree days, T_b = 32°F, corrected to an 8 a.m. observation.

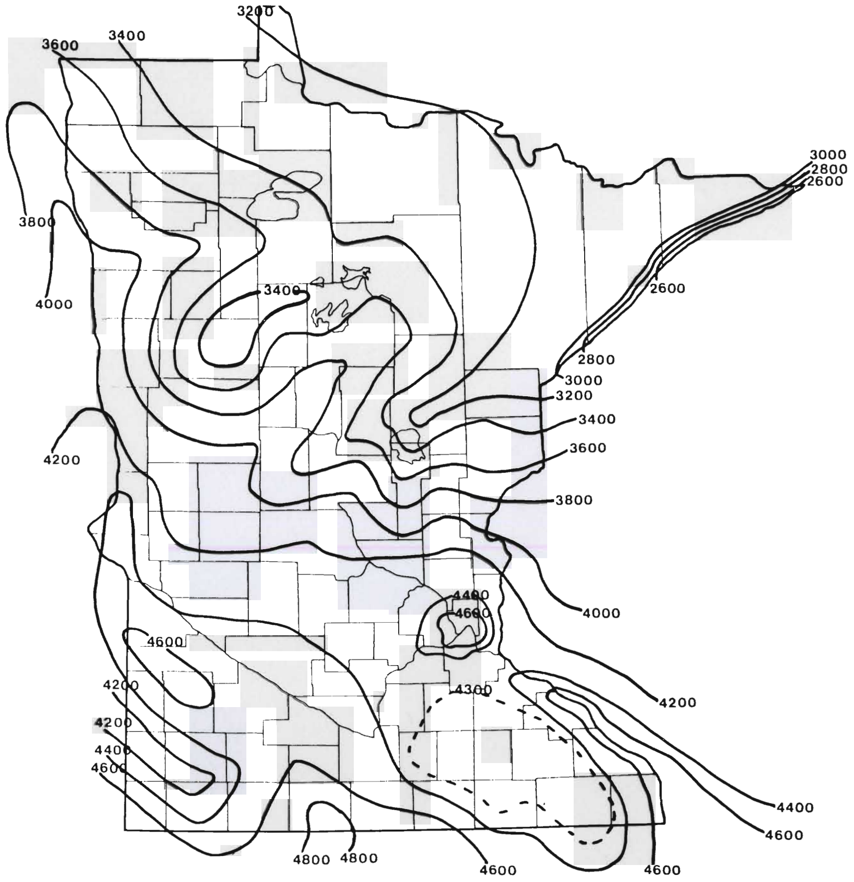

Figure 33.

Normal total annual growing degree days, T_b = 40°F, corrected to an 8 a.m. observation.

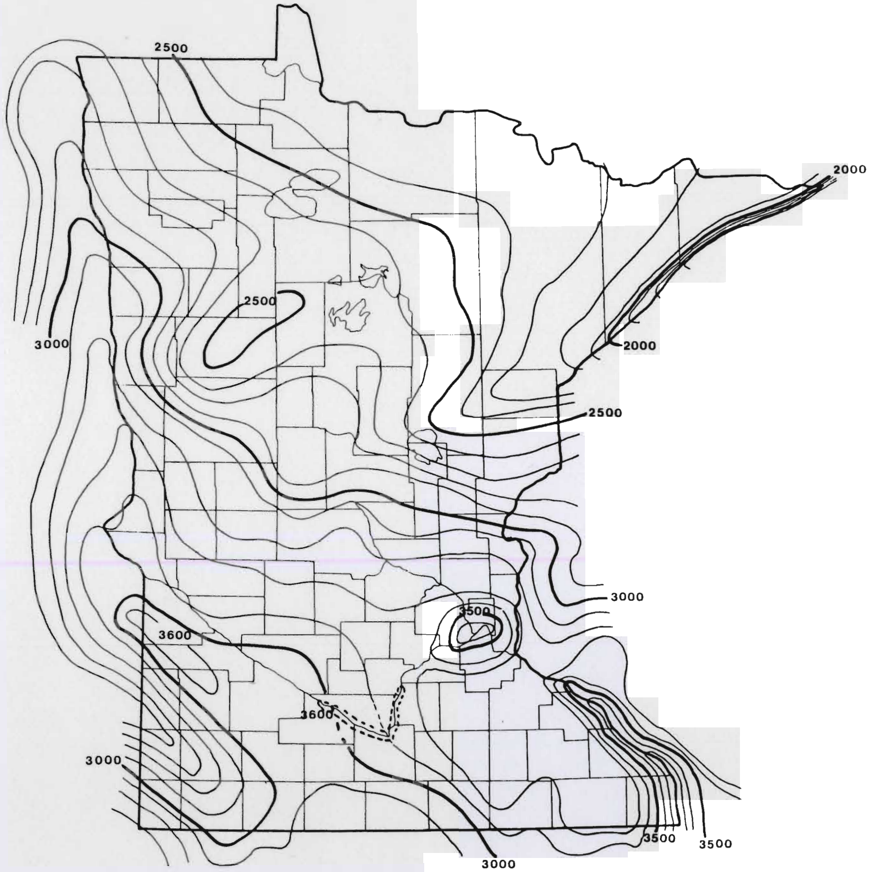

Figure 34.

Normal total annual growing degree days, T_b = 45°F, corrected to an 8 a.m. observation.

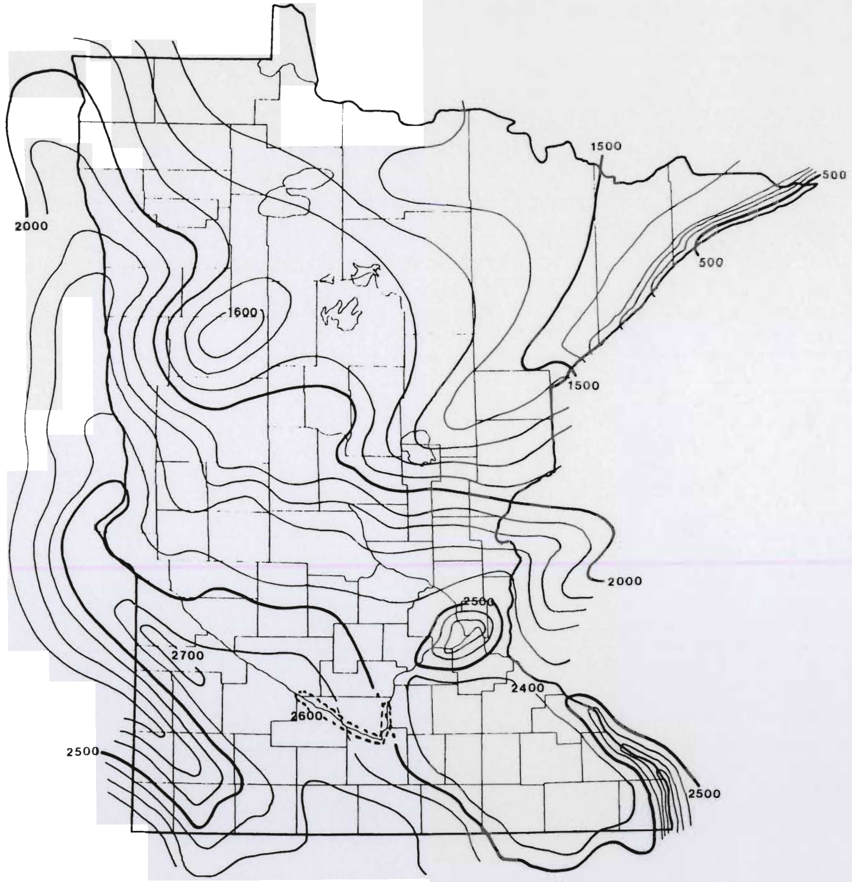

Figure 35.

Normal total annual growing degree days, T_b = 50°F, corrected to an 8 a.m. observation.

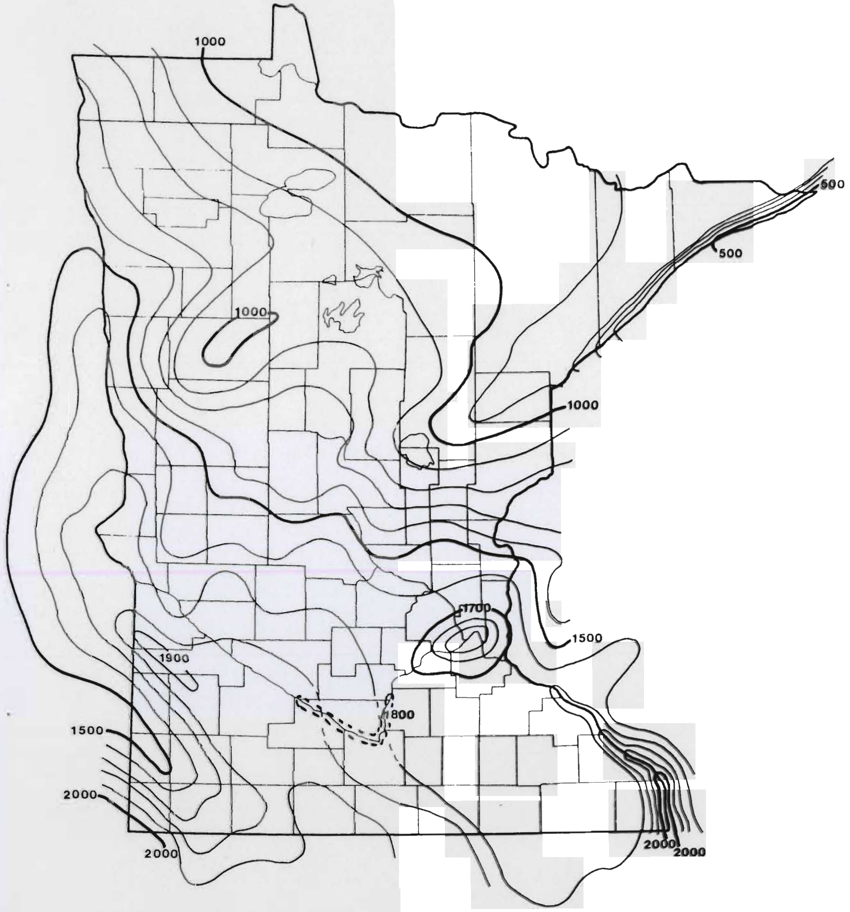

Figure 36.

Normal total annual growing degree days, $T_b = 55°F$, corrected to an 8 a.m. observation.

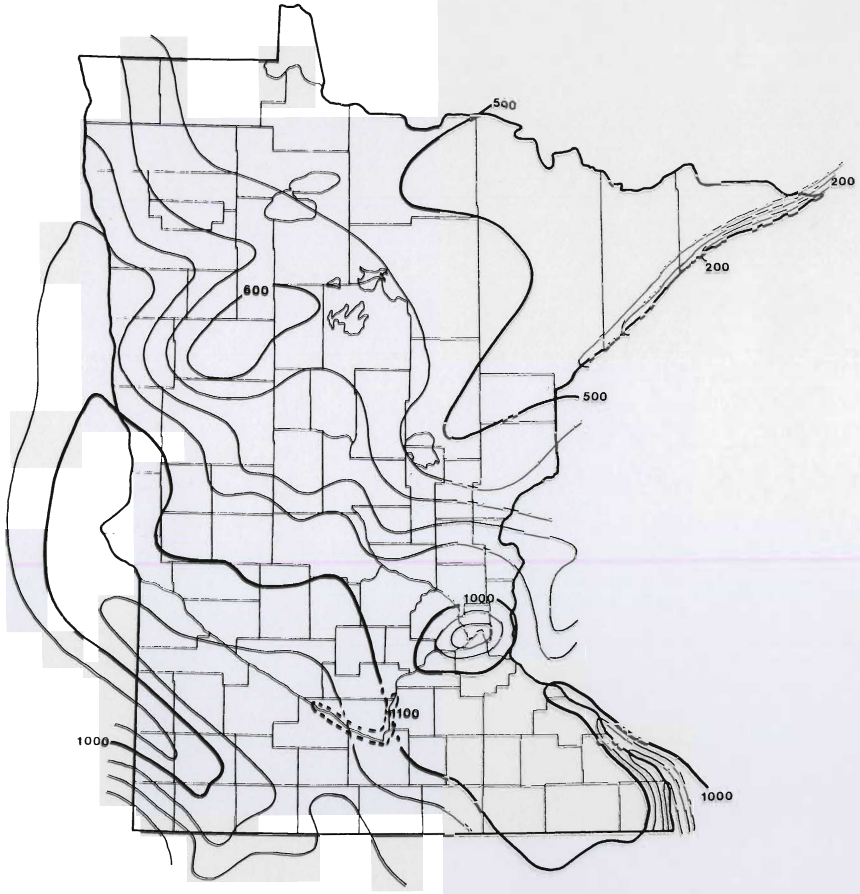

Figure 37.

Normal total annual growing degree days, $T_b = 60°F$, corrected to an 8 a.m. observation.

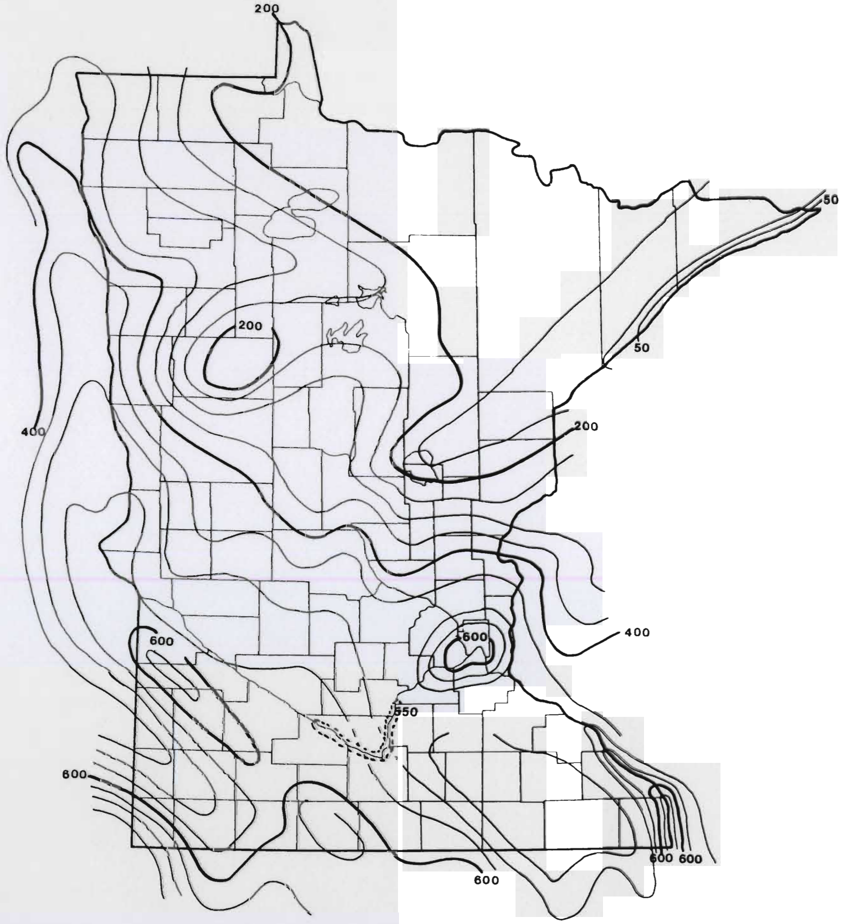

Figure 38.

Normal total annual cooling (growing) degree days, $T_b = 65°F$, corrected to an 8 a.m.

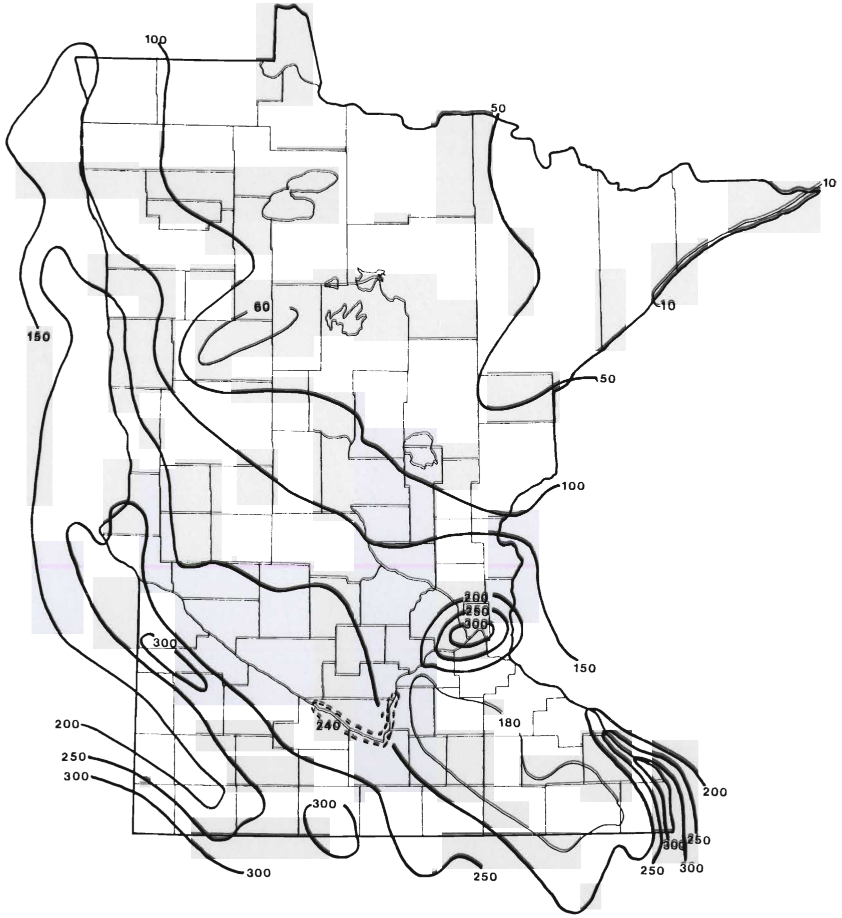

Figure 39.

Normal total annual growing degree days, $T_b = 70°F$, corrected to an 8 a.m. observation.

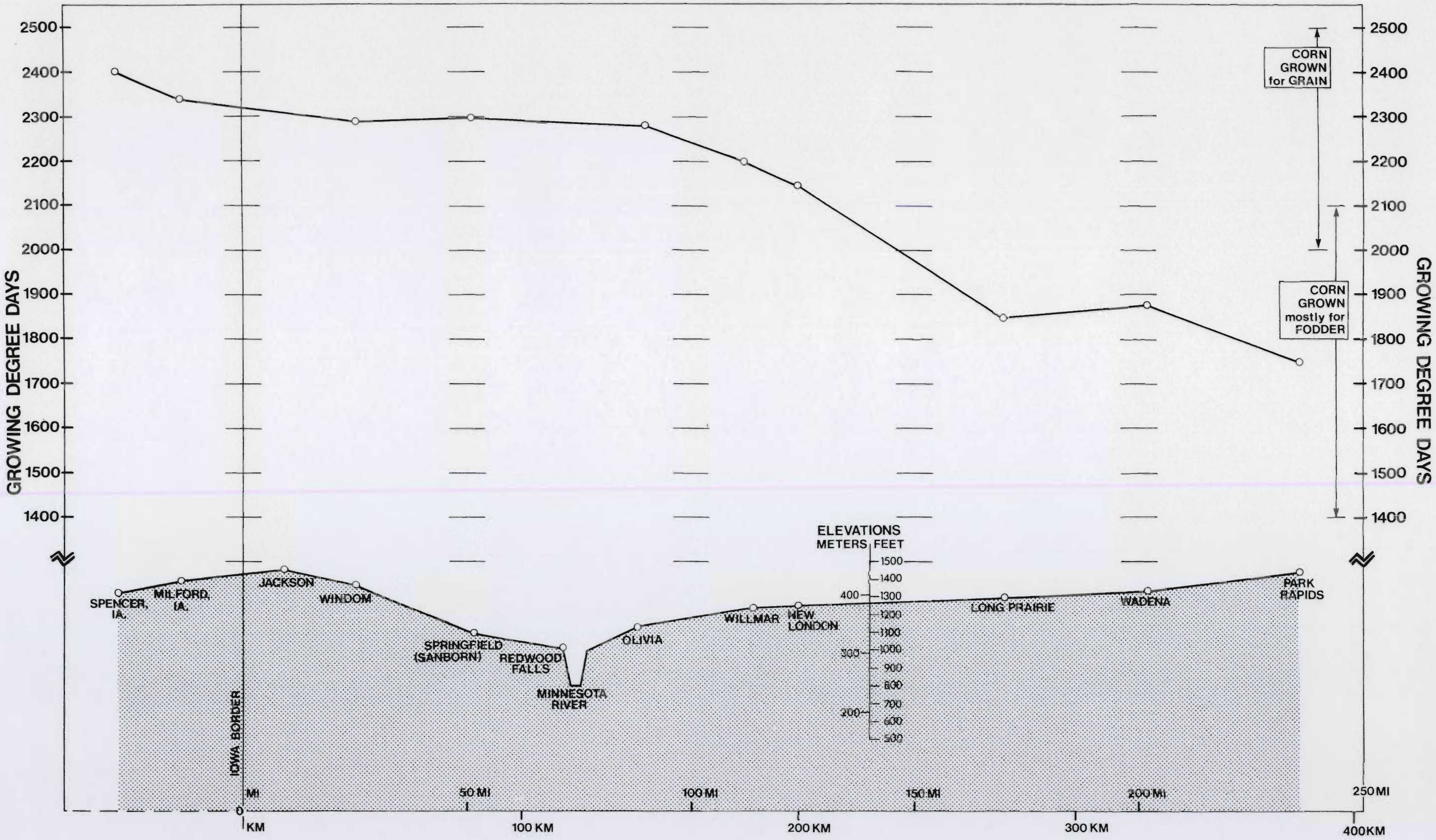

Figure 40.

A south to north profile of growing degree days, $T_b = 50°F$, across western Minnesota.

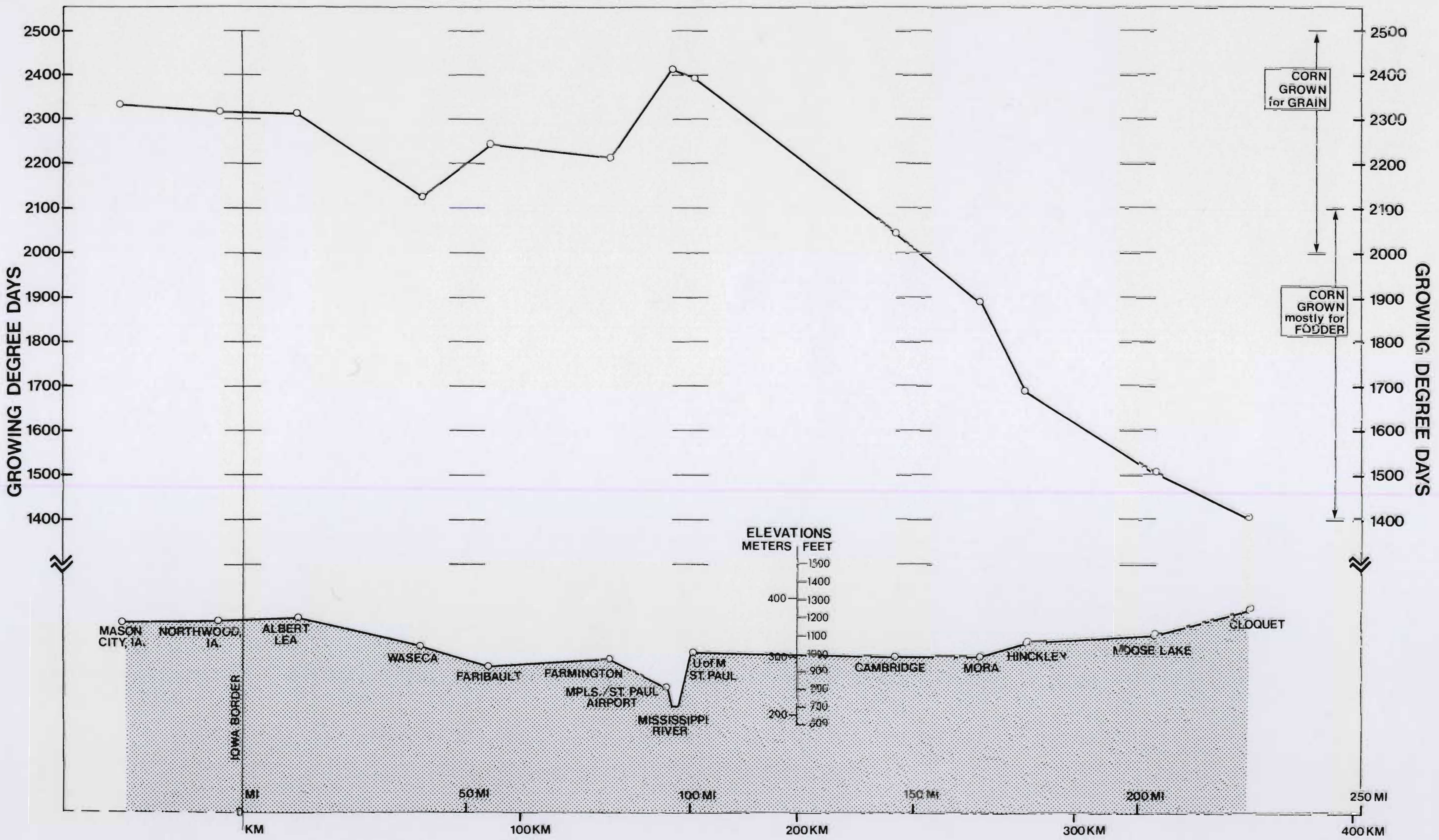

Figure 41.

A south to north profile of growing degree days, T_b = 50°F, across eastern Minnesota.

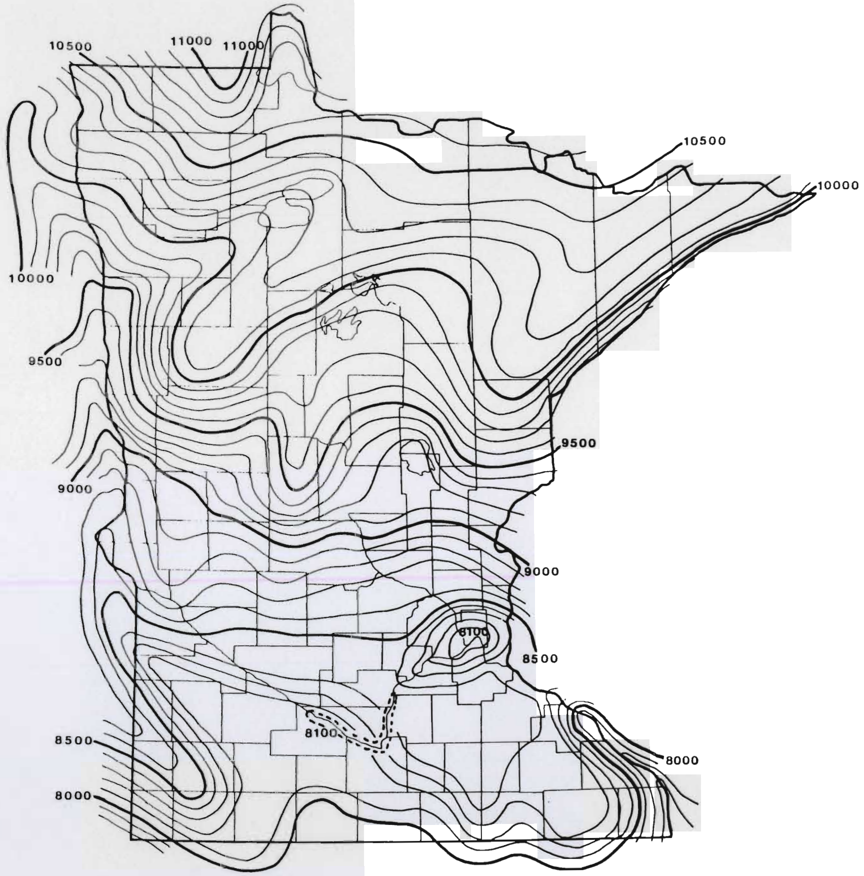

Figure 42.

Normal total annual heating degree days, T_b = 65°F, corrected to a midnight observation.

The American Gas Association found that residential gas consumption varies directly with the number of HDD calculated using 65°F as the base temperature (American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc., 1962). Use of this temperature was further substantiated in a National District Heating Association study that examined steam heated buildings served by district heating companies. Where interior temperatures are not so critical, such as in industrial plants, a lower base temperature, usually 5°F lower than the desired inside temperature, is suggested.

In windy localities the correlation between fuel consumed and HDD is reduced because heat is removed more rapidly in the presence of air movement. For this reason HDD are more effective in predicting fuel consumption in the eastern part of Minnesota than in the western part, which generally has greater winds.

Freezing Degree Days. A final application to the physical realm is the use of freezing degree days (FDD), which are defined as:

$$FDD = \Sigma (T_b - \bar{T}).$$

With T_b set at 32°F this measure obviously is the accumulation of temperatures below freezing (Appendix Table 12). Distribution of total annual values are shown in Figure 43. FDD have been used to predict the depth of soil freezing and lake ice (Lunardini, 1981). Because snow is such an effective insulator, FDD are effective predictors only when snow is shallow or where snow has been removed, as on highways, airport runways, and parking lots.

Freezing degree days also can be applied to the freezing rate of water bodies, a matter of some concern with respect to aquatic wildlife. The widgeon, shoveler, gadwall, and mallard ducks are particularly affected by an ice cover because they are dependent on shallow water bodies as an important food source. An early ice cover hastens their migration (Joselyn, 1985; Kitts, 1985).

The prediction of an ice cover of water bodies obviously is difficult due to the great variation that exists in terms of the exposure, areal extent, and depth of a lake. A meteorological factor adding further complexity is the wind speed associated with cold air outbreaks. An increase in water depth (greater heat reservoir) and an increase in wind speed (wave action) delay the occurrence of an ice cover. If, however, a limit is placed on the water depth, the effect of a major variable is reduced and a reasonable estimation of the first date of complete ice cover can be made.

A 15-year record from Lake Judy (also known as Mud Lake) (Kuehnast, 1985), a 16-acre lake no more than 4 feet deep located in Shoreview, Ramsey County, is the source of the basic data on which an estimation can be made. When compared to FDD over the same 15-year period, it was found that on the average a total of 15 FDD had accumulated by the time the complete ice cover was reached. Next the mean date when 15 FDD occurred at each of the stations used in this study was found and plotted on the map. Then isolines of the mean date of 15 FDD were drawn. The result is Figure 44. It is important to recognize that these dates do not necessarily represent the dates of continuous ice cover. Continuous cover often occurs sometime later. Figure 44 represents the estimated date at which small water bodies 4 feet or less in depth can be expected to have a complete ice cover. The map is based on a limited data set, but it is satisfactory as a first approximation for such an ill-defined event.

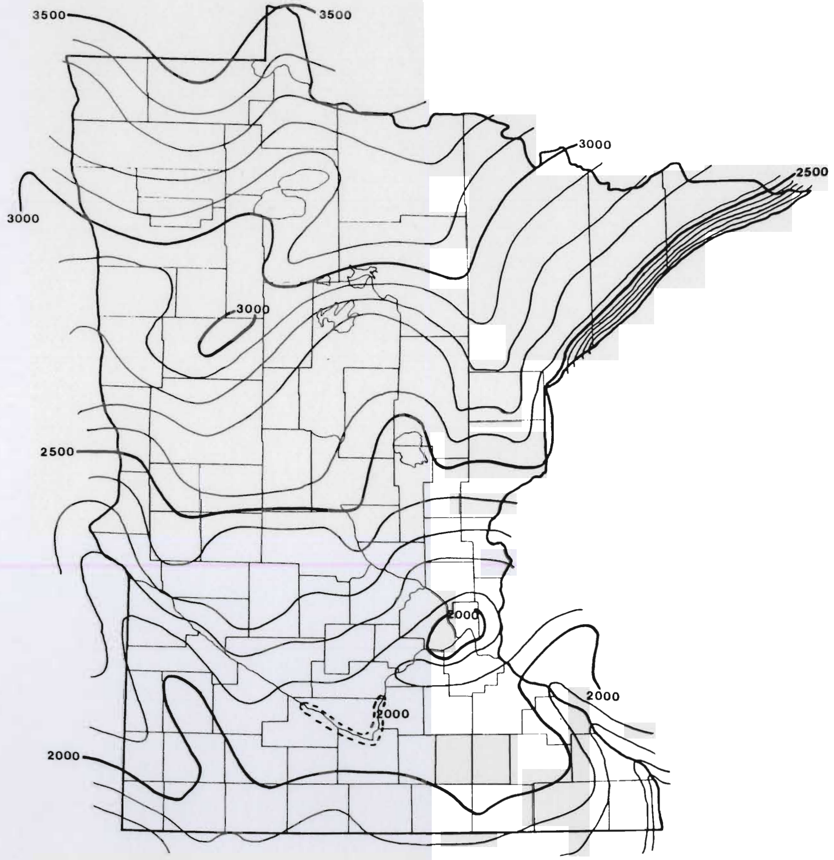

Figure 43.

Normal total annual freezing degree days, T_b = 32°F, corrected to an 8 a.m. observation.

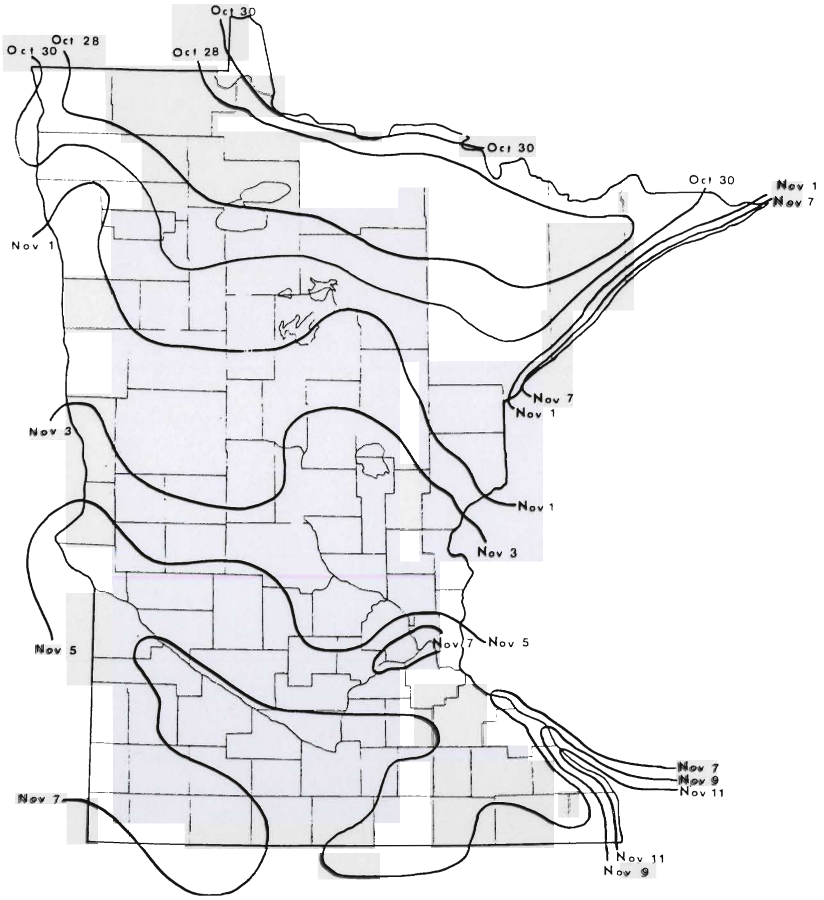

Figure 44.

Normal date for the occurrence of an ice cover on small bodies of water (no more than four feet deep).

Appendix Table 1. Normal monthly, annual, and seasonal temperatures, °F, adjusted to an 8 a.m. observation time, 1951-1980, Minnesota.

STATION NAME		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	SPR	SUM	FAL	WIN
ADA	MAX	12.1	19.8	33.4	51.9	68.0	76.3	82.6	81.1	70.3	58.1	37.3	21.7	51.1	51.1	80.0	55.2	17.9
	MIN	-8.6	-1.4	12.3	30.6	41.9	52.6	57.6	55.5	45.5	34.7	18.4	2.7	28.5	28.2	55.2	32.9	-2.4
	AVE	1.8	9.2	22.8	41.3	55.0	64.4	70.0	68.3	58.0	46.4	27.9	12.2	39.8	39.7	67.6	44.1	7.7
ALBERT LEA	MAX	19.7	26.0	36.1	53.9	68.5	78.2	82.6	80.3	71.5	60.2	42.1	27.1	53.9	52.8	80.4	57.9	24.3
	MIN	1.3	7.2	18.9	35.3	47.1	57.4	62.2	59.6	49.8	38.7	24.0	10.6	34.3	33.8	59.7	37.5	6.3
	AVE	10.5	16.6	27.5	44.7	57.8	67.8	72.5	70.0	60.8	49.5	33.0	19.0	44.1	43.3	70.1	47.8	15.4
ALEXANDRIA FAA AP	MAX	14.5	21.8	32.9	50.4	66.1	75.1	81.6	79.0	68.8	57.1	37.4	22.7	50.6	49.8	78.6	54.4	19.7
	MIN	-5.8	.8	13.3	32.2	44.8	54.9	60.3	58.2	48.0	36.6	20.7	5.4	30.8	30.1	57.8	35.1	.1
	AVE	4.4	11.2	23.1	41.2	55.4	65.1	70.9	68.7	58.5	46.9	29.0	14.1	40.7	39.9	68.2	44.8	9.9
ARGYLE 4 E	MAX	9.8	17.1	30.0	49.7	67.0	75.8	81.2	80.0	68.3	56.1	34.6	18.8	49.0	48.9	79.0	53.0	15.3
	MIN	-11.1	-5.2	9.7	29.4	40.7	50.9	54.9	52.8	43.5	33.3	17.0	.0	26.3	26.6	52.9	31.3	-5.4
	AVE	-.6	5.9	19.8	39.5	53.8	63.3	68.1	66.3	55.9	44.7	25.8	9.2	37.7	37.7	65.9	42.1	4.8
ARTICHOKE LAKE	MAX	16.5	23.0	34.5	52.5	67.7	77.1	83.5	81.2	71.6	59.7	40.1	25.0	52.7	51.6	80.6	57.1	21.5
	MIN	-4.4	2.2	14.7	32.7	45.1	55.4	60.2	57.8	47.6	36.5	20.5	6.4	31.2	30.8	57.8	34.9	1.4
	AVE	6.1	12.6	24.7	42.6	56.4	66.1	71.8	69.5	59.6	48.1	30.3	15.7	42.0	41.2	69.2	46.0	11.4
AUSTIN 3 S	MAX	19.3	25.3	36.6	54.2	68.1	77.5	81.9	79.6	71.7	60.4	42.2	27.1	53.6	53.0	79.7	58.1	23.9
	MIN	-1.0	5.3	17.5	33.7	44.9	54.8	59.1	56.5	47.1	34.6	22.4	9.7	32.0	32.0	56.8	34.7	4.7
	AVE	9.1	15.3	27.1	44.1	56.5	66.1	70.5	68.0	59.5	48.5	32.3	18.4	42.9	42.6	68.2	46.8	14.3
BABBITT 2 SE	MAX	12.4	19.4	31.6	46.6	62.1	70.8	75.7	72.7	61.9	51.5	33.2	19.5	46.4	46.7	73.1	48.9	17.1
	MIN	-6.7	-1.2	11.1	28.2	40.1	50.2	55.5	53.3	44.3	34.4	18.4	2.8	27.5	26.5	53.0	32.4	-1.7
	AVE	2.9	9.1	21.4	37.4	51.0	60.5	65.6	63.0	53.1	43.0	25.8	11.2	37.0	36.6	63.0	40.6	7.7
BAUDETTE	MAX	10.4	18.0	31.3	47.8	62.9	72.3	77.6	74.9	64.3	52.9	34.0	19.0	47.1	47.3	74.9	50.4	15.8
	MIN	-13.7	-8.5	5.5	26.5	39.1	49.5	54.8	52.1	42.5	33.2	16.7	-1.9	24.7	23.7	52.1	30.8	-8.0
	AVE	-1.6	4.8	18.4	37.2	51.1	60.9	66.2	63.5	53.5	43.1	25.3	8.6	35.9	35.6	63.5	40.6	3.9
BEMIDJI AP	MAX	12.3	20.7	32.1	48.7	64.5	73.6	79.6	76.7	65.8	54.7	34.8	20.1	48.6	48.4	76.7	51.8	17.7
	MIN	-11.1	-5.1	8.0	28.1	40.1	50.9	56.2	53.6	44.0	33.6	17.1	-.1	26.3	25.4	53.5	31.6	-5.4
	AVE	.7	7.8	20.1	38.4	52.3	62.3	67.9	65.2	55.0	44.1	26.0	10.0	37.5	36.9	65.1	41.7	6.2
BENSON	AVE	6.4	13.3	25.7	43.3	56.9	66.7	72.0	69.7	59.5	48.0	30.6	16.2	42.4	42.0	69.5	46.0	11.9
BIG FALLS	MAX	12.7	21.2	34.4	50.0	64.7	73.8	78.9	76.0	65.2	54.2	34.8	20.4	48.9	49.7	76.3	51.4	18.1
	MIN	-12.5	-6.4	7.3	26.4	37.7	47.9	52.9	50.5	41.1	32.0	15.9	-1.1	24.3	23.8	50.4	29.7	-6.6
	AVE	.1	7.4	20.9	38.1	51.2	60.8	65.9	63.3	53.2	43.1	25.4	9.7	36.6	36.7	63.4	40.6	5.8
BROWNS VALLEY	AVE	7.0	13.7	25.6	43.3	56.1	65.8	71.8	69.9	59.7	48.4	30.7	16.0	42.3	41.7	69.2	46.3	12.2
CAMBRIDGE ST HOSP	MAX	17.0	24.2	35.6	53.0	67.6	76.1	81.7	78.9	68.9	58.0	39.2	24.9	52.1	52.0	78.9	55.4	22.1
	MIN	-3.6	2.6	15.4	33.1	44.8	54.6	59.4	56.8	47.5	36.9	21.5	7.1	31.3	31.1	56.9	35.3	2.0
	AVE	6.7	13.4	25.5	43.0	56.2	65.4	70.6	67.9	58.3	47.4	30.4	16.0	41.7	41.6	67.9	45.4	12.0
CAMPBELL	MAX	15.2	21.7	34.0	52.6	68.0	77.2	83.2	81.8	70.9	58.9	38.5	23.0	52.1	51.6	80.8	56.1	19.9
	MIN	-5.9	.7	15.0	32.1	42.8	53.2	57.1	55.4	45.4	34.5	19.3	3.9	29.5	30.0	55.2	33.1	-.4
	AVE	4.6	11.2	24.5	42.3	55.4	65.3	70.2	68.6	58.2	46.6	28.9	13.5	40.8	40.8	68.1	44.5	9.8
CANBY	MAX	19.8	25.9	37.1	54.7	69.3	79.7	85.7	83.4	73.7	61.9	42.3	27.7	55.1	53.7	82.9	59.3	24.5
	MIN	-.9	5.6	17.1	33.1	45.1	55.7	60.8	58.8	48.4	37.4	21.8	8.6	32.6	31.7	58.4	35.9	4.5
	AVE	9.4	15.8	27.1	43.9	57.3	67.7	73.3	71.2	61.0	49.6	32.1	18.2	43.9	42.8	70.7	47.6	14.5
CASS LAKE	AVE	1.3	7.8	21.0	39.0	52.1	62.4	67.3	65.0	54.8	44.0	26.5	9.7	37.6	37.4	64.9	41.8	6.3
CHASKA	AVE	8.5	15.1	27.5	44.7	57.8	67.4	72.3	69.7	60.1	49.1	32.5	18.1	43.6	43.3	69.8	47.2	13.9
CLOQUET FOR RES CEN	MAX	14.7	21.3	32.7	48.2	63.2	72.4	78.3	74.9	64.5	53.4	35.6	22.0	48.4	48.0	75.2	51.2	19.3
	MIN	-6.2	-1.1	11.1	27.3	37.1	46.8	53.4	51.8	43.5	33.7	19.1	4.2	26.7	25.2	50.6	32.1	-1.0
	AVE	4.3	10.0	21.9	37.8	50.1	59.6	65.9	63.3	53.9	43.6	27.4	13.1	37.6	36.6	62.9	41.6	9.1
COLLEGEVILLE ST JOHN	MAX	15.8	22.6	34.3	51.7	67.2	75.9	81.4	78.9	69.0	57.8	39.0	24.3	51.5	51.1	78.7	55.3	20.9
	MIN	-3.4	3.1	15.3	33.2	45.4	55.3	60.5	58.4	48.8	38.0	22.4	7.5	32.0	31.3	58.1	36.4	2.4
	AVE	6.2	12.9	24.8	42.5	56.2	65.6	70.9	68.7	58.9	47.9	30.7	16.0	41.8	41.2	68.4	45.8	11.7
CROOKSTON NW EXP STA	MAX	10.3	17.5	30.7	49.5	66.3	75.1	81.0	79.5	68.4	56.1	35.3	19.9	49.1	48.8	78.6	53.3	15.9
	MIN	-9.9	-3.4	10.7	30.2	41.3	52.2	57.1	55.2	45.2	34.5	17.4	1.4	27.7	27.4	54.8	32.4	-4.0
	AVE	.2	7.0	20.7	39.9	53.9	63.7	69.0	67.4	56.8	45.3	26.4	10.7	38.4	38.2	66.7	42.8	6.0
DETROIT LAKES 1 NNE	MAX	12.3	19.4	31.9	49.7	64.6	73.1	78.7	76.8	66.4	55.3	35.8	21.0	48.8	48.7	76.2	52.5	17.6
	MIN	-10.3	-4.6	9.3	28.6	40.0	50.5	55.1	53.2	42.9	32.8	16.9	1.2	26.3	26.0	52.9	30.8	-4.6
	AVE	1.0	7.5	20.6	39.2	52.4	61.8	66.9	65.0	54.6	44.1	26.4	11.2	37.5	37.4	64.6	41.7	6.5
DULUTH WSO	MAX	14.7	21.0	31.0	46.2	61.0	69.9	76.6	73.6	64.0	53.3	35.4	21.8	47.4	46.0	73.4	50.9	19.2
	MIN	-4.4	1.0	12.6	29.4	39.7	48.7	54.9	53.3	45.2	35.7	20.9	5.6	28.5	27.2	52.3	33.9	.7
	AVE	5.2	11.0	21.8	37.8	50.3	59.4	65.7	63.5	54.7	44.5	28.1	13.7	38.0	36.6	62.8	42.4	10.0
FAIRMONT	MAX	20.4	27.1	37.2	54.7	70.0	79.3	83.8	81.4	72.7	61.2	42.4	27.7	54.8	53.9	81.5	58.8	25.1
	MIN	1.3	7.8	19.1	36.5	48.5	58.5	62.6	60.2	51.2	40.0	24.7	10.9	35.1	34.7	60.4	38.6	6.7
	AVE	10.9	17.4	28.2	45.6	59.2	69.0	73.3	70.9	62.0	50.6	33.5	19.3	45.0	44.3	71.0	48.7	15.9
FARIBAULT	MAX	19.6	25.9	36.9	54.6	68.8	78.2	83.2	80.2	71.6	60.6	42.0	27.3	54.1	53.4	80.5	58.1	24.3
	MIN	-.9	5.1	17.4	34.3	45.9	56.0	60.6	58.3	49.0	38.2	23.4	9.9	33.1	32.5	58.3	36.8	4.7
	AVE	9.4	15.5	27.2	44.5	57.4	67.1	72.0	69.3	60.4	49.5	32.7	18.7	43.6	43.0	69.5	47.5	14.5
FARMINGTON 3 NW	MAX	18.0	24.4	36.1	54.3	68.8	77.5	82.4	80.0	70.8	59.7	41.1	26.2	53.3	53.1	79.9	57.2	22.8
	MIN	-1.4	4.9	17.4	34.6	46.5	56.2	60.6	58.1	48.7	38.0	23.3	9.2	33.0	32.8	58.3	36.7	4.2
	AVE	8.3	14.7	26.8	44.5	57.6	66.9	71.5	69.1	59.8	48.9	32.2	17.7	43.2	43.0	69.2	47.0	13.5
FERGUS FALLS	MAX	13.6	21.0	33.6	51.8	67.1	76.2	82.3	80.2	69.7	57.6	37.5	22.5	51.1	50.8	79.5	54.9	19.0
	MIN	-6.2	.6	13.7	31.6	43.7	53.7	58.9	57.0	46.4	35.4	19.8	4.8	30.0	29.7	56.5	33.9	-.2
	AVE	3.8	10.9	23.7	41.7	55.5	65.0	70.6	68.6	58.1	46.5	28.7	13.6	40.5	40.3	68.1	44.4	9.4
FOSSTON	MAX	11.9	19.2	32.1	49.8	65.2	74.1	79.9	78.1	67.2	55.9	35.6	21.0	49.2	49.1	77.4	52.9	17.4
	MIN	-9.2	-2.8	10.6	29.8	41.7	51.9	56.7	54.6	44.6	34.5	17.8	2.0	27.7	27.4	54.4	32.3	-3.3
	AVE	1.3	8.2	21.4	39.8	53.4	63.0	68.3	66.3	55.9	45.2	26.7	11.5	38.4	38.2	65.9	42.6	7.0
GLENWOOD	AVE	6.0	12.6	24.8	42.3	55.8	65.3	70.8	68.6	58.5	47.4	30.3	15.2	41.5	40.9	68.2	45.4	11.3
GRAND MARAIS	MAX	18.9	22.6	31.8	43.8	54.5	62.3	69.7	68.7	60.4	50.9	37.3	25.9	45.6	43.4	66.9	49.6	22.5
	MIN	-.2	3.8	15.3	29.7	37.7	44.7	52.0	53.4	46.1	36.7	23.3	9.7	29.4	27.6	50.0	35.4	4.4
	AVE	9.4	13.2	23.6	36.8	46.1	53.5	60.9	61.0	53.3	43.9	30.3	17.8	37.5	35.5	58.5	42.5	13.5

Appendix Table 1. Normal monthly, annual, and seasonal temperatures, °F, adjusted to an 8 a.m. observation time, 1951-1980, Minnesota.

STATION NAME		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	SPR	SUM	FAL	WIN
GRAND MEADOW	MAX	20.0	26.0	36.0	53.6	67.5	76.7	81.0	78.8	70.2	59.3	41.5	26.6	53.1	52.4	78.9	57.0	24.2
	MIN	1.1	6.8	19.2	35.0	46.2	56.0	59.9	57.4	48.9	38.6	24.2	10.3	33.6	33.5	57.8	37.2	6.1
	AVE	10.6	16.4	27.6	44.4	56.9	66.3	70.5	68.2	59.6	49.0	32.9	18.5	43.4	43.0	68.3	47.2	15.2
GRAND RAPIDS NC SCHL	MAX	14.1	21.8	33.9	49.5	64.1	73.3	78.2	75.3	64.9	54.1	35.5	21.5	48.8	49.2	75.6	51.5	19.1
	MIN	-8.4	-2.5	10.3	28.1	39.4	49.1	54.4	51.9	43.0	33.7	18.6	2.5	26.7	25.9	51.8	31.8	-2.8
	AVE	2.9	9.7	22.1	38.8	51.8	61.2	66.3	63.7	54.0	43.9	27.1	12.0	37.8	37.6	63.7	41.6	8.2
GULL LAKE DAM	MAX	15.1	22.3	34.1	50.3	65.3	74.5	79.7	76.9	67.0	56.4	37.7	22.8	50.2	49.9	77.0	53.7	20.0
	MIN	-6.1	-.2	12.2	29.5	42.0	52.8	58.4	56.0	46.3	35.7	20.0	4.9	29.3	27.9	55.7	34.0	-.5
	AVE	4.4	11.0	23.1	39.9	53.6	63.6	69.1	66.5	56.6	46.0	28.9	13.9	39.7	38.9	66.4	43.8	9.8
HALLOCK	MAX	9.0	16.4	29.5	49.4	66.2	75.4	81.1	79.4	67.6	55.3	34.2	17.8	48.4	48.3	78.6	52.4	14.4
	MIN	-11.3	-5.1	9.0	29.1	41.0	51.7	55.9	53.5	43.4	32.7	16.5	-.6	26.3	26.3	53.7	30.9	-5.7
	AVE	-1.1	5.6	19.2	39.2	53.6	63.5	68.6	66.1	55.5	43.8	25.4	8.5	37.3	37.3	66.1	41.6	4.3
HINCKLEY	MAX	16.6	23.6	35.7	52.6	66.2	74.9	80.5	78.2	67.8	57.1	39.0	24.1	51.4	51.5	77.8	54.6	21.4
	MIN	-5.5	.2	13.6	30.3	40.8	50.2	55.1	52.9	43.5	33.7	20.2	5.1	28.3	28.2	52.7	32.5	-.1
	AVE	5.6	11.9	24.7	41.4	53.6	62.5	67.8	65.5	55.6	45.5	29.5	14.8	39.9	39.9	65.3	43.6	10.8
INTERNATIONAL FALLS	MAX	10.3	18.8	31.1	47.7	63.6	72.7	78.7	75.4	64.5	53.1	33.1	17.8	47.2	47.4	75.6	50.2	15.7
	MIN	-12.5	-6.1	7.6	27.6	39.0	49.5	54.3	51.4	42.5	33.1	16.6	-1.6	25.1	24.7	51.7	30.7	-6.7
	AVE	-1.0	6.4	19.4	37.7	51.3	61.2	66.5	63.5	53.5	43.1	24.8	8.1	36.2	36.1	63.7	40.5	4.5
ITASCA ST PARK SCHL	MAX	13.7	22.0	34.1	49.8	65.1	73.9	79.7	77.1	66.5	55.4	35.7	21.5	49.5	49.7	76.9	52.5	19.0
	MIN	-11.0	-5.0	8.0	26.3	38.1	48.9	54.0	51.9	42.4	32.5	16.6	.3	25.3	24.1	51.6	30.5	-5.2
	AVE	1.4	8.5	21.1	38.1	51.6	61.5	66.9	64.5	54.4	44.0	26.2	10.9	37.4	36.9	64.3	41.5	7.0
JORDAN 1 S	MAX	18.3	24.1	35.7	54.0	68.5	77.0	82.2	79.2	70.2	59.2	40.8	26.2	52.9	52.7	79.4	56.7	22.9
	MIN	-1.6	4.5	17.0	34.2	45.5	55.0	59.4	57.1	47.6	37.5	22.6	9.1	32.3	32.2	57.2	35.9	4.0
	AVE	8.3	14.4	26.3	44.1	56.9	66.1	70.8	68.1	59.0	48.4	31.7	17.6	42.6	42.4	68.3	46.4	13.4
LEECH LAKE DAM	MAX	14.3	22.0	34.1	49.5	64.2	73.4	78.8	76.1	65.9	55.3	36.4	22.0	49.3	49.3	76.1	52.5	19.4
	MIN	-8.3	-2.5	10.3	28.2	40.2	50.9	56.5	53.7	44.5	34.3	19.0	2.6	27.4	26.2	53.7	32.6	-2.7
	AVE	3.0	9.7	22.2	38.9	52.1	62.2	67.6	64.9	55.2	44.8	27.7	13.6	38.5	37.8	64.9	42.6	8.8
LITCHFIELD	MAX	17.3	23.7	35.3	53.1	68.1	77.5	82.6	79.9	70.7	59.3	40.1	25.6	52.8	52.1	80.0	56.7	22.2
	MIN	-2.8	3.4	15.8	33.3	45.4	55.7	60.7	58.5	48.2	37.4	21.7	7.8	32.1	31.5	58.3	35.8	2.8
	AVE	7.3	13.5	25.6	43.2	56.7	66.6	71.7	69.2	59.4	48.4	31.0	16.8	42.4	41.8	69.2	46.3	12.5
LITTLE FALLS 1 N	MAX	15.9	23.0	35.0	52.3	67.0	75.9	81.6	78.7	68.9	57.8	38.8	24.0	51.6	51.4	78.7	55.1	21.0
	MIN	-6.7	-.9	12.3	30.5	42.5	53.0	58.1	55.5	45.7	35.0	19.7	4.3	29.1	28.4	55.5	33.5	-1.1
	AVE	4.6	11.1	23.6	41.4	54.7	64.4	69.8	67.1	57.4	46.4	29.3	14.2	40.3	39.9	67.1	44.4	10.0
LONG PRAIRIE	MAX	14.4	21.3	33.2	50.7	65.3	74.7	80.7	77.8	67.9	56.7	37.7	22.9	50.3	49.7	77.7	54.1	19.6
	MIN	-7.1	-1.3	12.1	30.8	42.5	52.8	57.7	55.2	45.2	34.7	19.2	4.3	28.8	28.4	55.2	33.1	-1.4
	AVE	3.7	10.0	22.6	40.7	53.9	63.7	69.2	66.5	56.6	45.7	28.5	13.6	39.6	39.1	66.5	43.6	9.1
MADISON SEWAGE PLANT	MAX	18.8	25.1	36.7	54.4	68.9	78.5	84.4	82.0	72.6	61.3	42.5	27.4	54.4	53.3	81.6	58.8	23.8
	MIN	-2.5	4.1	16.2	32.9	44.9	55.2	60.2	57.7	46.7	36.0	20.6	7.5	31.6	31.3	57.7	34.5	3.1
	AVE	8.2	14.6	26.5	43.6	56.9	66.9	72.3	69.8	59.7	48.7	31.6	18.6	43.1	42.3	69.7	46.7	12.8
MAPLE PLAIN	MAX	18.6	25.0	36.7	54.4	68.4	77.1	82.4	79.7	70.3	59.5	41.1	26.4	53.3	53.2	79.8	57.0	23.3
	MIN	-2.2	3.8	16.3	33.2	45.2	55.1	59.7	57.4	47.9	37.2	22.4	8.1	32.0	31.6	57.4	35.8	3.2
	AVE	8.2	14.4	26.4	43.9	56.8	66.1	71.1	68.6	59.1	48.4	31.8	17.3	42.7	42.4	68.6	46.4	13.3
MARSHALL	MAX	20.1	26.2	37.0	54.9	69.4	78.8	84.1	82.0	72.3	61.0	42.1	27.4	54.6	53.7	81.7	58.5	24.5
	MIN	.4	6.5	18.3	34.3	46.2	57.0	61.5	59.1	49.0	37.8	22.8	9.4	33.5	32.9	59.2	36.5	5.4
	AVE	10.3	16.4	27.6	44.7	57.9	67.9	72.8	70.6	60.7	49.4	32.5	18.7	44.1	43.4	70.4	47.5	15.1
MEADOWLANDS	MAX	15.0	22.0	34.0	49.3	64.1	73.0	78.6	75.5	65.3	54.5	36.1	22.3	49.1	49.1	75.7	51.9	19.8
	MIN	-9.4	-3.7	9.0	27.0	37.5	47.3	52.9	50.8	41.9	32.3	17.6	1.4	25.4	24.5	50.3	30.6	-3.9
	AVE	2.8	9.3	20.8	38.1	50.9	60.2	65.7	63.1	53.6	43.4	26.9	11.9	37.2	36.6	63.0	41.3	8.0
MILACA	MAX	16.4	23.4	35.1	52.5	67.0	75.7	81.5	79.0	69.0	57.7	39.1	24.4	51.7	51.5	78.7	55.3	21.4
	MIN	-4.5	1.6	14.1	30.9	42.4	52.2	57.5	54.9	45.4	34.7	20.4	6.3	29.6	29.1	54.9	33.5	1.1
	AVE	5.9	12.4	24.5	41.8	54.7	63.9	69.5	67.0	57.2	46.2	29.8	15.3	40.7	40.3	66.8	44.4	11.2
MILAN	MAX	17.2	23.9	35.9	53.5	68.6	77.8	83.5	81.1	71.4	59.6	40.4	25.6	53.2	52.7	80.8	57.2	22.2
	MIN	-4.3	2.3	15.1	32.5	44.3	54.9	59.5	57.4	46.8	35.5	20.1	6.4	30.9	30.6	57.3	34.1	1.5
	AVE	6.5	13.1	25.6	43.0	56.4	66.4	71.5	69.3	59.2	47.6	30.3	16.0	42.1	41.7	69.1	45.7	11.8
MINNEAPOLIS-ST PAUL	MAX	19.1	25.7	36.6	54.6	69.1	77.9	83.6	80.9	71.4	60.0	41.3	26.7	53.9	53.4	80.8	57.6	23.9
	MIN	.9	7.3	19.5	36.5	48.0	58.2	63.3	60.8	51.1	39.7	25.0	11.5	35.1	34.6	60.7	38.6	6.6
	AVE	10.1	16.5	28.1	45.5	58.5	68.1	73.5	70.9	61.3	49.9	33.1	19.1	44.5	44.0	70.8	48.1	15.2
MONTEVIDEO 1 SW	MAX	18.0	24.7	36.2	54.3	69.0	78.2	83.5	81.3	72.1	61.1	41.4	26.3	53.9	53.2	81.0	58.2	23.0
	MIN	-2.5	4.0	17.1	33.9	45.7	55.7	60.1	57.7	47.3	37.0	21.6	8.0	32.1	32.2	57.8	35.3	3.1
	AVE	7.7	14.4	26.7	44.2	57.4	66.9	71.8	69.6	59.8	49.1	31.5	17.2	43.0	42.8	69.4	46.8	13.1
MOOSE LAKE 1 SSE	MAX	16.1	22.8	34.5	50.2	64.6	73.6	79.7	76.6	66.8	56.1	37.8	23.4	50.2	49.7	76.6	53.6	20.7
	MIN	-8.0	-2.8	10.4	27.1	37.2	46.9	53.6	51.7	43.3	32.9	18.6	3.1	26.2	24.9	50.7	31.6	-2.6
	AVE	4.1	10.0	22.5	38.7	50.9	60.3	66.6	64.2	55.0	44.5	28.2	13.2	38.2	37.4	63.7	42.6	9.1
MORA	MAX	16.8	23.8	35.5	52.7	67.0	75.8	81.5	78.9	68.8	57.7	39.0	24.6	51.8	51.7	78.7	55.2	21.7
	MIN	-5.6	.3	13.4	30.9	42.3	52.0	57.5	55.0	45.6	34.9	20.2	5.6	29.3	28.9	54.8	33.6	.1
	AVE	5.7	12.1	24.5	41.8	54.6	63.8	69.6	66.9	57.2	46.3	29.6	15.1	40.6	40.3	66.8	44.4	11.0
MORRIS W C SCHOOL	MAX	15.5	21.9	33.6	52.5	67.6	76.7	82.1	80.4	70.2	58.4	38.9	23.4	51.8	51.2	79.7	55.9	20.3
	MIN	-4.0	2.2	15.5	32.8	44.7	55.0	59.3	57.1	46.6	35.4	20.6	6.4	31.0	31.0	57.1	34.2	1.5
	AVE	5.7	12.1	24.6	42.7	56.1	65.9	70.7	68.8	58.5	47.0	29.8	14.6	41.4	41.1	68.5	45.1	10.8
NEW LONDON	AVE	6.5	12.8	24.9	42.5	56.3	66.1	71.5	68.9	59.0	48.0	30.6	15.9	41.9	41.2	68.8	45.9	11.8
NEW ULM	MAX	20.2	26.3	37.5	55.7	69.9	79.5	84.1	81.5	72.9	61.9	42.8	27.9	55.0	54.4	81.7	59.2	24.8
	MIN	-.5	5.8	18.3	35.0	46.4	56.5	61.3	58.8	48.9	38.1	23.3	10.1	33.5	33.3	58.9	36.8	5.2
	AVE	9.9	16.0	28.0	45.4	58.1	68.0	72.7	70.1	61.0	50.0	33.1	19.1	44.3	43.8	70.3	48.0	15.0
OLIVIA	AVE	8.0	14.4	26.4	44.0	57.6	67.5	72.2	69.6	60.3	49.2	31.7	17.3	43.2	42.6	69.8	47.0	13.2
PARK RAPIDS	MAX	13.8	21.9	33.8	50.4	65.3	74.5	80.2	78.0	67.3	56.2	36.3	21.8	50.0	49.9	77.6	53.3	19.2
	MIN	-9.8	-3.3	10.1	28.6	40.7	51.1	56.1	54.0	43.8	33.3	17.4	1.4	27.0	26.5	53.7	31.5	-3.9
	AVE	2.0	9.4	22.0	39.5	53.1	62.8	68.1	66.1	55.6	44.8	26.9	11.6	38.5	38.2	65.7	42.4	7.6
PINE RIVER DAM	MAX	15.4	23.0	35.1	50.9	65.7	74.5	80.0	77.0	67.1	56.4	37.7	23.2	50.5	50.6	77.2	53.8	20.5
	MIN	-8.3	-2.1	10.7	28.0	40.2	50.6	56.3	53.6	44.5	34.2	19.6	3.3	27.5	26.3	53.5	32.8	-2.4
	AVE	3.6	10.5	22.9	39.4	53.0	62.6	68.1	65.3	55.8	45.4	28.7	13.3	39.0	38.4	65.3	43.3	9.1

Appendix Table 1. Normal monthly, annual, and seasonal temperatures, °F, adjusted to an 8 a.m. observation time, 1951-1980, Minnesota.

STATION NAME		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	SPR	SUM	FAL	WIN
PIPESTONE	MAX	18.9	25.2	36.7	54.6	68.4	78.3	83.9	81.8	71.8	60.4	41.5	26.9	54.0	53.3	81.4	57.9	23.7
	MIN	-2.3	4.5	16.6	32.0	43.4	53.7	58.6	56.3	46.0	34.7	19.9	7.0	30.9	30.7	56.2	33.5	3.1
	AVE	8.4	14.9	26.7	43.4	55.9	66.0	71.2	69.1	59.0	47.5	30.7	16.9	42.5	42.0	68.8	45.7	13.4
POKEGAMA DAM	MAX	14.4	21.9	34.1	50.1	64.4	73.3	78.6	75.7	65.4	54.9	36.3	21.9	49.3	49.5	75.9	52.2	19.4
	MIN	-8.9	-3.1	9.9	28.0	39.7	49.9	55.4	53.2	44.0	34.1	18.8	2.2	26.9	25.9	52.8	32.3	-3.3
	AVE	2.8	9.4	22.1	39.1	52.0	61.6	67.0	64.5	54.7	44.6	27.6	12.1	38.1	37.7	64.4	42.3	8.1
PRESTON	AVE	10.6	16.2	27.7	43.8	55.8	65.4	70.0	67.6	58.7	47.9	32.4	19.4	43.0	42.4	67.7	46.3	15.4
RED LAKE FALLS	MAX	10.5	17.9	31.0	49.7	65.7	74.6	80.5	78.3	67.9	56.0	35.2	19.9	48.9	48.8	77.8	53.0	16.1
	MIN	-11.3	-4.5	9.5	29.9	41.4	51.7	56.5	54.4	44.5	33.9	17.0	.7	27.0	26.9	54.2	31.8	-5.1
	AVE	-.4	6.7	20.4	39.8	53.6	63.1	68.5	66.4	56.2	45.0	26.1	10.3	38.0	37.9	66.0	42.4	5.6
RED LAKE INDIAN	MAX	12.2	19.6	31.6	48.3	63.4	72.9	78.2	76.1	65.2	54.2	35.1	19.9	48.1	47.8	75.7	51.5	17.2
	MIN	-9.7	-4.5	9.5	28.1	41.2	51.8	57.0	54.5	44.8	34.9	18.9	.6	27.3	26.3	54.4	32.9	-4.5
	AVE	1.2	7.7	20.6	38.2	52.3	62.4	67.6	65.3	55.0	44.5	27.0	10.3	37.7	37.0	65.1	42.2	6.4
ROCHESTER WSO	MAX	18.9	25.5	35.8	53.5	67.9	77.0	81.6	79.1	70.7	59.5	41.3	26.3	53.1	52.4	79.3	57.2	23.6
	MIN	.4	6.5	17.9	34.8	46.0	56.0	60.5	58.1	49.0	38.4	23.8	10.5	33.5	32.9	58.2	37.1	5.8
	AVE	9.7	16.0	26.9	44.1	56.9	66.6	71.1	68.7	59.9	49.0	32.5	18.4	43.3	42.6	68.8	47.1	14.7
ROSEAU 1 E	MAX	8.2	16.0	29.0	47.4	63.6	72.6	78.0	75.6	65.0	53.4	32.9	17.3	46.6	46.6	75.4	50.5	13.8
	MIN	-13.9	-7.9	5.2	27.1	38.6	49.0	53.9	51.1	41.5	31.6	14.8	-2.4	24.0	23.6	51.3	29.3	-8.1
	AVE	-2.9	4.2	17.1	37.3	51.1	60.9	66.0	63.3	53.2	42.5	23.9	7.5	35.3	35.2	63.4	39.9	2.9
ROSEMOUNT AGRI EXP	MAX	17.7	23.8	35.4	53.3	67.3	76.8	81.8	79.1	70.2	59.2	40.7	25.8	52.6	52.0	79.2	56.7	22.4
	MIN	-2.7	3.4	16.3	33.0	44.5	54.8	59.5	57.1	47.5	36.8	21.9	8.3	31.7	31.3	57.1	35.4	3.0
	AVE	7.5	13.6	25.8	43.1	55.9	65.8	70.7	68.1	58.8	48.0	31.4	17.1	42.1	41.6	68.2	46.1	12.7
ST CLOUD WSO	MAX	16.6	23.8	34.9	52.7	68.0	76.3	82.0	79.2	69.4	58.3	39.0	24.2	52.0	51.8	79.2	55.6	21.6
	MIN	-4.8	1.6	14.2	32.3	43.7	53.6	58.3	55.9	46.6	35.8	20.5	6.0	30.3	30.0	55.9	34.3	.9
	AVE	5.9	12.7	24.6	42.5	55.8	65.0	70.2	67.6	58.1	47.1	29.7	15.1	41.2	41.0	67.6	45.0	11.2
ST PETER 2 SW	MAX	20.5	27.1	38.0	55.8	70.1	79.4	84.2	81.5	72.9	61.9	42.9	27.9	55.2	54.6	81.7	59.2	25.2
	MIN	-.9	5.8	18.6	35.1	46.7	56.8	61.3	58.6	48.7	37.6	23.8	9.9	33.5	33.5	58.9	36.7	4.9
	AVE	9.8	16.5	28.3	45.5	58.4	68.1	72.7	70.2	60.8	49.8	33.4	18.9	44.4	44.0	70.3	48.0	15.1
SANDY LAKE DAM	MAX	15.6	22.6	34.3	49.9	64.2	73.0	78.3	75.3	65.6	55.3	37.2	22.7	49.5	49.4	75.5	52.7	20.3
	MIN	-7.7	-2.0	10.5	28.7	40.8	50.7	56.1	53.9	44.6	34.7	19.4	3.5	27.8	26.7	53.5	32.9	-2.1
	AVE	4.0	10.3	22.5	39.3	52.4	61.9	67.2	64.6	55.1	45.0	28.3	13.2	38.7	38.1	64.6	42.8	9.1
SPRINGFIELD 1 NW	MAX	19.6	25.9	36.6	54.9	70.0	79.5	83.8	80.9	72.8	61.4	42.4	27.2	54.6	53.9	81.4	58.9	24.2
	MIN	-.3	6.1	18.5	34.8	46.1	56.7	60.4	57.8	48.1	37.7	23.0	9.4	33.2	33.2	58.3	36.2	5.1
	AVE	9.7	16.0	27.7	44.9	58.1	68.1	72.1	69.4	60.5	49.6	32.7	18.4	43.9	43.6	69.9	47.6	14.7
THEIF RIVER FALLS	AVE	-.8	6.0	19.3	38.7	52.9	62.5	67.8	65.9	55.3	44.0	25.3	9.5	37.2	37.0	65.4	41.5	4.9
TRACY	MAX	20.5	26.1	37.0	54.9	69.3	79.3	84.4	82.4	72.7	61.3	42.4	27.6	54.8	53.7	82.0	58.8	24.7
	MIN	-.3	6.1	17.6	33.5	45.7	56.2	60.9	58.4	48.2	37.3	22.3	9.1	32.9	32.2	58.5	35.9	5.0
	AVE	10.1	16.1	27.3	44.2	57.5	67.7	72.7	70.4	60.5	49.3	32.4	18.3	43.9	43.0	70.3	47.4	14.8
TWO HARBORS	MAX	19.1	23.2	32.7	45.0	56.4	65.6	73.7	71.9	63.0	52.9	38.3	26.2	47.4	44.7	70.4	51.4	22.8
	MIN	-.5	3.7	15.2	29.3	37.6	44.3	52.7	53.9	46.4	36.9	23.2	9.4	29.4	27.4	50.3	35.5	4.2
	AVE	9.4	13.5	24.0	37.2	46.9	54.9	63.2	62.9	54.8	44.9	30.9	17.8	38.4	36.0	60.4	43.5	13.6
VIRGINIA	MAX	13.9	21.4	33.6	49.3	64.3	73.3	78.6	75.7	64.9	53.9	35.2	21.0	48.7	49.0	75.8	51.3	18.8
	MIN	-8.6	-2.7	9.9	27.4	38.9	48.6	53.9	51.5	43.0	33.0	17.5	1.5	26.2	25.4	51.3	31.2	-3.3
	AVE	2.6	9.4	21.8	38.4	51.6	60.9	66.3	63.6	53.9	43.5	26.4	11.3	37.5	37.2	63.6	41.3	7.8
WADENA 3 S	MAX	14.3	21.9	33.6	51.1	66.2	74.9	80.6	78.7	67.9	56.7	37.4	22.4	50.5	50.3	78.1	54.0	19.5
	MIN	-7.4	-1.1	12.2	30.3	42.4	52.6	57.6	55.3	45.1	34.4	19.2	3.5	28.7	28.3	55.1	32.9	-1.6
	AVE	3.5	10.4	23.0	40.7	54.3	63.8	69.2	67.1	56.6	45.6	28.3	13.5	39.7	39.3	66.7	43.5	9.2
WALKER	AVE	3.0	10.2	22.4	39.3	52.8	62.1	67.6	65.3	55.3	45.2	27.7	12.4	38.6	38.2	65.0	42.7	8.6
WARROAD	MAX	9.4	16.8	29.7	46.0	61.2	71.2	77.1	74.6	64.1	52.9	33.4	18.3	46.2	45.6	74.3	50.1	14.8
	MIN	-13.2	-7.5	6.1	26.2	39.5	50.9	56.0	53.3	43.5	33.1	15.8	-1.7	25.2	23.9	53.4	30.8	-7.5
	AVE	-1.9	4.7	17.9	36.1	50.4	61.0	66.6	64.0	53.8	43.0	24.6	8.3	35.7	34.8	63.9	40.5	3.7
WASECA EXP STA	MAX	18.8	25.0	35.5	53.8	68.2	77.5	81.7	79.1	70.9	59.7	41.5	26.3	53.2	52.5	79.4	57.4	23.4
	MIN	-1.3	5.2	17.1	33.9	45.6	55.5	59.9	57.4	47.7	36.8	22.6	8.6	32.4	32.2	57.6	35.7	4.2
	AVE	8.8	15.1	26.4	43.9	57.0	66.5	70.8	68.3	59.3	48.2	32.1	17.5	42.8	42.4	68.6	46.5	13.8
WHEATON	MAX	16.9	23.1	35.4	53.1	68.4	77.6	83.9	82.2	72.3	60.3	40.4	25.3	53.2	52.3	81.2	57.7	21.8
	MIN	-3.0	3.4	16.0	32.9	44.9	55.4	60.1	58.2	47.8	36.6	20.8	6.8	31.7	31.3	57.9	35.1	2.4
	AVE	6.9	13.3	25.7	43.1	56.3	66.6	72.0	70.2	60.0	48.5	30.6	16.0	42.4	41.7	69.6	46.4	12.1
WILLMAR ST HOSP	MAX	16.3	23.1	34.5	52.6	67.5	76.8	82.1	79.7	71.0	59.6	40.0	24.9	52.3	51.5	79.5	56.8	21.4
	MIN	-3.0	3.3	15.9	33.7	45.8	56.2	61.0	58.8	48.5	37.8	22.0	7.7	32.3	31.8	58.7	36.1	2.7
	AVE	6.6	13.2	25.2	43.2	56.7	66.5	71.6	69.2	59.8	48.7	31.0	16.3	42.3	41.7	69.1	46.5	12.1
WINDOM	MAX	20.0	26.2	37.2	54.6	68.8	79.1	83.9	81.0	72.4	61.4	43.1	27.8	54.6	53.5	81.3	58.9	24.6
	MIN	-.3	6.1	17.7	33.9	45.8	56.4	61.0	58.5	48.2	37.0	22.3	9.5	33.0	32.5	58.6	35.8	5.1
	AVE	9.9	16.2	27.5	44.2	57.3	67.7	72.4	69.8	60.4	49.4	33.1	19.7	44.0	43.0	70.0	47.6	15.3
WINNEBAGO	MAX	19.9	26.4	36.8	55.1	69.3	78.9	82.9	80.6	71.7	60.4	41.9	26.7	54.2	53.8	80.8	58.0	24.3
	MIN	1.1	7.3	19.3	34.7	46.2	56.6	60.9	58.6	49.5	38.7	24.2	10.0	33.9	33.4	58.7	37.5	6.1
	AVE	10.5	16.9	28.0	45.0	57.8	67.7	72.0	69.7	60.6	49.6	33.1	18.4	44.1	43.6	69.8	47.8	15.3
WINNIBIGOSHISH DAM	MAX	13.2	20.9	33.3	49.5	64.4	73.9	79.2	76.1	65.3	54.1	35.5	21.2	48.9	49.1	76.4	51.6	18.4
	MIN	-9.6	-3.9	9.0	27.4	40.2	51.0	56.7	54.1	44.6	34.5	18.7	1.8	27.0	25.5	53.9	32.6	-3.9
	AVE	1.8	8.5	21.1	38.5	52.3	62.5	67.9	65.2	55.0	44.3	27.1	12.7	38.1	37.3	65.2	42.1	7.7
WINONA	MAX	23.4	29.9	40.5	57.3	70.6	79.8	84.5	82.1	73.3	62.1	44.8	29.7	56.5	56.2	82.2	60.1	27.7
	MIN	2.0	7.0	19.7	35.4	46.9	56.5	61.1	58.7	49.7	39.6	25.7	11.4	34.5	34.0	58.8	38.3	6.8
	AVE	12.7	18.5	30.1	46.4	58.8	68.1	72.9	70.4	61.5	50.9	35.2	20.6	45.5	45.1	70.5	49.2	17.3
WORTHINGTON	AVE	10.6	16.9	27.6	44.5	57.3	67.1	71.8	69.3	59.7	48.7	32.4	18.3	43.7	43.1	69.4	46.9	15.3
ZUMBROTA	MAX	19.8	25.9	37.1	54.7	68.2	77.6	82.9	80.3	71.4	60.7	42.3	27.7	54.0	53.3	80.3	58.2	24.4
	MIN	-1.6	3.7	16.1	32.9	44.1	54.4	59.1	56.6	47.2	36.4	22.1	9.1	31.7	31.0	56.7	35.2	3.7
	AVE	9.1	14.8	26.6	43.8	56.1	66.0	71.0	68.5	59.3	48.6	32.3	18.4	42.9	42.2	68.5	46.7	14.1

Appendix Table 1. Normal monthly, annual, and seasonal temperatures, °F, adjusted to an 8 a.m. observation time, 1951-1980, Minnesota.

STATION NAME		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	SPR	SUM	FAL	WIN
ALGONA 3 W, IA	MAX	21.1	27.2	38.2	56.1	69.6	79.5	83.5	81.0	72.7	61.7	43.8	28.8	55.3	54.6	81.3	59.4	25.7
	MIN	1.9	8.3	19.3	35.0	46.7	56.8	61.1	58.6	49.2	38.3	23.7	11.3	34.2	33.7	58.8	37.1	7.2
	AVE	11.5	17.7	28.8	45.6	58.2	68.2	72.4	69.8	60.9	50.1	33.8	20.1	44.8	44.2	70.1	48.3	16.4
BRITT, IA	MAX	21.0	27.4	38.2	56.0	70.0	79.8	83.4	80.9	73.3	62.5	43.9	28.9	55.4	54.7	81.4	59.9	25.8
	MIN	1.4	7.8	19.3	35.5	47.2	57.6	61.6	59.2	49.5	38.7	24.0	11.2	34.4	34.0	59.5	37.4	6.8
	AVE	11.2	17.6	28.7	45.8	58.7	68.6	72.5	70.1	61.4	50.7	34.0	20.1	45.0	44.4	70.4	48.7	16.3
CHARLES CITY, IA	MAX	21.2	27.3	38.3	55.3	68.9	78.6	82.8	80.7	72.6	61.3	43.6	28.8	55.0	54.2	80.7	59.2	25.8
	MIN	2.6	9.0	20.3	36.2	47.6	57.2	61.6	59.4	50.0	39.3	25.0	12.7	35.1	34.7	59.4	38.1	8.1
	AVE	11.9	18.2	29.3	45.8	58.3	67.9	72.3	70.1	61.3	50.3	34.4	20.8	45.1	44.5	70.1	48.7	17.0
CRESCO, IA	MAX	19.9	25.9	36.9	54.1	67.4	76.6	81.2	78.8	70.4	59.3	42.0	27.2	53.3	52.8	78.9	57.2	24.3
	MIN	1.7	7.8	19.0	35.0	46.4	56.2	60.3	58.2	48.9	38.3	24.2	11.3	33.9	33.5	58.2	37.1	7.0
	AVE	10.8	16.8	28.0	44.6	56.9	66.4	70.8	68.5	59.7	48.8	33.1	19.3	43.6	43.2	68.6	47.2	15.6
DECORAH 2 N, IA	MAX	21.7	27.7	38.9	55.7	69.3	78.1	82.9	81.1	72.6	61.2	43.8	29.3	55.2	54.7	80.7	59.2	26.2
	MIN	2.0	7.8	19.4	35.3	46.8	56.3	60.6	58.5	49.4	38.6	24.7	12.3	34.3	33.8	58.5	37.6	7.4
	AVE	11.8	17.8	29.2	45.5	58.0	67.2	71.7	69.8	61.1	49.9	34.3	20.8	44.8	44.2	69.6	48.4	16.8
EMMETSBURG, IA	MAX	21.3	27.5	38.3	55.9	69.7	79.3	83.7	81.1	73.1	62.2	43.8	29.2	55.4	54.6	81.4	59.7	26.0
	MIN	2.2	8.5	19.6	35.6	47.2	57.4	61.8	59.1	49.3	38.3	23.9	11.7	34.5	34.1	59.4	37.2	7.5
	AVE	11.7	18.0	28.9	45.8	58.5	68.3	72.8	70.2	61.2	50.3	33.9	20.5	45.0	44.4	70.4	48.5	16.8
ESTHERVILLE 2 N, IA	MAX	21.2	27.5	37.8	55.9	70.2	79.3	83.6	81.4	72.9	61.7	43.2	28.2	55.2	54.6	81.4	59.2	25.6
	MIN	1.8	8.0	18.9	34.7	46.5	56.8	61.0	58.7	48.5	37.2	23.8	10.8	33.9	33.4	58.8	36.5	6.8
	AVE	11.5	17.8	28.4	45.3	58.4	68.0	72.4	70.0	60.7	49.5	33.5	19.5	44.6	44.0	70.1	47.9	16.3
FOREST CITY, IA	MAX	20.4	26.6	37.6	54.9	69.1	78.8	82.7	80.6	72.2	61.4	42.8	28.1	54.6	53.9	80.7	58.8	25.0
	MIN	.8	7.6	18.9	35.1	46.8	56.6	61.3	58.8	49.2	38.3	23.7	10.9	34.0	33.6	58.9	37.1	6.4
	AVE	10.7	17.2	28.3	45.0	57.9	67.7	72.0	69.7	60.8	49.9	33.2	19.5	44.3	43.7	69.8	48.0	15.8
HAWARDEN, IA	MAX	24.1	30.5	41.7	59.1	71.9	80.9	86.1	83.9	75.1	64.1	45.9	31.7	57.9	57.6	83.6	61.7	28.7
	MIN	2.5	9.3	20.4	36.1	47.5	58.3	63.2	60.9	50.2	38.0	23.2	11.6	35.1	34.6	60.8	37.1	7.8
	AVE	13.3	19.9	31.1	47.7	59.7	69.6	74.6	72.4	62.7	51.1	34.6	21.7	46.5	46.2	72.2	49.5	18.3
HUMBOLDT NO 2, IA	MAX	23.2	29.6	40.1	57.4	71.2	80.4	84.9	82.2	74.5	63.4	45.2	30.6	56.9	56.2	82.5	61.1	27.8
	MIN	3.6	10.0	21.0	36.7	48.4	57.8	62.3	59.4	50.0	38.9	24.9	12.8	35.5	35.4	59.8	37.9	8.8
	AVE	13.4	19.8	30.6	47.1	59.9	69.2	73.6	70.8	62.3	51.2	35.0	21.7	46.2	45.9	71.2	49.5	18.3
LAKE PARK, IA	MAX	20.8	27.0	37.4	55.2	69.2	78.7	83.6	81.2	72.5	61.2	42.8	27.9	54.8	53.9	81.2	58.8	25.2
	MIN	.7	7.1	18.2	34.5	46.1	56.4	61.1	58.6	48.5	37.5	23.2	10.0	33.5	32.9	58.7	36.4	5.9
	AVE	10.7	17.1	27.9	44.9	57.7	67.5	72.4	70.0	60.6	49.4	33.0	18.9	44.2	43.5	70.0	47.7	15.6
MASON CITY FAA, IA	MAX	20.6	26.9	37.1	55.3	69.8	79.0	83.4	81.2	73.0	61.8	43.4	28.0	55.0	54.0	81.2	59.4	25.2
	MIN	2.0	8.4	19.4	35.8	47.1	57.2	61.7	59.2	49.7	38.6	24.2	11.4	34.5	34.1	59.3	37.5	7.3
	AVE	11.4	17.6	28.3	45.5	58.4	68.2	72.6	70.3	61.4	50.2	33.8	19.7	44.8	44.1	70.3	48.5	16.2
MASON CITY 3 N, IA	MAX	20.6	27.1	38.0	55.3	69.6	78.8	83.2	81.0	72.8	61.7	43.8	28.6	55.0	54.3	81.0	59.4	25.5
	MIN	1.4	8.0	19.1	35.4	46.0	56.8	61.2	58.8	49.3	38.5	24.0	11.3	34.2	33.8	58.9	37.3	6.9
	AVE	11.1	17.6	28.6	45.3	58.2	67.9	72.2	69.9	61.1	50.1	33.9	20.0	44.6	44.1	70.0	48.4	16.2
MILFORD 4 NW, IA	MAX	20.1	26.8	37.6	55.5	69.8	79.3	84.1	81.7	72.9	61.6	42.9	28.1	55.0	54.3	81.7	59.2	25.0
	MIN	-.3	6.7	17.9	34.2	45.8	56.0	60.7	58.6	48.8	37.4	22.5	9.7	33.2	32.6	58.4	36.2	5.4
	AVE	9.9	16.8	27.9	44.8	57.8	67.7	72.4	70.2	61.0	49.5	32.7	18.9	44.1	43.5	70.1	47.7	15.2
NEW HAMPTON, IA	MAX	21.0	27.2	37.8	54.8	68.3	77.1	81.2	79.5	71.7	61.2	43.4	28.9	54.3	53.6	79.3	58.8	25.7
	MIN	1.9	8.3	19.1	35.0	46.7	56.2	60.9	58.6	49.3	38.7	24.0	11.6	34.2	33.6	58.6	37.4	7.3
	AVE	11.6	17.7	28.5	44.9	57.6	66.7	71.1	69.1	60.5	50.0	33.8	20.3	44.3	43.7	69.0	48.1	16.5
NORTHWOOD, IA	MAX	19.9	26.3	37.2	54.7	68.9	78.6	82.9	80.6	72.6	61.3	42.6	27.7	54.4	53.6	80.7	58.8	24.6
	MIN	.7	7.2	18.5	34.9	46.6	57.0	61.5	58.9	48.9	38.4	23.6	10.8	33.9	33.3	59.1	37.0	6.2
	AVE	10.3	16.7	27.8	44.8	57.8	67.8	72.2	69.8	60.8	49.9	33.1	19.3	44.2	43.5	69.9	47.9	15.5
OSAGE, IA	MAX	20.4	26.4	37.3	54.3	67.8	77.2	81.4	79.3	71.3	60.5	43.0	28.3	53.9	53.1	79.3	58.2	25.0
	MIN	1.6	8.2	19.6	35.6	47.2	57.1	61.6	59.3	49.6	39.1	24.3	11.7	34.6	34.1	59.3	37.7	7.2
	AVE	11.0	17.3	28.4	45.0	57.6	67.1	71.5	69.3	60.5	49.8	33.7	20.0	44.3	43.7	69.3	48.0	16.1
ROCK RAPIDS, IA	MAX	22.5	28.8	39.6	57.8	71.2	80.2	85.7	83.3	73.9	62.8	44.5	30.0	56.7	56.2	83.0	60.4	27.1
	MIN	.8	7.7	19.4	34.8	46.4	57.1	61.8	59.4	48.7	36.6	22.5	10.2	33.8	33.5	59.4	35.9	6.2
	AVE	11.7	18.3	29.5	46.4	58.8	68.7	73.7	71.3	61.3	49.8	33.5	20.1	45.3	44.9	71.2	48.2	16.7
SANBORN, IA	MAX	20.6	27.2	38.2	56.3	70.3	79.5	84.1	81.8	72.8	61.4	43.2	28.6	55.3	55.0	81.8	59.2	25.4
	MIN	.4	7.4	18.4	34.3	46.1	56.2	61.0	58.7	48.9	37.7	22.7	10.2	33.5	32.9	58.6	36.4	6.0
	AVE	10.5	17.4	28.4	45.4	58.2	67.9	72.5	70.3	60.9	49.6	33.0	19.4	44.5	44.0	70.2	47.8	15.7
SHELDON, IA	MAX	21.3	27.8	38.7	56.6	70.3	79.4	84.2	81.6	73.0	61.8	43.6	29.1	55.6	55.2	81.7	59.5	26.0
	MIN	1.0	7.9	19.0	34.6	46.1	56.4	61.1	58.7	48.8	37.3	22.7	10.5	33.7	33.2	58.7	36.3	6.5
	AVE	11.2	17.9	28.9	45.6	58.2	67.9	72.6	70.2	61.0	49.6	33.2	19.9	44.7	44.2	70.2	47.9	16.3
SIBLEY, IA	MAX	20.7	26.9	38.1	55.8	68.8	78.5	83.2	80.5	72.2	61.2	43.5	28.9	54.9	54.2	80.7	59.0	25.5
	MIN	.4	7.1	18.3	33.9	45.3	55.3	60.2	57.6	47.7	36.8	21.9	9.9	32.9	32.5	57.7	35.5	5.8
	AVE	10.6	17.0	28.2	44.8	57.0	66.9	71.7	69.1	60.0	49.0	32.8	19.4	43.9	43.4	69.2	47.3	15.7
SPENCER 1 N, IA	MAX	22.1	28.7	38.7	56.3	70.7	79.7	84.5	82.2	73.6	62.6	43.8	29.4	56.0	55.2	82.2	60.0	26.8
	MIN	1.0	7.7	19.0	34.8	46.6	57.1	61.4	58.8	48.7	37.2	22.8	10.3	33.8	33.4	59.1	36.2	6.3
	AVE	11.6	18.2	28.9	45.5	58.6	68.4	72.9	70.6	61.2	49.9	33.2	19.9	44.9	44.3	70.6	48.1	16.6
WAUKON, IA	MAX	20.4	26.5	37.8	54.6	67.6	75.8	80.7	78.9	70.9	60.2	42.8	28.1	53.7	53.4	78.4	58.0	25.0
	MIN	2.9	8.7	19.7	35.7	47.1	56.5	61.1	59.1	50.1	39.3	24.7	12.4	34.8	34.1	58.9	38.0	8.0
	AVE	11.7	17.7	28.8	45.2	57.3	66.2	70.9	69.0	60.6	49.8	33.8	20.3	44.3	43.8	68.7	48.1	16.5
AMENIA, ND	MAX	12.7	20.1	33.4	52.3	69.0	77.3	83.7	82.3	72.0	59.0	37.8	21.6	51.8	51.6	81.1	56.3	18.1
	MIN	-8.2	-.7	13.3	31.2	42.5	52.3	57.2	55.2	44.9	34.1	17.7	2.0	28.5	29.0	54.9	32.2	-2.3
	AVE	2.3	9.6	23.4	41.7	55.7	64.8	70.5	68.8	58.5	46.6	27.8	11.9	40.1	40.3	68.0	44.3	7.9
CAVALIER, ND	MAX	9.9	17.5	29.7	49.2	66.4	75.5	80.8	79.2	68.3	56.1	35.0	18.9	48.9	48.5	78.5	53.1	15.4
	MIN	-10.0	-3.2	10.0	29.0	40.8	51.3	56.2	53.5	43.8	33.4	16.9	.5	26.9	26.8	53.7	31.4	-4.2
	AVE	-.0	7.2	19.9	39.1	53.6	63.4	68.5	66.3	56.0	44.8	26.0	9.8	37.9	37.5	66.1	42.3	5.6
FARGO WSO, ND	MAX	12.9	19.8	32.3	51.1	67.8	76.3	82.9	81.1	70.2	58.0	37.2	21.3	50.9	50.4	80.1	55.1	18.0
	MIN	-6.6	.3	13.5	31.1	43.4	54.0	59.0	56.9	46.6	35.2	19.1	3.8	29.8	29.6	56.6	33.6	-.8
	AVE	3.2	10.0	22.9	41.6	55.6	65.2	71.0	69.1	58.5	46.6	28.1	12.6	40.4	40.0	68.4	44.4	8.6

Appendix Table 1. Normal monthly, annual, and seasonal temperatures, °F, adjusted to an 8 a.m. observation time, 1951-1980, Minnesota.

STATION NAME		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	SPR	SUM	FAL	WIN
FORMAN 5 SSE, ND	MAX	14.9	22.1	34.7	52.5	67.4	76.8	83.8	82.3	71.3	59.1	39.3	23.8	52.3	51.6	81.0	56.6	20.3
	MIN	-2.5	1.2	14.1	31.3	42.8	53.2	58.3	56.2	44.6	33.7	18.4	4.2	29.6	29.4	55.9	32.2	1.0
	AVE	4.4	11.7	24.4	42.0	55.1	65.0	71.1	69.3	58.0	46.4	28.8	14.1	40.9	40.5	68.4	44.4	10.1
GRAFTON, ND	MAX	9.9	17.4	30.3	49.6	66.5	75.4	81.6	80.0	69.0	56.4	35.0	19.0	49.2	48.8	79.0	53.5	15.4
	MIN	-10.6	-3.9	9.5	28.9	40.6	51.0	55.4	53.3	43.5	33.0	16.3	.2	26.4	26.3	53.2	30.9	-4.8
	AVE	-.3	6.7	20.0	39.3	53.6	63.2	68.5	66.7	56.2	44.7	25.7	9.6	37.8	37.6	66.1	42.2	5.3
GRAND FORKS FAA, ND	MAX	10.8	18.4	30.5	49.2	66.9	75.6	81.8	80.1	68.8	56.3	35.0	19.7	49.4	48.8	79.2	53.4	16.3
	MIN	-8.9	-1.8	11.4	31.3	41.9	52.1	56.6	54.2	44.9	34.0	17.9	2.1	28.0	28.2	54.3	32.3	-2.9
	AVE	1.1	8.3	21.0	40.2	54.4	63.9	69.2	67.2	56.9	45.2	26.4	11.0	38.7	38.5	66.7	42.8	6.8
GRAND FORKS UNIV, ND	MAX	10.5	18.0	30.8	50.1	67.4	76.1	81.7	80.2	69.3	56.7	35.4	19.7	49.6	49.4	79.3	53.8	16.0
	MIN	-8.0	-1.2	12.1	31.5	42.7	53.1	57.7	55.4	45.6	35.0	18.7	2.8	28.8	28.8	55.4	33.1	-2.2
	AVE	1.2	8.4	21.5	40.8	55.0	64.5	69.7	67.8	57.5	45.9	27.1	11.3	39.2	39.1	67.4	43.5	7.0
HANKINSON R R, ND	MAX	17.0	23.1	34.6	52.9	67.9	77.2	83.3	81.6	70.3	59.3	40.0	24.8	52.7	51.8	80.7	56.5	21.7
	MIN	-4.2	2.2	15.3	32.0	43.7	54.1	59.1	56.7	46.1	35.3	19.9	5.0	30.4	30.3	56.7	33.8	1.0
	AVE	6.4	12.7	25.0	42.5	55.9	65.7	71.2	69.2	58.3	47.4	30.0	14.9	41.6	41.1	68.7	45.2	11.3
HILLSBORO, ND	MAX	11.9	19.0	32.1	50.7	67.3	76.3	82.7	81.2	70.5	58.0	36.9	21.0	50.6	50.0	80.1	55.2	17.3
	MIN	-7.3	-.6	12.5	31.1	42.3	53.0	58.1	55.5	45.3	34.5	18.3	3.2	28.8	28.6	55.5	32.7	-1.6
	AVE	2.3	9.2	22.2	40.9	54.9	64.6	70.4	68.3	58.0	46.3	27.7	12.2	39.8	39.3	67.8	44.0	7.9
LANGDON EXP FARM, ND	MAX	7.3	15.0	27.6	46.5	63.3	72.4	78.1	76.6	65.8	53.5	32.4	16.7	46.3	45.8	75.7	50.6	13.0
	MIN	-13.2	-6.5	6.2	26.3	37.8	48.5	53.0	50.7	40.4	30.0	13.0	-2.4	23.6	23.4	50.7	27.8	-7.4
	AVE	-3.0	4.2	16.9	36.4	50.6	60.4	65.6	63.7	53.1	41.8	22.8	7.2	35.0	34.6	63.2	39.2	2.8
LARIMORE, ND	MAX	11.7	18.7	31.3	49.7	66.0	75.0	81.1	79.4	68.6	56.3	36.3	21.0	49.6	49.0	78.5	53.7	17.1
	MIN	-7.6	-1.5	11.2	29.1	40.9	51.6	56.2	53.7	43.7	33.4	17.4	1.4	27.5	27.1	53.8	31.5	-2.6
	AVE	2.1	8.6	21.2	39.4	53.5	63.4	68.7	66.7	56.1	44.8	26.9	11.2	38.6	38.0	66.3	42.6	7.3
LISBON, ND	MAX	15.5	22.6	35.5	53.4	68.0	76.7	83.0	81.5	71.1	59.8	39.6	24.2	52.6	52.3	80.4	56.8	20.8
	MIN	-5.8	.3	13.2	30.2	41.3	51.8	56.7	54.5	43.8	33.0	17.9	3.4	28.3	28.2	54.3	31.5	-.7
	AVE	4.9	11.5	24.4	41.8	54.7	64.3	69.9	68.0	57.4	46.4	28.7	13.8	40.5	40.3	67.4	44.2	10.1
MAYVILLE, ND	MAX	11.5	18.5	31.6	50.2	66.5	75.4	81.7	80.2	69.3	57.2	36.2	20.8	49.9	49.4	79.1	54.2	16.9
	MIN	-7.6	-.8	12.4	30.9	42.1	52.8	57.7	55.5	45.4	34.7	18.3	3.3	28.7	28.4	55.3	32.8	-1.7
	AVE	1.9	8.8	22.0	40.6	54.4	64.1	69.7	67.9	57.3	46.0	27.3	12.1	39.3	39.0	67.2	43.5	7.6
MCLEOD 3 E, ND	MAX	14.5	21.4	34.6	52.9	68.2	76.9	83.2	81.7	71.4	59.7	39.1	23.5	52.3	51.9	80.6	56.7	19.8
	MIN	-7.4	-.4	12.9	30.7	42.3	52.9	58.1	56.1	45.1	33.9	17.7	3.3	28.8	28.6	55.7	32.2	-1.5
	AVE	3.6	10.6	23.8	41.9	55.3	64.9	70.7	68.8	58.3	46.8	28.4	13.5	40.5	40.3	68.1	44.5	9.2
PARK RIVER, ND	MAX	10.8	18.0	30.6	49.6	66.2	75.2	81.5	80.0	69.1	56.8	35.6	19.9	49.4	48.8	78.9	53.9	16.2
	MIN	-8.1	-1.5	11.0	29.4	41.3	52.2	57.2	54.6	44.7	34.2	17.5	2.2	27.9	27.2	54.6	32.1	-2.5
	AVE	1.3	8.2	20.9	39.5	53.7	63.7	69.4	67.3	56.9	45.5	26.6	11.1	38.7	38.0	66.8	43.0	6.9
PEMBINA 1 S, ND	MAX	8.3	16.0	28.7	49.3	66.0	75.2	80.6	78.9	68.2	55.8	34.3	18.0	48.3	48.0	78.2	52.8	14.1
	MIN	-12.6	-3.3	8.0	28.2	40.0	50.4	55.3	52.4	42.8	32.3	15.6	-1.3	25.4	25.4	52.7	30.2	-6.7
	AVE	-2.1	4.9	18.4	38.8	53.0	62.8	68.0	65.6	55.5	44.1	25.0	8.4	36.9	36.8	65.5	41.5	3.7
PETERSBURG 2 N, ND	MAX	10.4	17.1	29.2	47.8	64.3	73.5	79.6	78.3	66.7	54.7	34.0	18.9	47.9	47.1	77.1	51.8	15.5
	MIN	-10.0	-3.4	9.3	28.0	39.9	50.1	54.5	51.8	41.5	31.1	15.2	-.4	25.6	25.8	52.2	29.3	-4.6
	AVE	.2	6.9	19.3	38.0	52.2	61.8	67.1	65.1	54.1	43.0	24.6	9.3	36.8	36.5	64.7	40.5	5.4
SHARON, ND	MAX	10.1	17.4	30.2	48.6	64.7	73.4	79.8	78.9	68.0	56.1	34.9	19.4	48.5	47.8	77.4	53.0	15.6
	MIN	-9.3	-2.0	10.7	29.1	40.6	51.1	55.8	53.8	43.3	32.9	15.9	1.1	26.9	26.8	53.6	30.7	-3.4
	AVE	.4	7.7	20.4	38.9	52.7	62.2	67.8	66.4	55.7	44.5	25.4	10.3	37.7	37.3	65.5	41.9	6.2
WAHPETON, ND	MAX	14.4	21.2	33.9	52.4	68.3	77.3	83.4	81.1	71.0	59.2	39.0	23.6	52.1	51.6	80.6	56.4	19.7
	MIN	-5.4	1.3	14.5	32.4	44.0	54.4	59.4	57.4	46.9	36.3	20.1	5.3	30.5	30.3	57.1	34.4	.4
	AVE	4.6	11.2	24.2	42.5	56.2	65.9	71.5	69.3	58.9	47.8	29.6	14.5	41.3	41.0	68.9	45.4	10.1
BROOKINGS 2 NE, SD	MAX	19.1	25.1	36.5	54.2	67.9	77.1	83.3	81.3	71.4	60.1	41.3	26.7	53.7	52.8	80.6	57.6	23.6
	MIN	-2.9	3.8	16.5	32.1	43.0	53.2	57.9	55.5	45.1	34.0	19.7	6.7	30.4	30.5	55.5	32.9	2.5
	AVE	8.1	14.5	26.5	43.2	55.5	65.2	70.5	68.4	58.3	47.1	30.6	16.7	42.0	41.7	68.0	45.3	13.1
CANTON, SD	MAX	23.2	29.8	41.2	58.8	71.9	81.6	87.4	84.8	75.7	64.4	45.5	30.9	57.9	57.3	84.6	61.8	28.0
	MIN	.4	7.6	19.0	34.6	46.0	56.4	61.4	59.2	48.3	36.5	21.7	9.8	33.4	33.2	59.0	35.5	6.0
	AVE	11.8	18.7	30.1	46.7	59.0	69.0	74.4	72.0	62.0	50.4	33.6	20.4	45.7	45.3	71.8	48.7	17.0
CASTLEWOOD, SD	MAX	18.6	25.7	37.5	54.8	68.6	78.0	84.7	83.1	73.1	61.3	41.4	27.1	54.5	53.6	81.9	58.6	23.8
	MIN	-4.7	2.7	14.9	30.8	41.9	52.9	57.5	55.8	44.7	33.2	18.0	5.5	29.4	29.2	55.4	32.0	1.2
	AVE	7.0	14.2	26.1	42.9	55.3	65.4	71.1	69.4	58.9	47.3	29.7	16.3	42.0	41.4	68.6	45.3	12.5
FLANDREAU, SD	MAX	20.4	26.6	37.3	55.5	68.8	78.2	84.3	82.3	72.4	61.1	42.5	28.0	54.8	53.9	81.6	58.7	25.0
	MIN	-1.9	4.7	17.1	32.9	44.3	54.9	59.8	57.2	46.6	34.8	20.5	7.7	31.6	31.4	57.3	34.0	3.5
	AVE	9.3	15.7	27.2	44.3	56.6	66.6	72.1	69.8	59.5	47.9	31.5	17.9	43.2	42.7	69.5	46.3	14.3
MILBANK, SD	MAX	18.9	24.9	36.6	54.1	68.8	78.1	84.6	82.7	73.2	61.4	41.8	27.3	54.4	53.2	81.8	58.8	23.7
	MIN	-2.3	4.3	16.8	32.7	44.4	54.9	59.6	58.0	47.3	36.5	21.1	7.9	31.8	31.3	57.5	35.0	3.3
	AVE	8.4	14.7	26.7	43.4	56.6	66.5	72.1	70.3	60.3	49.0	31.5	17.7	43.1	42.3	69.7	46.9	13.6
SIOUX FALLS WSO, SD	MAX	22.1	28.6	39.2	56.7	70.2	79.9	86.4	83.9	73.9	62.4	43.9	29.3	56.4	55.3	83.4	60.1	26.7
	MIN	.4	7.7	19.3	35.1	46.1	56.8	62.4	60.2	49.4	37.0	22.0	9.9	33.8	33.5	59.8	36.1	6.0
	AVE	11.3	18.1	29.3	45.8	58.2	68.4	74.4	72.1	61.7	49.7	32.9	19.6	45.1	44.4	71.6	48.1	16.3
SISSETON, SD	MAX	17.8	24.4	36.6	53.9	68.3	77.4	84.2	82.7	73.1	61.4	41.1	26.8	54.0	52.9	81.4	58.5	23.0
	MIN	-3.0	4.0	16.2	32.4	44.0	54.5	59.9	57.9	46.9	36.1	20.7	7.2	31.4	30.8	57.4	34.6	2.8
	AVE	7.4	14.2	26.4	43.1	56.2	65.9	72.1	70.3	60.0	48.8	30.9	17.0	42.7	41.9	69.4	46.6	12.9
WATERTOWN FAA AP, SD	MAX	17.6	24.5	35.4	52.5	67.3	76.6	83.6	81.8	71.2	59.1	39.7	25.4	52.9	51.7	80.7	56.7	22.5
	MIN	-3.7	3.4	15.3	32.2	43.6	54.5	59.5	57.3	46.9	35.3	19.7	6.6	30.9	30.3	57.1	34.0	2.1
	AVE	7.0	13.9	25.4	42.3	55.4	65.6	71.6	69.6	59.1	47.2	29.7	16.1	41.9	41.0	68.9	45.3	12.3
WEBSTER, SD	MAX	16.4	22.7	34.9	52.2	66.4	75.8	82.8	81.5	71.0	58.6	39.2	25.2	52.2	51.2	80.0	56.3	21.4
	MIN	-4.9	2.3	14.0	30.9	42.7	53.0	58.5	56.6	44.8	33.9	18.0	5.4	29.6	29.2	56.0	32.2	.9
	AVE	5.7	12.6	24.5	41.5	54.5	64.4	70.6	69.0	58.0	46.2	28.6	15.3	40.9	40.2	68.0	44.3	11.2
WENTWORTH 2 WNW, SD	MAX	20.6	26.8	38.0	55.6	69.0	78.3	84.7	82.4	73.0	61.6	42.8	28.3	55.1	54.2	81.8	59.1	25.2
	MIN	-1.0	5.9	17.1	33.0	44.4	55.0	60.0	57.6	47.2	36.2	21.0	8.7	32.1	31.5	57.5	34.8	4.6
	AVE	9.8	16.4	27.5	44.3	56.8	66.6	72.4	70.0	60.1	48.9	31.9	18.5	43.6	42.9	69.7	47.0	14.9

Appendix Table 1. Normal monthly, annual, and seasonal temperatures, °F, adjusted to an 8 a.m. observation time, 1951-1980, Minnesota.

STATION NAME		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	SPR	SUM	FAL	WIN
AMERY, WI	MAX	17.7	24.0	35.6	52.9	66.7	75.5	80.9	78.5	68.9	58.0	39.9	25.2	52.0	51.8	78.3	55.6	22.3
	MIN	-4.4	.4	14.3	32.1	43.5	53.0	57.9	55.6	46.2	35.9	21.5	6.6	30.2	30.0	55.5	34.5	.8
	AVE	6.7	12.3	25.0	42.6	55.2	64.2	69.5	67.0	57.6	47.0	30.7	15.9	41.1	40.9	66.9	45.1	11.6
BLAIR, WI	MAX	21.1	27.3	38.5	55.3	68.8	77.6	82.6	80.1	71.2	60.1	42.7	28.2	54.5	54.2	80.1	58.0	25.5
	MIN	-.9	4.1	16.7	33.0	43.6	53.4	58.0	55.8	46.4	36.1	23.1	9.7	31.6	31.1	55.8	35.2	4.3
	AVE	10.1	15.7	27.6	44.2	56.2	65.5	70.4	68.0	58.8	48.1	33.0	19.0	43.0	42.7	67.9	46.6	14.9
CUMBERLAND, WI	MAX	17.1	23.7	35.4	52.5	66.5	75.4	80.6	77.8	67.9	56.9	38.8	24.5	51.4	51.4	77.9	54.6	21.7
	MIN	-3.6	.9	13.7	31.7	43.9	54.0	59.3	56.8	47.5	36.8	21.8	7.2	30.8	29.8	56.7	35.4	1.5
	AVE	6.8	12.3	24.6	42.1	55.2	64.7	70.0	67.3	57.6	46.9	30.4	15.9	41.1	40.6	67.3	45.0	11.7
DANBURY, WI	MAX	17.7	24.6	36.3	52.8	67.0	74.9	80.4	77.6	67.9	57.4	39.2	24.9	51.7	52.0	77.6	54.8	22.4
	MIN	-6.6	-1.5	12.1	29.0	39.6	49.6	55.2	52.8	44.0	33.5	19.4	4.6	27.6	26.9	52.5	32.3	-1.2
	AVE	5.5	11.6	24.2	40.9	53.3	62.3	67.8	65.2	56.0	45.5	29.3	14.8	39.7	39.5	65.1	43.6	10.6
EAU CLAIRE FAA, WI	MAX	19.0	25.7	36.7	54.3	68.6	77.1	82.5	79.7	70.3	59.2	40.9	26.4	53.4	53.2	79.8	56.8	23.7
	MIN	-1.6	3.5	16.2	33.4	45.0	54.9	59.7	57.3	48.1	37.2	22.9	8.7	32.1	31.5	57.3	36.1	3.5
	AVE	8.7	14.5	26.5	43.9	56.8	66.1	71.2	68.6	59.3	48.2	31.9	17.6	42.8	42.4	68.6	46.5	13.6
GENOA DAM, WI	MAX	24.7	30.7	41.2	57.6	70.8	79.5	83.6	81.4	72.8	61.8	44.5	30.6	56.6	56.6	81.5	59.7	28.7
	MIN	6.5	11.5	23.8	38.4	49.2	58.3	62.6	60.7	52.8	43.0	28.9	15.4	37.6	37.1	60.5	41.6	11.1
	AVE	15.6	21.2	32.5	48.1	60.1	68.9	73.2	71.1	62.8	52.4	36.7	23.0	47.1	46.9	71.1	50.6	19.9
GRANTSBURG, WI	MAX	17.4	24.4	35.9	53.6	67.2	75.6	81.0	78.3	68.1	57.6	39.8	25.0	52.0	52.2	78.3	55.1	22.3
	MIN	-6.1	-.9	12.9	30.5	41.8	51.6	56.4	54.3	45.0	34.6	20.8	4.7	28.8	28.4	54.1	33.4	-.8
	AVE	5.7	11.9	24.4	42.1	54.5	63.7	68.7	66.3	56.6	46.1	30.2	14.9	40.4	40.3	66.2	44.3	10.8
LA CROSSE FAA AP, WI	MAX	22.2	28.7	39.1	56.1	69.9	78.5	83.7	81.4	72.4	61.1	43.3	29.2	55.5	55.0	81.2	58.9	26.7
	MIN	3.5	8.7	20.5	37.4	48.9	58.3	63.0	60.8	52.1	41.3	27.1	13.6	36.2	35.6	60.7	40.2	8.6
	AVE	12.9	18.7	29.8	46.7	59.4	68.5	73.4	71.2	62.3	51.2	35.2	21.4	45.9	45.3	71.0	49.6	17.7
MENOMONIE, WI	MAX	20.5	26.5	38.2	55.4	69.2	77.9	83.4	80.5	71.3	60.4	42.3	27.8	54.4	54.3	80.6	58.0	24.9
	MIN	-.6	4.6	16.8	33.4	44.5	54.4	59.0	56.8	47.8	37.4	23.3	10.0	32.3	31.6	56.7	36.2	4.7
	AVE	9.9	15.6	27.5	44.4	56.9	66.2	71.2	68.7	59.7	48.9	32.8	18.9	43.4	42.9	68.7	47.1	14.8
MONDOVI, WI	MAX	20.5	26.6	37.9	54.8	68.0	76.9	81.8	79.1	70.2	59.6	42.2	27.8	53.8	53.6	79.2	57.3	25.0
	MIN	-1.4	4.0	16.5	33.2	44.1	54.5	58.9	56.7	47.5	36.8	22.1	9.0	31.8	31.3	56.7	35.5	3.9
	AVE	9.6	15.3	27.3	44.1	56.1	65.7	70.3	67.9	58.9	48.2	32.2	18.4	42.8	42.5	68.0	46.4	14.4
RICE LAKE, WI	MAX	17.8	24.2	35.4	52.5	66.0	74.6	80.0	77.3	67.6	57.3	39.4	25.0	51.4	51.3	77.3	54.8	22.3
	MIN	-4.6	.4	13.5	30.8	42.1	51.9	57.2	54.9	45.6	35.1	20.9	6.3	29.5	28.8	54.7	33.9	.7
	AVE	6.6	12.4	24.5	41.7	54.0	63.3	68.7	66.1	56.7	46.3	30.2	15.7	40.5	40.1	66.0	44.4	11.6
RIVER FALLS, WI	MAX	18.6	24.6	36.4	53.9	67.5	76.5	81.7	78.9	69.5	58.8	41.0	26.5	52.8	52.6	79.1	56.4	23.3
	MIN	-1.6	4.2	16.9	33.5	45.3	55.1	60.0	58.0	48.4	38.0	23.0	9.5	32.5	31.9	57.7	36.5	4.0
	AVE	8.5	14.4	26.6	43.8	56.5	65.8	70.9	68.4	59.0	48.4	32.1	18.1	42.7	42.3	68.4	46.5	13.7
ST CROIX FALLS, WI	MAX	19.3	26.3	37.4	54.5	68.8	77.3	82.8	80.2	70.7	59.6	41.0	26.6	53.7	53.6	80.1	57.1	24.1
	MIN	-4.0	1.4	14.9	32.8	44.6	54.4	59.5	57.5	48.3	37.3	22.5	7.8	31.4	30.8	57.2	36.0	1.7
	AVE	7.7	13.9	26.2	43.7	56.7	65.9	71.2	68.9	59.5	48.5	31.8	17.2	42.6	42.2	68.7	46.6	12.9
SOLON SPRINGS, WI	MAX	17.9	24.3	35.9	51.8	66.4	75.5	80.9	77.8	67.6	56.6	38.2	24.5	51.4	51.3	78.1	54.2	22.2
	MIN	-5.8	-.8	11.8	28.2	39.0	48.7	54.7	52.5	43.8	33.8	19.4	4.7	27.5	26.3	51.9	32.3	-.6
	AVE	6.0	11.7	23.9	40.0	52.7	62.1	67.8	65.2	55.7	45.2	28.9	14.7	39.5	38.9	65.0	43.3	10.8
SPARTA, WI	MAX	21.3	27.4	38.8	55.5	68.9	77.7	82.6	80.1	71.2	59.9	42.5	28.4	54.5	54.4	80.1	57.8	25.7
	MIN	.8	5.9	18.1	34.0	44.7	54.1	58.6	56.4	47.5	37.5	24.2	11.2	32.8	32.3	56.4	36.4	6.0
	AVE	11.0	16.6	28.5	44.8	56.8	65.9	70.6	68.3	59.3	48.6	33.4	19.8	43.6	43.3	68.3	47.1	15.8
SPOONER EXP FARM, WI	MAX	17.7	24.1	35.6	52.5	66.0	74.7	80.0	77.0	67.3	56.9	38.9	24.7	51.3	51.3	77.2	54.4	22.1
	MIN	-5.1	-.5	12.8	30.3	41.3	51.2	56.4	53.9	45.0	35.0	20.4	5.7	28.9	28.1	53.8	33.5	.0
	AVE	6.3	11.8	24.3	41.4	53.6	63.0	68.2	65.5	56.1	46.0	29.7	15.2	40.1	39.8	65.6	43.9	11.1
SUPERIOR, WI	MAX	18.5	23.9	33.8	47.0	59.0	68.8	76.9	74.5	65.6	55.5	38.9	25.3	49.0	46.6	73.4	53.3	22.6
	MIN	-3.4	1.8	13.3	28.5	37.1	45.9	53.5	53.1	45.0	35.2	21.9	7.3	28.3	26.3	50.8	34.0	1.9
	AVE	7.5	12.9	23.6	37.8	48.1	57.3	65.3	63.8	55.4	45.4	30.4	16.4	38.7	36.5	62.1	43.7	12.3
TREMPEALEAU DAM, WI	MAX	21.8	27.9	39.0	55.3	69.2	78.0	83.0	80.7	71.9	60.5	43.3	29.2	55.0	54.5	80.6	58.5	26.3
	MIN	1.8	7.0	19.2	36.2	47.8	57.1	61.8	59.5	50.6	40.3	26.0	12.4	35.0	34.4	59.5	39.0	7.1
	AVE	11.8	17.5	29.1	45.8	58.5	67.6	72.5	70.2	61.2	50.5	34.6	20.9	45.0	44.5	70.1	48.8	16.7
VIROQUA, WI	MAX	22.7	29.0	39.4	56.5	69.2	77.7	82.2	80.3	71.7	60.5	42.9	28.5	55.1	55.0	80.1	58.4	26.7
	MIN	3.8	8.5	19.9	34.7	45.6	55.1	59.3	57.0	48.6	38.5	25.1	12.2	34.0	33.4	57.1	37.4	8.2
	AVE	13.3	18.8	29.7	45.6	57.4	66.4	70.7	68.7	60.2	49.6	34.1	20.4	44.6	44.2	68.6	48.0	17.5

Appendix Table 2. Normal annual degree days for selected base temperatures for the indicated time of observation, 1951-1980.

STATION	BELOW 32 (6AM)	ABOVE 32 (8AM)	ABOVE 40 (8AM)	ABOVE 45 (8AM)	ABOVE 50 (8AM)	ABOVE 55 (8AM)	ABOVE 60 (8AM)	ABOVE 70 (8AM)	ABOVE 65 (MID)	BELOW 65 (MID)
ADA	2849	5742	4030	3061	2233	1500	898	174	431	9522
ALBERT LEA	1918	6399	4568	3550	2627	1811	1125	226	559	8063
ALEXANDRIA	2607	5836	4115	3160	2305	1562	946	165	459	9216
ARGYLE	3235	5357	3699	2783	1970	1275	717	105	307	10171
ARTICHOKE LAKE	2407	6097	4325	3340	2453	1679	1033	206	511	8806
AUSTIN	2056	6101	4282	3277	2375	1591	942	162	435	8375
BABBITT	2894	4768	3172	2307	1557	938	471	47	169	10281
BAUDETTE	3368	4845	3245	2376	1618	987	506	54	188	10695
BEMIDJI	3099	5149	3513	2617	1830	1165	641	90	268	10203
BENSON	2329	6159	4379	3390	2501	1724	1072	231	544	8698
BIG FALLS	3125	4655	3236	2357	1596	966	492	54	183	10439
BROWNS VALLEY	2263	6083	4305	3320	2437	1669	1030	217	516	8681
CAMBRIDGE	2302	5902	4140	3163	2286	1527	904	163	424	8808
CAMPBELL	2582	5843	4101	3137	2278	1533	917	163	432	9155
CANBY	2061	6450	4631	3623	2715	1916	1237	318	673	8269
CASS LAKE	3056	5142	3494	2592	1802	1137	613	74	244	10143
CHASKA	2014	6289	4476	3470	2561	1763	1094	228	549	8258
CLOQUET	2697	4780	3150	2270	1511	891	432	37	145	10047
COLLEGEVILLE	2361	5979	4220	3244	2368	1604	965	176	458	8826
CROOKSTON	3088	5485	3812	2866	2063	1356	781	119	344	9931
DETROIT LAKES	2993	5069	3416	2507	1712	1051	542	56	200	10110
DULUTH	2618	4844	3204	2315	1544	909	440	36	145	9904
FAIRMONT	1689	6677	4818	3782	2844	2010	1295	316	694	7891
FARIBAULT	1990	6287	4462	3451	2539	1737	1065	210	523	8212
FARMINGTON	2124	6249	4436	3430	2523	1726	1054	199	511	8372
FERGUS FALLS	2615	5765	4065	3110	2256	1519	913	180	442	9257
FOSSTON	2974	5370	3704	2786	1973	1278	720	107	310	9899
GLENWOOD	2384	5887	4140	3170	2301	1548	928	180	445	8927
GRAND MARAIS	2139	4182	2526	1672	980	475	163	3	30	9972
GRAND MEADOW	1934	6146	4322	3314	2411	1623	966	163	447	8220
GRAND RAPIDS	2804	4966	3318	2423	1643	995	501	47	179	10002
GULL LAKE	2599	5465	3771	2841	2018	1313	742	105	317	9436
HALLOCK	3300	5301	3673	2773	1976	1298	755	140	351	10335
HINCKLEY	2386	5310	3601	2660	1833	1142	597	58	219	9280
INTL FALLS	3289	4873	3270	2396	1635	1004	523	60	200	10601
ITASCA	2989	5017	3382	2491	1712	1061	555	59	209	10166
JORDAN	2150	6085	4285	3287	2389	1604	952	158	438	8488
LEECH LAKE	2764	5189	3516	2604	1806	1133	605	70	235	9795
LITCHFIELD	2266	6131	4351	3363	2474	1697	1047	217	523	8643
LITTLE FALLS	2562	5657	3939	2991	2147	1418	819	126	363	9252
LONG PRAIRIE	2698	5512	3811	2872	2038	1325	751	112	325	9496
MADISON	2167	6277	4453	3443	2538	1749	1090	241	558	8433
MAPLE PLAIN	2150	6094	4306	3313	2420	1642	996	196	485	8526
MARSHALL	1951	6427	4600	3584	2668	1862	1181	272	617	8127
MEADOWLAND	2869	4842	3203	2314	1545	915	447	39	152	10184
MILACA	2383	5607	3880	2928	2081	1357	771	115	335	9095
MILAN	2351	6078	4305	3323	2443	1676	1035	220	521	8779
MPLS-ST PAUL	1922	6551	4708	3686	2764	1949	1256	319	679	8036
MONTEVIDEO	2139	6210	4410	3406	2502	1711	1054	223	528	8441
MOOSE LAKE	2680	4987	3324	2422	1639	992	504	54	165	9862
MORA	2419	5609	3879	2927	2081	1358	776	124	344	9139
MORRIS	2450	5925	4182	3215	2349	1596	970	188	472	8981
NEW LONDON	2322	5999	4242	3267	2394	1631	995	198	467	8795
NEW ULM	1939	6476	4630	3602	2672	1851	1158	241	586	8034
OLIVIA	2190	6320	4515	3508	2600	1800	1124	241	572	8427
PARK RAPIDS	2644	5264	3605	2692	1887	1203	657	81	264	9829
PINE RIVER	2607	5269	3602	2679	1867	1180	636	75	253	9616
PIPESTONE	2095	5970	4197	3217	2337	1560	954	176	454	8565
POKEGAMA DAM	2806	5093	3432	2527	1735	1074	561	57	209	9909
PRESTON	1917	5964	4145	3151	2267	1505	879	145	399	8337
RED LAKE FALLS	3158	5391	3725	2805	1969	1292	732	104	314	10066
RED LAKE AGENCY	3047	5171	3531	2632	1841	1173	644	86	266	10128
ROCHESTER	2013	6169	4369	3363	2459	1668	1009	195	468	8297
ROSEAU	3553	4825	3234	2366	1611	966	511	58	193	10901
ROSEMOUNT	2222	5976	4197	3215	2335	1568	931	162	432	8663
ST CLOUD	2415	5617	4070	3102	2236	1486	871	145	397	8980
ST PETER	1890	6452	4614	3592	2667	1848	1156	248	590	8014
SANDY LAKE	2676	5155	3482	2567	1704	1092	572	65	219	9727
SPRINGFIELD	1956	6359	4532	3516	2597	1787	1105	215	545	8127
THIEF RIVER	3235	5181	3567	2612	1682	1211	677	99	289	10318
TRACY	1952	6337	4526	3522	2616	1621	1151	267	600	8201
TWO HARBORS	2137	4509	2830	1954	1226	673	302	25	95	9708
VIRGINIA	2870	4917	3285	2398	1626	993	513	58	195	10132
WADENA	2652	5503	3810	2876	2049	1341	759	123	341	9476
WALKER	2759	5221	3554	2641	1839	1163	632	63	257	9759
WARROAD	3425	4835	3253	2392	1641	1014	551	60	203	10718
WASECA	2049	6053	4266	3276	2383	1605	958	159	443	8424
WHEATON	2331	6195	4409	3421	2536	1762	1109	254	576	8698
WILLMAR	2320	6143	4363	3373	2480	1696	1058	200	501	8668
WINDOM	2006	6425	4573	3545	2621	1814	1137	253	565	8153
WINNEBAGO	1947	6415	4570	3549	2632	1825	1144	249	565	8102
WINNIBIGOSHISH	2305	5175	3520	2616	1823	1154	624	76	249	9964
WINONA	1665	6604	4770	3723	2761	1950	1242	291	655	7650
WORTHINGTON	1962	6275	4447	3436	2529	1737	1076	226	541	8214
ZUMBROTA	2074	6092	4283	3264	2369	1811	966	178	455	8425

Appendix Table 3. First and last dates of degree days seasons, length of season in calendar days, and total degree days during the normal season, 1951-1980, at indicated observation times.

	DD ABOVE 32 (8AM)				DD ABOVE 40 (8AM)				DD ABOVE 50 (8AM)				DD BELOW 65 (MID)			
STATION	START	END	LEN	DD	START	END	LEN	DD	START	END	LEN	DD	START	END	LEN	DD
ADA	MAR 31	NOV 7	222	5598	APR 11	OCT 25	198	3911	MAY 3	OCT 7	156	2118	AUG 27	JUN 13	291	9531
ALBERT LEA	MAR 26	NOV 17	237	6262	APR 6	NOV 1	210	4467	APR 24	OCT 13	173	2529	SEP 5	JUN 5	274	8105
ALEXANDRIA	APR 1	NOV 9	223	5697	APR 12	OCT 26	198	4000	MAY 2	OCT 8	160	2198	AUG 28	JUN 11	286	9237
ARGYLE	APR 3	NOV 5	217	5227	APR 14	OCT 23	193	3589	MAY 8	OCT 2	148	1850	AUG 19	JUN 16	302	10176
ARTICHOKE LAKE	MAR 30	NOV 12	228	5946	APR 9	OCT 28	203	4209	APR 29	OCT 10	165	2348	SEP 1	JUN 9	282	8838
AUSTIN	MAR 27	NOV 16	235	5948	APR 7	OCT 30	207	4164	APR 26	OCT 11	169	2273	AUG 30	JUN 9	284	8395
BABBITT	APR 5	NOV 4	214	4675	APR 19	OCT 20	185	3082	MAY 16	SEP 26	134	1435	JUL 1	JUN 30	365	10360
BAUDETTE	APR 6	NOV 3	212	4728	APR 18	OCT 20	186	3144	MAY 16	SEP 27	135	1496	JUL 15	JUN 27	348	10738
BEMIDJI	APR 4	NOV 4	215	5022	APR 16	OCT 22	190	3408	MAY 13	SEP 30	141	1704	AUG 9	JUN 20	316	10216
BENSON	MAR 28	NOV 12	230	6013	APR 8	OCT 26	204	4261	APR 27	OCT 10	167	2399	SEP 1	JUN 8	281	8729
BIG FALLS	APR 4	NOV 3	214	4732	APR 17	OCT 20	187	3127	MAY 16	SEP 26	134	1467	JUL 10	JUN 29	355	10493
BROWNS VALLEY	MAR 28	NOV 12	230	5963	APR 8	OCT 29	205	4212	APR 28	OCT 11	167	2350	SEP 2	JUN 10	282	8710
CAMBRIDGE	MAR 29	NOV 12	229	5775	APR 9	OCT 28	203	4038	APR 28	OCT 8	164	2185	AUG 26	JUN 11	290	8829
CAMPBELL	MAR 29	NOV 9	226	5702	APR 9	OCT 26	201	3986	MAY 2	OCT 6	158	2165	AUG 29	JUN 10	286	9176
CANBY	MAR 27	NOV 15	234	6284	APR 7	OCT 31	208	4508	APR 26	OCT 13	171	2600	SEP 6	JUN 6	274	8294
CASS LAKE	APR 3	NOV 6	218	5017	APR 15	OCT 22	191	3379	MAY 14	SEP 29	139	1670	AUG 3	JUN 19	321	10160
CHASKA	MAR 26	NOV 16	236	6182	APR 6	OCT 31	209	4393	APR 24	OCT 12	172	2479	SEP 3	JUN 6	277	8294
CLOQUET	APR 4	NOV 6	217	4684	APR 18	OCT 21	187	3064	MAY 20	SEP 28	132	1401	JUL 1	JUN 30	365	10126
COLLEGEVILLE	MAR 30	NOV 12	228	5845	APR 10	OCT 28	202	4109	APR 29	OCT 9	164	2259	AUG 29	JUN 10	286	8857
CROOKSTON	APR 2	NOV 5	218	5354	APR 14	OCT 23	193	3697	MAY 8	OCT 4	150	1948	AUG 24	JUN 15	296	9951
DETROIT LAKES	APR 3	NOV 5	217	4966	APR 15	OCT 22	191	3325	MAY 13	SEP 30	141	1619	AUG 5	JUN 22	322	10129
DULUTH	APR 4	NOV 7	218	4745	APR 18	OCT 23	189	3115	MAY 19	OCT 1	136	1427	JUL 1	JUN 30	365	9963
FAIRMONT	MAR 25	NOV 19	240	6515	APR 5	NOV 2	212	4694	APR 21	OCT 15	178	2740	SEP 9	JUN 3	268	7920
FARIBAULT	MAR 26	NOV 17	237	6164	APR 6	OCT 31	209	4368	APR 24	OCT 13	173	2451	SEP 3	JUN 7	276	8244
FARMINGTON	MAR 27	NOV 16	235	6108	APR 7	OCT 31	208	4328	APR 24	OCT 11	171	2415	SEP 1	JUN 7	280	8407
FERGUS FALLS	MAR 31	NOV 9	224	5665	APR 11	OCT 26	199	3968	MAY 2	OCT 7	159	2158	AUG 28	JUN 11	288	9266
FOSSTON	APR 2	NOV 6	219	5246	APR 14	OCT 23	193	3588	MAY 9	OCT 3	148	1840	AUG 18	JUN 17	304	9912
GLENWOOD	MAR 30	NOV 12	228	5768	APR 10	OCT 28	202	4041	MAY 1	OCT 8	161	2199	AUG 28	JUN 11	286	8946
GRAND MARAIS	APR 4	NOV 11	222	4101	APR 22	OCT 23	185	2467	JUN 3	SEP 27	117	922	JUL 1	JUN 30	365	10044
GRAND MEADOW	MAR 26	NOV 17	237	6011	APR 6	NOV 1	210	4220	APR 25	OCT 11	170	2311	AUG 31	JUN 8	282	8244
GRAND RAPIDS	APR 3	NOV 6	218	4855	APR 16	OCT 22	190	3221	MAY 14	SEP 29	139	1527	JUL 18	JUN 26	344	10039
GULL LAKE	APR 2	NOV 9	222	5347	APR 14	OCT 25	195	3672	MAY 9	OCT 5	150	1906	AUG 19	JUN 15	301	9459
HALLOCK	APR 4	NOV 4	215	5189	APR 15	OCT 21	190	3566	MAY 9	SEP 30	145	1650	AUG 17	JUN 15	303	10331
HINCKLEY	MAR 30	NOV 10	226	5229	APR 11	OCT 25	198	3527	MAY 7	OCT 2	149	1747	AUG 12	JUN 19	312	9306
INTL FALLS	APR 5	NOV 3	213	4764	APR 17	OCT 20	187	3172	MAY 16	SEP 27	135	1509	JUL 20	JUN 25	341	10633
ITASCA	APR 4	NOV 4	215	4893	APR 17	OCT 22	189	3279	MAY 15	SEP 30	139	1593	JUL 29	JUN 23	330	10193
JORDAN	MAR 27	NOV 15	234	5947	APR 7	OCT 30	207	4177	APR 25	OCT 10	169	2283	AUG 28	JUN 9	286	8523
LEECH LAKE	APR 3	NOV 6	218	5044	APR 15	OCT 23	192	3407	MAY 13	OCT 2	143	1686	AUG 6	JUN 20	319	9818
LITCHFIELD	MAR 28	NOV 13	231	5992	APR 9	OCT 29	204	4236	APR 28	OCT 11	167	2367	AUG 31	JUN 6	282	8669
LITTLE FALLS	MAR 31	NOV 10	225	5537	APR 11	OCT 26	199	3838	MAY 4	OCT 6	156	2036	AUG 22	JUN 13	296	9281
LONG PRAIRIE	APR 1	NOV 8	222	5380	APR 12	OCT 25	197	3701	MAY 7	OCT 4	151	1915	AUG 19	JUN 15	301	9517
MADISON	MAR 28	NOV 14	232	6075	APR 8	OCT 29	205	4308	APR 27	OCT 11	168	2424	SEP 1	JUN 7	280	8462
MAPLE PLAIN	MAR 27	NOV 15	234	5970	APR 7	OCT 30	207	4202	APR 26	OCT 10	168	2310	AUG 30	JUN 9	284	8543
MARSHALL	MAR 26	NOV 16	236	6283	APR 6	OCT 31	209	4490	APR 24	OCT 12	172	2565	SEP 5	JUN 5	274	8160
MEADOWLAND	APR 4	NOV 5	216	4708	APR 17	OCT 21	188	3093	MAY 17	SEP 28	135	1427	JUL 6	JUL 5	365	10263
MILACA	MAR 30	NOV 11	227	5504	APR 10	OCT 26	200	3794	MAY 3	OCT 5	156	1963	AUG 22	JUN 15	298	9119
MILAN	MAR 28	NOV 12	230	5931	APR 9	OCT 28	203	4185	APR 29	OCT 9	164	2332	AUG 31	JUN 8	282	8800
MPLS-ST PAUL	MAR 25	NOV 18	239	6412	APR 5	NOV 1	211	4602	APR 22	OCT 13	175	2663	SEP 7	JUN 5	272	8060
MONTEVIDEO	MAR 27	NOV 14	233	6094	APR 7	OCT 30	207	4316	APR 25	OCT 12	171	2416	SEP 1	JUN 7	280	8467
MOOSE LAKE	APR 2	NOV 8	221	4878	APR 16	OCT 23	191	3231	MAY 17	OCT 1	138	1527	JUL 25	JUN 29	340	9900
MORA	MAR 30	NOV 10	226	5495	APR 11	OCT 26	199	3786	MAY 3	OCT 6	157	1986	AUG 21	JUN 15	299	9157
MORRIS	MAR 29	NOV 11	228	5807	APR 9	OCT 27	202	4078	APR 30	OCT 7	161	2241	AUG 30	JUN 9	284	9000
NEW LONDON	MAR 29	NOV 12	229	5887	APR 10	OCT 29	203	4150	APR 29	OCT 10	165	2302	AUG 30	JUN 9	284	8824
NEW ULM	MAR 25	NOV 18	239	6343	APR 5	NOV 1	211	4520	APR 22	OCT 14	176	2579	SEP 5	JUN 5	274	8078
OLIVIA	MAR 27	NOV 14	233	6167	APR 7	OCT 30	207	4391	APR 25	OCT 12	171	2489	SEP 3	JUN 6	277	8456
PARK RAPIDS	APR 2	NOV 6	219	5166	APR 14	OCT 23	193	3517	MAY 10	OCT 2	146	1786	AUG 17	JUN 18	306	9849
PINE RIVER	APR 2	NOV 9	222	5171	APR 15	OCT 25	194	3505	MAY 10	OCT 3	147	1759	AUG 10	JUN 19	314	9643
PIPESTONE	MAR 27	NOV 12	231	5871	APR 8	OCT 28	204	4114	APR 29	OCT 8	163	2258	AUG 31	JUN 9	283	8599
POKEGAMA DAM	APR 2	NOV 7	220	4981	APR 15	OCT 23	192	3332	MAY 14	SEP 30	140	1612	JUL 29	JUN 23	330	9939
PRESTON	MAR 26	NOV 16	236	5817	APR 7	OCT 30	207	4039	APR 28	OCT 9	165	2170	AUG 27	JUN 11	289	8356
RED LAKE FALLS	APR 3	NOV 5	217	5252	APR 14	OCT 23	193	3606	MAY 8	OCT 4	150	1666	AUG 18	JUN 17	304	10089
RED LAKE AGENCY	APR 4	NOV 6	217	5047	APR 17	OCT 23	190	3422	MAY 13	SEP 30	141	1706	AUG 10	JUN 19	314	10141
ROCHESTER	MAR 27	NOV 16	235	6039	APR 7	OCT 31	208	4261	APR 25	OCT 11	170	2356	SEP 1	JUN 8	281	8315
ROSEAU	APR 6	NOV 1	210	4695	APR 18	OCT 19	185	3119	MAY 17	SEP 26	133	1475	JUL 12	JUN 27	351	10956
ROSEMOUNT	MAR 28	NOV 14	232	5845	APR 8	OCT 29	205	4094	APR 29	OCT 9	164	2226	AUG 28	JUN 10	287	8692
ST CLOUD	MAR 30	NOV 10	226	5684	APR 10	OCT 27	201	3965	APR 29	OCT 8	163	2137	AUG 25	JUN 12	292	9004
ST PETER	MAR 25	NOV 18	239	6339	APR 5	NOV 2	212	4527	APR 22	OCT 13	175	2579	SEP 5	JUN 5	274	8054
SANDY LAKE	APR 2	NOV 8	221	5044	APR 15	OCT 24	193	3366	MAY 12	OCT 2	144	1651	JUL 31	JUN 22	327	9748
SPRINGFIELD	MAR 26	NOV 17	237	6241	APR 6	NOV 1	210	4439	APR 23	OCT 13	174	2512	SEP 3	JUN 4	275	8168
THIEF RIVER	APR 4	NOV 3	214	5083	APR 16	OCT 21	189	3463	MAY 11	OCT 1	144	1764	AUG 16	JUN 19	308	10325
TRACY	MAR 26	NOV 16	236	6224	APR 7	OCT 31	208	4437	APR 25	OCT 12	171	2526	SEP 4	JUN 5	275	8230
TWO HARBORS	APR 3	NOV 13	225	4411	APR 20	OCT 25	189	2760	MAY 31	OCT 1	124	1146	JUL 1	JUN 30	365	9785
VIRGINIA	APR 3	NOV 5	217	4812	APR 17	OCT 21	188	3190	MAY 15	SEP 28	137	1511	JUL 18	JUN 27	345	10172
WADENA	APR 1	NOV 8	222	5396	APR 12	OCT 24	196	3716	MAY 6	OCT 4	152	1946	AUG 22	JUN 15	298	9491
WALKER	APR 2	NOV 7	220	5108	APR 15	OCT 24	193	3455	MAY 11	OCT 2	145	1717	AUG 11	JUN 21	315	9795
WARROAD	APR 7	NOV 2	210	4720	APR 21	OCT 20	183	3150	MAY 18	SEP 27	133	1519	JUL 21	JUN 25	340	10811
WASECA	MAR 27	NOV 16	235	5957	APR 7	OCT 30	207	4187	APR 26	OCT 10	168	2299	AUG 30	JUN 8	283	8458
WHEATON	MAR 28	NOV 12	230	6035	APR 8	OCT 29	205	4287	APR 29	OCT 11	166	2426	SEP 3	JUN 8	279	8722
WILLMAR	MAR 29	NOV 13	230	6002	APR 9	OCT 29	204	4247	APR 27	OCT 11	168	2374	SEP 1	JUN 8	281	8702
WINDOM	MAR 26	NOV 18	238	6226	APR 7	OCT 31	208	4410	APR 25	OCT 12	171	2496	SEP 3	JUN 6	277	8183
WINNEBAGO	MAR 25	NOV 18	239	6258	APR 6	NOV 1	210	4445	APR 23	OCT 13	174	2527	SEP 4	JUN 5	275	8129
WINNIBIGOSISH	APR 4	NOV 5	216	5038	APR 16	OCT 22	190	3414	MAY 13	OCT 1	142	1705	AUG 10	JUN 19	314	9985
WINONA	MAR 22	NOV 22	246	6514	APR 3	NOV 5	217	4661	APR 20	OCT 15	179	2677	SEP 7	JUN 4	271	7687
WORTHINGTON	MAR 26	NOV 16	236	6116	APR 6	OCT 31	209	4325	APR 25	OCT 11	170	2421	SEP 2	JUN 7	279	8239
ZUMBROTA	MAR 27	NOV 16	235	5949	APR 7	OCT 30	207	4173	APR 27	OCT 11	168	2285	AUG 30	JUN 9	284	8450

DEGREE DAY SEASONS ARE TAKEN AS THE TIME PERIOD FOR WHICH THE AVERAGE DAILY TEMPERATURE EQUALS OR EXCEEDS THE BASE TEMPERATURE USED FOR DEGREE DAY CALCULATIONS ABOVE THAT BASE, OR AS THE TIME PERIOD WHEN TEMPERATURE IS BELOW THE BASE FOR DEGREE DAY SUMMATIONS BELOW THE BASE.

Appendix Table 4. Normal total growing degree days, T_b = 40°F, at selected dates and adjusted to an 8 a.m. observation time.

	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER			OCTOBER		
	10	20	30	10	20	31	10	20	30	10	20	31	10	20	31	10	20	30	10	20	31
ADA	29	80	160	275	426	633	852	1098	1366	1653	1955	2297	2604	2892	3174	3391	3570	3715	3828	3910	3967
ALBERT LEA	38	103	202	339	516	755	1008	1288	1590	1907	2233	2596	2918	3223	3526	3766	3973	4148	4291	4400	4478
ALEXANDRIA FAA AP	28	77	158	275	430	641	866	1118	1393	1689	2000	2351	2662	2954	3239	3460	3643	3793	3910	3995	4053
ARGYLE 4 E	22	63	132	235	376	572	784	1019	1273	1542	1824	2143	2430	2699	2960	3156	3314	3438	3534	3605	3653
ARTICHOKE LAKE	32	88	175	299	462	684	919	1181	1468	1774	2094	2454	2774	3074	3370	3601	3797	3959	4087	4182	4247
AUSTIN 3 S	39	101	194	321	485	708	944	1208	1492	1791	2098	2437	2738	3022	3306	3532	3726	3890	4022	4120	4189
BABBITT 2 SE	9	34	84	166	282	449	631	837	1063	1308	1566	1856	2114	2349	2570	2732	2862	2965	3047	3109	3151
BAUDETTE	14	43	95	178	296	464	648	859	1091	1342	1607	1903	2164	2404	2631	2799	2933	3038	3118	3176	3215
BEMIDJI AP	17	52	112	204	331	511	708	932	1179	1446	1728	2044	2322	2579	2824	3007	3156	3273	3364	3430	3474
BENSON	35	94	186	315	484	713	955	1223	1513	1822	2145	2507	2829	3131	3428	3658	3852	4011	4138	4232	4297
BIG FALLS	15	46	99	181	298	465	649	860	1090	1339	1600	1893	2153	2392	2617	2781	2912	3015	3097	3158	3202
BROWNS VALLEY	31	86	172	294	454	672	903	1163	1447	1751	2070	2431	2755	3059	3358	3591	3787	3948	4078	4174	4240
CAMBRIDGE ST HOSP	31	87	175	300	463	680	910	1164	1441	1737	2045	2390	2694	2977	3253	3468	3650	3801	3922	4012	4074
CAMPBELL	32	85	166	282	436	649	878	1133	1409	1700	2004	2346	2655	2947	3234	3454	3635	3780	3892	3974	4031
CANBY	40	104	200	332	503	737	987	1266	1569	1891	2226	2602	2939	3256	3569	3814	4023	4199	4342	4452	4530
CASS LAKE	21	58	118	208	332	510	708	934	1182	1446	1721	2028	2302	2558	2803	2987	3134	3248	3337	3403	3448
CHASKA	35	99	197	334	511	749	998	1275	1572	1886	2212	2575	2897	3199	3496	3730	3930	4098	4234	4337	4408
CLOQUET FOR RES CEN	11	36	83	156	260	410	578	774	997	1243	1505	1800	2059	2296	2522	2692	2830	2940	3025	3086	3126
COLLEGEVILLE ST JOHN	32	88	176	301	464	683	914	1171	1450	1748	2060	2410	2721	3014	3300	3522	3710	3865	3991	4085	4151
CROOKSTON NW EXP STA	23	64	132	234	374	570	782	1020	1280	1557	1849	2180	2478	2758	3030	3236	3403	3535	3638	3712	3763
DETROIT LAKES 1 NNE	17	51	109	197	321	497	690	910	1151	1409	1680	1985	2259	2514	2759	2941	3086	3198	3282	3343	3384
DULUTH WSO	12	39	88	165	270	420	587	781	1001	1244	1504	1797	2056	2295	2525	2700	2846	2965	3059	3128	3174
FAIRMONT	46	120	230	380	571	826	1092	1384	1695	2021	2356	2727	3058	3371	3684	3936	4155	4343	4497	4614	4699
FARIBAULT	38	103	201	336	508	740	986	1259	1555	1866	2189	2545	2861	3159	3453	3688	3892	4065	4205	4311	4384
FARMINGTON 3 NW	39	106	206	344	520	754	1000	1270	1561	1867	2184	2538	2853	3149	3441	3671	3867	4034	4170	4274	4349
FERGUS FALLS	25	72	150	265	420	632	858	1109	1382	1675	1983	2331	2642	2934	3218	3435	3614	3760	3874	3957	4014
FOSSTON	23	66	136	238	374	565	771	1002	1255	1525	1810	2133	2422	2691	2949	3143	3300	3427	3528	3605	3658
GLENWOOD	28	79	161	281	438	653	881	1135	1411	1707	2017	2366	2677	2968	3252	3471	3656	3807	3927	4017	4078
GRAND MARAIS	4	16	41	82	144	237	347	482	644	832	1043	1291	1517	1732	1942	2104	2237	2341	2419	2472	2507
GRAND MEADOW	37	100	195	326	494	721	961	1226	1511	1809	2116	2456	2759	3046	3331	3558	3754	3919	4054	4157	4231
GRAND RAPIDS NC SCHL	17	50	107	195	316	488	675	888	1122	1375	1641	1939	2201	2443	2672	2843	2981	3091	3178	3241	3285
GULL LAKE DAM	20	59	126	227	364	558	767	1004	1265	1544	1838	2166	2457	2727	2988	3188	3353	3487	3594	3673	3726
HALLOCK	20	61	129	231	369	563	774	1011	1270	1546	1833	2156	2443	2710	2966	3159	3313	3434	3527	3594	3640
HINCKLEY	19	58	125	226	361	549	750	977	1225	1492	1772	2088	2368	2628	2878	3067	3222	3347	3446	3519	3569
INTERNATIONAL FALLS	14	43	98	182	301	471	657	870	1106	1360	1628	1927	2189	2429	2654	2821	2954	3059	3141	3201	3242
ITASCA ST PARK SCHL	16	47	102	186	305	477	666	883	1122	1379	1650	1954	2225	2475	2713	2891	3034	3147	3235	3301	3346
JORDAN 1 S	38	101	196	328	497	723	960	1222	1505	1804	2115	2460	2765	3051	3332	3553	3742	3902	4033	4131	4201
LEECH LAKE DAM	17	50	108	197	321	498	694	917	1164	1429	1708	2020	2295	2549	2792	2976	3127	3250	3347	3419	3467
LITCHFIELD	35	93	183	311	477	704	945	1212	1501	1808	2127	2483	2801	3098	3389	3617	3810	3972	4103	4202	4272
LITTLE FALLS 1 N	27	75	152	264	413	617	835	1080	1349	1636	1937	2273	2570	2846	3114	3320	3493	3635	3747	3830	3886
LONG PRAIRIE	26	72	145	249	390	584	795	1034	1296	1578	1872	2201	2491	2761	3022	3221	3385	3519	3624	3702	3756
MADISON SEWAGE PLANT	37	98	190	319	487	715	958	1229	1523	1835	2160	2524	2848	3152	3449	3680	3876	4040	4173	4273	4342
MAPLE PLAIN	35	96	189	319	487	713	950	1212	1496	1796	2109	2458	2769	3060	3344	3567	3758	3918	4050	4152	4225
MARSHALL	38	103	202	339	516	756	1010	1292	1594	1913	2243	2612	2941	3252	3559	3801	4007	4180	4321	4429	4507
MEADOWLANDS	15	43	93	172	285	446	623	826	1051	1297	1557	1849	2106	2341	2565	2732	2867	2974	3058	3118	3159
MILACA	25	73	151	263	410	610	824	1064	1328	1611	1909	2243	2538	2813	3080	3285	3456	3595	3704	3783	3836
MILAN	36	94	183	308	472	695	933	1199	1487	1791	2109	2464	2782	3080	3373	3601	3792	3948	4071	4162	4225
MINNEAPOLIS-ST PAUL	44	118	227	374	559	803	1058	1339	1645	1969	2307	2683	3017	3330	3640	3886	4098	4277	4424	4534	4612
MONTEVIDEO 1 SW	34	95	189	322	495	728	973	1244	1536	1843	2163	2521	2841	3142	3438	3669	3865	4030	4165	4267	4338
MOOSE LAKE 1 SSE	13	41	92	171	283	442	618	821	1050	1303	1572	1875	2142	2389	2626	2807	2956	3077	3172	3240	3286
MORA	25	72	149	260	407	607	820	1059	1322	1606	1904	2238	2534	2807	3073	3277	3448	3588	3698	3778	3831
MORRIS W C SCHOOL	33	90	177	300	461	682	917	1178	1460	1757	2065	2412	2723	3017	3305	3528	3712	3860	3976	4061	4120
NEW LONDON	29	83	170	294	456	677	912	1175	1461	1766	2083	2437	2751	3044	3332	3556	3745	3902	4027	4120	4184
NEW ULM	43	112	215	356	536	778	1033	1315	1618	1937	2266	2631	2955	3261	3566	3808	4018	4195	4341	4451	4530
OLIVIA	40	104	200	335	510	748	999	1276	1574	1887	2211	2571	2891	3192	3489	3724	3926	4097	4236	4342	4417
PARK RAPIDS	16	51	113	208	339	526	730	959	1210	1479	1762	2082	2368	2635	2891	3083	3237	3360	3455	3525	3573
PINE RIVER DAM	17	52	114	211	343	528	728	955	1205	1475	1759	2076	2355	2613	2861	3050	3206	3333	3434	3507	3557
PIPESTONE	28	80	162	281	439	657	890	1152	1436	1738	2052	2404	2719	3016	3308	3534	3723	3876	3997	4084	4144
POKEGAMA DAM	18	53	112	202	325	499	690	907	1147	1405	1677	1983	2254	2504	2743	2923	3069	3186	3278	3346	3393
PRESTON	36	94	182	304	461	676	904	1160	1437	1729	2031	2367	2665	2945	3223	3442	3628	3783	3907	3999	4062
RED LAKE FALLS	25	68	139	242	379	570	776	1009	1263	1537	1824	2147	2436	2705	2965	3162	3322	3451	3551	3624	3675
RED LAKE INDIAN	15	48	105	197	325	508	707	933	1180	1444	1722	2035	2314	2573	2819	3003	3151	3270	3365	3437	3488
ROCHESTER WSO	37	99	194	325	494	721	962	1230	1518	1821	2134	2482	2790	3081	3370	3600	3798	3966	4103	4207	4280
ROSEAU 1 E	16	48	102	185	301	468	652	862	1094	1344	1606	1900	2159	2397	2622	2788	2920	3022	3102	3160	3200
ROSEMOUNT AGRI EXP	33	90	177	298	457	674	906	1166	1447	1745	2055	2398	2703	2989	3270	3490	3678	3835	3962	4058	4124
ST CLOUD WSO	30	84	169	290	449	663	888	1139	1411	1703	2007	2347	2648	2928	3202	3415	3595	3744	3862	3949	4009
ST PETER 2 SW	39	108	213	356	539	784	1040	1323	1626	1945	2275	2640	2965	3271	3575	3816	4023	4199	4342	4452	4530
SANDY LAKE DAM	17	50	110	201	327	505	699	919	1162	1422	1696	2004	2276	2527	2767	2949	3099	3221	3319	3391	3442
SPRINGFIELD 1 NW	38	102	202	341	520	764	1021	1304	1607	1923	2246	2602	2918	3215	3512	3749	3954	4127	4268	4375	4450
THIEF RIVER FALLS	19	57	122	219	351	536	737	963	1211	1477	1757	2073	2357	2622	2876	3067	3219	3338	3428	3493	3537
TRACY	34	95	189	322	496	733	985	1264	1565	1881	2210	2578	2907	3216	3521	3760	3963	4135	4275	4381	4455
TWO HARBORS	7	24	56	107	179	284	404	553	732	942	1178	1452	1701	1934	2163	2341	2488	2607	2697	2760	2800
VIRGINIA	13	42	95	180	299	468	653	864	1097	1349	1615	1913	2175	2416	2644	2815	2953	3063	3150	3213	3256
WADENA 3 S	21	62	134	240	383	582	795	1035	1296	1575	1868	2199	2495	2772	3038	3240	3405	3537	3641	3717	3770
WALKER	17	53	115	210	340	522	719	942	1186	1450	1729	2043	2322	2580	2826	3011	3163	3286	3386	3461	3514
WARROAD	11	36	83	159	269	431	615	827	1063	1318	1586	1886	2152	2397	2630	2802	2939	3046	3128	3186	3226
WASECA EXP STA	31	88	179	308	477	706	947	1214	1501	1803	2113	2458	2763	3051	3336	3561	3753	3914	4044	4140	4207
WHEATON	36	94	182	306	469	693	933	1201	1492	1800	2123	2485	2810	3118	3421	3658	3857	4021	4153	4251	4319
WILLMAR ST HOSP	35	94	185	312	478	704	943	1210	1499	1806	2125	2480	2795	3092	3384	3615	3813	3978	4112	4212	4283
WINDOM	41	106	202	334	505	739	989	1268	1570	1888	2214	2576	2897	3199	3499	3736	3940	4110	4248	4354	4432
WINNEBAGO	44	113	215	353	530	769	1022	1302	1601	1914	2236	2593	2911	3213	3514	3753	3959	4132	4274	4382	4459
WINNIBIGOSHISH DAM	16	48	106	196	322	503	701	928	1177	1446	1727	2042	2321	2578	2822	3005	3154	3272	3365	3433	3478
WINONA	49	128	242	393	580	826	1083	1366	1671	1991	2322	2690	3017	3326	3633	3879	4093	4278	4432	4552	4642
WORTHINGTON	40	105	200	333	505	738	984	1258	1552	1861	2181	2537	2854	3152	3446	3677	3873	4037	4170	4270	4343
ZUMBROTA	36	96	186	310	470	688	921	1183	1467	1768	2080	2428	2736	3026	3311	3536	3729	3891	4024	4125	4197
FARGO ND WSO	30	82	165	285	442	656	883	1135	1411	1706	2019	2371	2687	2984	3272	3494	3678	3827	3943	4029	4088
SIOUX FALLS SD WSO	47	120	226	369	550	792	1048	1333	1643	1974	2321	2709	3055	3381	3703	3957	4173	4353	4497	4605	4680
LA CROSSE WI WSO	48	128	245	401	595	848	1109	1395	1702	2026	2362	2737	3071	3387	3703	3957	4179	4370	4529	4651	4740

Appendix Table 5. Normal total growing degree days, T_b = 45°F, at selected dates and adjusted to an 8 a.m. observation time.

	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER			OCTOBER		
	10	20	30	10	20	31	10	20	30	10	20	31	10	20	31	10	20	30	10	20	31
ADA	14	42	91	166	272	425	594	790	1008	1245	1498	1784	2041	2279	2506	2673	2803	2901	2972	3022	3054
ALBERT LEA	19	55	116	207	334	516	718	948	1201	1468	1745	2052	2324	2579	2827	3017	3173	3299	3397	3468	3515
ALEXANDRIA FAA AP	13	40	89	166	274	431	606	807	1033	1279	1541	1836	2097	2339	2569	2739	2874	2976	3051	3102	3135
ARGYLE 4 E	10	31	71	136	233	377	538	724	928	1147	1379	1642	1879	2099	2304	2450	2559	2638	2696	2737	2764
ARTICHOKE LAKE	16	47	99	180	295	460	645	857	1094	1351	1622	1926	2195	2446	2687	2868	3013	3126	3211	3269	3306
AUSTIN 3 S	20	54	110	194	310	477	663	877	1112	1361	1618	1902	2153	2387	2615	2791	2935	3050	3137	3198	3238
BABBITT 2 SE	1	10	36	85	162	280	413	568	744	938	1146	1382	1590	1775	1941	2053	2136	2196	2242	2277	2302
BAUDETTE	4	17	46	96	174	292	428	588	770	971	1185	1427	1638	1828	2000	2119	2206	2268	2313	2344	2365
BEMIDJI AP	7	23	56	114	200	328	476	649	847	1064	1295	1556	1785	1992	2181	2315	2415	2488	2541	2578	2602
BENSON	17	50	107	193	314	488	679	897	1138	1397	1670	1977	2249	2501	2743	2923	3067	3177	3260	3318	3355
BIG FALLS	5	18	46	96	171	288	424	584	764	962	1173	1412	1622	1811	1981	2096	2179	2239	2285	2320	2345
BROWNS VALLEY	14	42	93	172	283	445	627	836	1071	1325	1595	1900	2173	2427	2672	2855	3001	3114	3199	3258	3296
CAMBRIDGE ST HOSP	14	45	98	180	294	457	635	840	1067	1313	1572	1861	2115	2348	2569	2734	2865	2968	3046	3101	3138
CAMPBELL	16	44	92	167	274	433	611	817	1043	1284	1538	1825	2083	2326	2557	2728	2859	2956	3027	3076	3108
CANBY	21	58	118	206	330	508	707	937	1190	1462	1748	2068	2354	2622	2880	3076	3234	3361	3459	3531	3578
CASS LAKE	9	28	61	115	197	324	473	649	847	1060	1285	1538	1763	1968	2158	2291	2389	2460	2511	2548	2574
CHASKA	16	50	110	202	330	511	710	936	1184	1449	1725	2032	2304	2556	2798	2982	3132	3251	3341	3406	3447
CLOQUET FOR RES CEN	3	12	34	74	137	236	355	501	674	869	1081	1321	1530	1718	1889	2008	2097	2162	2210	2242	2264
COLLEGEVILLE ST JOHN	16	47	101	184	300	464	645	852	1081	1329	1591	1886	2147	2389	2621	2793	2931	3038	3120	3178	3217
CROOKSTON NW EXP STA	10	31	70	133	228	370	532	721	930	1158	1400	1676	1923	2153	2370	2526	2644	2731	2793	2837	2866
DETROIT LAKES 1 NNE	6	21	50	101	179	301	444	614	805	1013	1234	1485	1708	1914	2103	2235	2330	2396	2442	2474	2496
DULUTH WSO	4	15	39	81	145	244	361	504	674	868	1078	1316	1525	1714	1888	2014	2111	2186	2241	2281	2306
FAIRMONT	24	68	139	244	386	585	801	1043	1304	1580	1865	2181	2461	2724	2983	3185	3354	3492	3600	3678	3730
FARIBAULT	19	55	115	205	329	505	700	923	1169	1431	1703	2005	2270	2517	2758	2943	3096	3219	3313	3380	3423
FARMINGTON 3 NW	20	58	121	215	342	520	715	936	1177	1433	1701	2000	2264	2510	2747	2927	3073	3191	3283	3350	3395
FERGUS FALLS	10	34	79	153	259	416	591	792	1016	1259	1517	1810	2071	2313	2541	2708	2838	2936	3008	3058	3091
FOSSTON	11	33	74	138	232	370	526	707	910	1130	1365	1632	1871	2091	2294	2438	2547	2628	2690	2736	2768
GLENWOOD	12	39	88	165	275	434	611	815	1042	1288	1549	1843	2103	2344	2573	2742	2877	2980	3057	3111	3147
GRAND MARAIS	0	1	7	21	46	92	154	239	351	489	650	843	1021	1185	1340	1450	1532	1590	1629	1653	1668
GRAND MEADOW	18	52	110	197	318	490	680	896	1130	1379	1635	1921	2174	2410	2640	2817	2962	3079	3169	3234	3278
GRAND RAPIDS NC SCHL	6	21	51	104	183	304	442	604	788	991	1207	1450	1663	1854	2028	2149	2238	2304	2352	2387	2411
GULL LAKE DAM	8	27	64	127	221	361	521	708	919	1148	1392	1665	1906	2126	2332	2481	2597	2684	2749	2796	2826
HALLOCK	9	30	69	134	229	371	532	720	928	1153	1391	1659	1897	2114	2315	2457	2563	2639	2695	2735	2761
HINCKLEY	5	21	55	114	202	335	486	663	861	1078	1309	1569	1800	2010	2204	2343	2447	2525	2583	2624	2652
INTERNATIONAL FALLS	4	17	46	98	177	296	434	597	782	986	1204	1448	1661	1850	2020	2137	2222	2284	2330	2364	2387
ITASCA ST PARK SCHL	6	20	49	99	176	296	436	603	791	999	1219	1469	1690	1890	2073	2201	2296	2364	2415	2452	2478
JORDAN 1 S	19	54	113	201	321	492	679	891	1124	1374	1634	1924	2179	2415	2641	2812	2951	3062	3148	3211	3252
LEECH LAKE DAM	6	21	52	105	187	313	459	632	828	1044	1272	1529	1754	1959	2147	2281	2383	2460	2517	2558	2586
LITCHFIELD	17	50	105	190	308	480	670	887	1127	1384	1653	1954	2221	2468	2705	2882	3026	3139	3226	3289	3330
LITTLE FALLS 1 N	12	37	83	155	258	408	577	772	990	1228	1479	1759	2006	2233	2445	2602	2725	2819	2890	2939	2971
LONG PRAIRIE	13	37	78	144	239	381	542	730	943	1174	1418	1692	1933	2153	2358	2507	2621	2708	2773	2819	2850
MADISON SEWAGE PLANT	19	53	109	194	314	486	679	900	1145	1407	1682	1990	2264	2517	2760	2942	3087	3202	3290	3352	3393
MAPLE PLAIN	17	50	107	193	313	483	669	882	1116	1366	1629	1923	2184	2425	2655	2827	2968	3080	3169	3235	3280
MARSHALL	19	55	115	207	334	518	721	953	1206	1476	1756	2069	2348	2609	2861	3053	3209	3333	3429	3499	3546
MEADOWLANDS	5	16	41	87	158	268	396	549	724	919	1129	1366	1574	1759	1927	2044	2131	2194	2240	2274	2296
MILACA	11	35	80	151	251	397	560	751	964	1198	1446	1725	1970	2195	2406	2561	2681	2772	2839	2885	2914
MILAN	18	51	105	188	304	473	660	876	1114	1369	1637	1937	2204	2452	2691	2869	3010	3117	3197	3253	3289
MINNEAPOLIS-ST PAUL	23	67	137	239	375	564	768	1000	1256	1530	1818	2139	2422	2685	2941	3137	3299	3429	3529	3601	3647
MONTEVIDEO 1 SW	16	48	105	193	316	493	687	908	1150	1409	1679	1981	2250	2501	2743	2924	3071	3186	3275	3338	3380
MOOSE LAKE 1 SSE	3	14	38	83	153	260	386	539	718	921	1140	1388	1605	1802	1984	2114	2214	2290	2346	2384	2409
MORA	10	34	78	148	249	395	557	746	960	1193	1442	1721	1966	2190	2400	2555	2675	2767	2835	2881	2911
MORRIS W C SCHOOL	16	48	101	183	297	463	647	859	1091	1338	1597	1888	2149	2393	2627	2799	2933	3033	3107	3158	3191
NEW LONDON	14	43	95	176	291	457	642	855	1091	1346	1613	1912	2175	2418	2651	2825	2965	3073	3154	3211	3247
NEW ULM	22	61	125	220	350	536	740	973	1227	1496	1775	2085	2358	2614	2864	3057	3216	3344	3443	3513	3560
OLIVIA	21	57	118	209	336	518	718	945	1194	1458	1732	2036	2306	2556	2799	2984	3136	3258	3352	3420	3465
PARK RAPIDS	5	20	53	110	197	331	484	663	864	1084	1317	1582	1818	2034	2235	2377	2482	2559	2615	2655	2682
PINE RIVER DAM	6	22	56	115	203	335	486	663	862	1082	1316	1578	1808	2016	2208	2347	2453	2534	2594	2636	2663
PIPESTONE	12	37	83	157	266	427	610	822	1057	1309	1574	1870	2135	2382	2619	2795	2933	3038	3114	3166	3199
POKEGAMA DAM	7	23	55	109	190	313	454	621	811	1019	1241	1492	1713	1913	2097	2227	2324	2396	2449	2487	2513
PRESTON	17	48	100	179	290	451	630	836	1062	1304	1556	1837	2085	2316	2539	2707	2843	2949	3029	3084	3120
RED LAKE FALLS	12	35	77	142	235	373	530	712	917	1140	1378	1646	1885	2104	2309	2456	2567	2651	2712	2755	2784
RED LAKE INDIAN	5	20	52	109	196	328	479	654	850	1064	1292	1551	1780	1989	2180	2313	2412	2486	2542	2585	2616
ROCHESTER WSO	18	53	111	198	319	491	682	899	1138	1391	1654	1947	2205	2446	2680	2860	3007	3126	3218	3284	3328
ROSEAU 1 E	6	21	51	101	177	294	429	589	771	970	1182	1421	1630	1819	1989	2106	2191	2252	2297	2330	2352
ROSEMOUNT AGRI EXP	16	47	99	178	290	453	634	844	1076	1324	1583	1872	2127	2362	2588	2758	2895	3004	3087	3147	3186
ST CLOUD WSO	14	43	94	173	285	443	618	819	1042	1284	1538	1823	2074	2304	2522	2685	2815	2916	2992	3045	3078
ST PETER 2 SW	19	57	122	220	353	542	747	980	1234	1504	1783	2093	2368	2624	2873	3064	3221	3347	3444	3514	3561
SANDY LAKE DAM	6	20	52	106	189	315	459	629	821	1032	1256	1508	1730	1932	2117	2248	2349	2425	2482	2525	2553
SPRINGFIELD 1 NW	18	53	114	207	338	525	731	965	1218	1485	1758	2058	2324	2571	2814	3001	3155	3279	3373	3441	3485
THIEF RIVER FALLS	8	28	65	126	215	348	499	675	873	1089	1319	1580	1814	2028	2228	2369	2474	2548	2601	2638	2662
TRACY	16	48	105	193	317	497	698	927	1179	1446	1725	2037	2315	2575	2825	3014	3168	3290	3384	3452	3497
TWO HARBORS	1	5	17	39	74	130	203	301	430	590	775	995	1194	1378	1551	1678	1775	1847	1897	1929	1947
VIRGINIA	3	15	42	92	169	287	422	583	766	968	1183	1427	1640	1831	2003	2124	2213	2279	2328	2364	2389
WADENA 3 S	8	28	68	134	231	376	539	728	940	1169	1412	1688	1934	2160	2372	2524	2640	2725	2788	2833	2863
WALKER	6	23	57	115	202	331	479	651	845	1059	1288	1547	1776	1984	2176	2311	2414	2492	2552	2597	2627
WARROAD	4	14	39	84	155	268	403	565	750	954	1172	1418	1634	1829	2007	2130	2219	2283	2329	2361	2383
WASECA EXP STA	13	43	97	181	301	474	664	882	1119	1371	1632	1921	2176	2414	2644	2819	2961	3073	3158	3218	3257
WHEATON	18	50	104	186	303	473	663	881	1122	1381	1653	1960	2235	2493	2741	2928	3078	3193	3280	3342	3382
WILLMAR ST HOSP	18	51	106	191	309	479	668	885	1125	1382	1651	1950	2215	2462	2700	2881	3028	3144	3234	3297	3339
WINDOM	22	59	118	206	328	506	706	935	1188	1455	1732	2038	2309	2561	2806	2994	3147	3268	3361	3429	3476
WINNEBAGO	23	63	127	221	351	535	738	968	1217	1481	1752	2054	2323	2574	2820	3009	3165	3289	3385	3454	3501
WINNIBIGOSHISH DAM	5	20	51	106	190	318	467	643	843	1061	1293	1553	1782	1988	2178	2311	2410	2483	2537	2575	2601
WINONA	25	72	146	252	392	584	791	1024	1278	1548	1830	2143	2420	2678	2930	3126	3290	3426	3533	3614	3669
WORTHINGTON	20	56	115	203	327	505	701	925	1169	1429	1699	2000	2266	2514	2753	2934	3080	3195	3283	3347	3390
ZUMBROTA	18	50	104	185	297	461	644	855	1090	1341	1603	1895	2154	2393	2624	2798	2941	3054	3143	3207	3250
FARGO ND WSO	14	43	94	174	285	445	622	824	1050	1296	1558	1856	2121	2368	2602	2773	2907	3009	3085	3137	3172
SIOUX FALLS SD WSO	25	67	133	231	363	550	755	990	1251	1532	1829	2162	2457	2733	3001	3205	3371	3501	3600	3669	3713
LA CROSSE WI WSO	25	71	147	257	402	600	811	1047	1304	1578	1864	2184	2468	2734	2995	3199	3371	3512	3624	3705	3760

Appendix Table 6. Normal total growing degree days, T_b = 50°F, at selected dates and adjusted to an 8 a.m. observation time.

	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER			OCTOBER		
	10	20	30	10	20	31	10	20	30	10	20	31	10	20	31	10	20	30	10	20	31
ADA	6	19	45	89	156	259	380	526	694	881	1083	1315	1522	1710	1882	2000	2084	2141	2180	2206	2224
ALBERT LEA	8	25	55	107	187	314	466	647	850	1067	1293	1546	1768	1973	2165	2304	2410	2489	2547	2589	2616
ALEXANDRIA FAA AP	5	18	43	88	156	263	388	540	715	912	1123	1363	1575	1767	1942	2063	2150	2211	2252	2279	2296
ARGYLE 4 E	3	12	32	69	129	225	338	473	627	795	977	1186	1373	1543	1694	1792	1858	1899	1928	1948	1963
ARTICHOKE LAKE	7	21	48	94	165	278	412	575	762	969	1190	1439	1658	1859	2044	2176	2273	2341	2389	2421	2441
AUSTIN 3 S	9	25	53	101	174	289	426	589	774	973	1179	1409	1610	1795	1967	2092	2187	2257	2306	2340	2361
BABBITT 2 SE	0	0	12	39	85	158	245	351	476	620	778	959	1116	1252	1365	1433	1476	1504	1525	1542	1556
BAUDETTE	0	4	18	46	92	166	255	366	497	647	812	999	1160	1300	1418	1493	1540	1570	1590	1604	1614
BEMIDJI AP	1	7	24	56	108	191	292	415	562	729	911	1117	1295	1452	1587	1674	1731	1769	1794	1812	1825
BENSON	7	22	52	104	182	303	445	613	804	1013	1236	1487	1709	1912	2098	2229	2324	2391	2437	2468	2488
BIG FALLS	0	5	17	43	87	160	249	359	489	637	799	983	1142	1281	1397	1468	1512	1540	1561	1578	1592
BROWNS VALLEY	4	16	40	84	153	262	394	554	738	942	1162	1412	1635	1840	2029	2163	2261	2330	2378	2409	2429
CAMBRIDGE ST HOSP	5	18	46	93	164	275	404	559	736	931	1140	1374	1579	1762	1928	2043	2126	2186	2229	2259	2278
CAMPBELL	6	19	43	85	152	260	389	545	720	912	1115	1348	1556	1748	1925	2046	2131	2187	2224	2250	2267
CANBY	10	28	61	113	194	319	469	648	852	1074	1309	1575	1811	2028	2231	2377	2488	2569	2629	2670	2698
CASS LAKE	3	11	26	55	104	185	288	414	561	724	899	1097	1271	1427	1562	1649	1705	1740	1764	1782	1796
CHASKA	5	20	50	103	185	312	461	637	835	1050	1276	1528	1750	1952	2139	2273	2373	2445	2497	2533	2555
CLOQUET FOR RES CEN	0	2	10	29	61	117	190	286	408	553	715	900	1060	1197	1313	1386	1433	1463	1484	1499	1510
COLLEGEVILLE ST JOHN	6	21	50	99	173	286	418	575	754	952	1163	1403	1615	1807	1983	2106	2196	2260	2306	2338	2359
CROOKSTON NW EXP STA	3	12	30	65	122	216	329	467	627	804	996	1217	1415	1595	1757	1865	1938	1986	2018	2040	2055
DETROIT LAKES 1 NNE	1	6	17	40	83	157	252	372	512	670	841	1037	1211	1366	1500	1584	1636	1666	1684	1698	1708
DULUTH WSO	0	3	13	33	66	121	191	285	404	547	707	891	1050	1189	1309	1388	1443	1482	1509	1529	1542
FAIRMONT	11	33	73	139	235	380	546	737	949	1175	1410	1671	1901	2115	2318	2469	2589	2680	2747	2794	2824
FARIBAULT	8	25	56	108	186	309	454	627	823	1036	1258	1504	1720	1917	2102	2237	2340	2416	2471	2508	2530
FARMINGTON 3 NW	9	27	61	117	200	326	471	641	832	1039	1256	1500	1715	1911	2093	2222	2319	2392	2446	2485	2511
FERGUS FALLS	3	12	33	73	138	243	368	520	694	887	1095	1332	1544	1735	1909	2027	2110	2166	2205	2232	2250
FOSSTON	4	14	34	71	128	219	327	458	610	780	965	1178	1367	1536	1685	1782	1848	1892	1924	1948	1967
GLENWOOD	4	15	39	83	151	259	386	540	717	913	1124	1362	1573	1764	1938	2057	2144	2204	2246	2275	2294
GRAND MARAIS	0	0	0	3	8	22	46	88	153	241	352	491	618	733	833	894	932	953	965	973	979
GRAND MEADOW	7	22	52	103	181	302	443	608	792	990	1197	1428	1631	1818	1992	2118	2214	2285	2338	2375	2399
GRAND RAPIDS NC SCHL	1	6	20	48	94	168	259	372	506	658	824	1012	1175	1316	1436	1510	1558	1589	1610	1627	1639
GULL LAKE DAM	2	9	27	62	119	211	323	459	619	798	992	1211	1402	1572	1723	1823	1893	1941	1974	1998	2013
HALLOCK	3	11	31	68	128	222	336	473	631	805	993	1207	1395	1563	1711	1806	1869	1909	1937	1957	1972
HINCKLEY	0	2	15	42	91	173	276	402	550	717	897	1103	1284	1444	1583	1673	1732	1770	1797	1817	1831
INTERNATIONAL FALLS	0	4	17	46	93	169	260	374	508	662	830	1020	1182	1322	1438	1510	1555	1584	1604	1620	1633
ITASCA ST PARK SCHL	1	6	19	45	89	164	257	373	511	668	839	1034	1204	1355	1484	1566	1619	1653	1677	1695	1708
JORDAN 1 S	8	24	55	107	184	301	438	600	784	983	1194	1429	1634	1820	1991	2111	2201	2268	2317	2353	2376
LEECH LAKE DAM	1	6	20	48	96	176	274	397	543	708	886	1088	1264	1418	1551	1638	1696	1736	1764	1785	1799
LITCHFIELD	7	22	51	101	177	297	437	605	794	1001	1220	1466	1683	1880	2062	2190	2285	2353	2404	2439	2462
LITTLE FALLS 1 N	4	15	38	79	144	245	364	509	677	864	1065	1291	1488	1664	1822	1929	2006	2060	2097	2123	2140
LONG PRAIRIE	5	15	36	72	130	222	335	473	635	816	1010	1229	1421	1591	1741	1840	1909	1956	1989	2013	2030
MADISON SEWAGE PLANT	9	25	54	103	179	298	441	612	807	1020	1245	1498	1721	1925	2112	2244	2341	2411	2460	2495	2517
MAPLE PLAIN	6	21	51	101	177	294	431	593	777	978	1191	1430	1640	1831	2006	2130	2222	2291	2344	2382	2409
MARSHALL	8	24	55	108	189	319	472	653	857	1077	1307	1564	1793	2004	2202	2344	2450	2529	2587	2628	2655
MEADOWLANDS	0	3	14	37	76	142	223	326	450	595	755	938	1095	1231	1345	1416	1461	1491	1511	1527	1538
MILACA	3	13	34	73	134	229	344	484	648	831	1029	1253	1449	1624	1780	1884	1957	2006	2039	2062	2077
MILAN	8	24	52	101	175	292	430	595	783	989	1206	1451	1668	1867	2050	2178	2272	2337	2381	2411	2430
MINNEAPOLIS-ST PAUL	10	32	72	136	227	363	517	699	904	1129	1367	1633	1866	2079	2279	2426	2539	2623	2684	2725	2750
MONTEVIDEO 1 SW	6	19	47	97	174	296	440	612	804	1013	1233	1480	1699	1900	2086	2218	2316	2386	2436	2471	2493
MOOSE LAKE 1 SSE	0	1	11	33	70	132	212	315	443	594	764	957	1125	1272	1399	1482	1538	1576	1603	1622	1635
MORA	3	12	33	72	133	228	342	481	644	828	1026	1251	1446	1620	1775	1879	1953	2003	2037	2061	2076
MORRIS W C SCHOOL	7	22	50	97	170	285	421	582	764	961	1169	1406	1617	1811	1990	2112	2199	2258	2297	2324	2341
NEW LONDON	5	18	44	91	164	278	413	576	763	967	1185	1428	1642	1835	2013	2138	2229	2294	2339	2369	2388
NEW ULM	9	27	61	117	201	333	487	669	874	1093	1322	1576	1800	2006	2201	2343	2452	2533	2591	2631	2656
OLIVIA	9	27	60	115	198	327	477	654	853	1067	1291	1540	1760	1961	2148	2283	2386	2462	2518	2557	2583
PARK RAPIDS	0	5	19	48	99	184	289	418	568	737	921	1131	1317	1483	1629	1723	1785	1824	1851	1870	1884
PINE RIVER DAM	0	6	21	53	106	191	293	420	569	739	922	1130	1310	1468	1605	1695	1757	1798	1827	1848	1862
PIPESTONE	2	10	30	68	133	241	374	536	721	923	1137	1379	1594	1791	1973	2098	2188	2249	2289	2316	2332
POKEGAMA DAM	1	7	22	51	98	175	269	387	525	683	856	1052	1223	1373	1503	1585	1639	1675	1699	1718	1731
PRESTON	6	19	46	91	161	272	402	557	733	925	1127	1353	1552	1733	1900	2018	2105	2166	2210	2239	2257
RED LAKE FALLS	5	15	36	73	130	221	329	462	617	790	977	1190	1379	1548	1698	1798	1866	1912	1943	1966	1981
RED LAKE INDIAN	0	5	21	53	106	193	297	423	568	732	910	1114	1294	1452	1589	1675	1731	1768	1795	1818	1836
ROCHESTER WSO	7	23	53	104	182	302	444	611	800	1003	1216	1453	1662	1854	2032	2160	2258	2331	2385	2423	2448
ROSEAU 1 E	1	7	21	48	93	166	255	365	496	645	808	992	1151	1290	1408	1481	1528	1558	1578	1594	1606
ROSEMOUNT AGRI EXP	6	20	47	92	163	274	407	566	748	946	1155	1389	1594	1780	1950	2070	2159	2223	2270	2303	2325
ST CLOUD WSO	5	18	44	90	159	266	392	543	716	907	1112	1342	1542	1723	1886	1999	2082	2141	2182	2210	2228
ST PETER 2 SW	7	24	58	116	203	337	493	676	880	1099	1329	1584	1809	2015	2209	2349	2455	2534	2592	2632	2658
SANDY LAKE DAM	0	5	19	47	95	174	270	390	532	692	866	1064	1236	1387	1518	1602	1658	1696	1723	1745	1761
SPRINGFIELD 1 NW	6	22	52	107	191	324	480	664	868	1084	1307	1553	1768	1966	2153	2289	2393	2470	2526	2563	2587
THIEF RIVER FALLS	3	11	29	63	117	204	308	434	582	747	927	1134	1317	1482	1627	1722	1785	1824	1849	1867	1879
TRACY	6	19	47	96	175	301	451	630	832	1050	1279	1536	1763	1973	2168	2308	2413	2490	2545	2584	2609
TWO HARBORS	0	0	3	11	23	44	77	129	209	318	453	619	769	903	1022	1099	1152	1185	1206	1218	1225
VIRGINIA	0	2	14	40	83	156	245	356	489	640	806	995	1158	1299	1418	1492	1540	1571	1594	1612	1625
WADENA 3 S	1	9	27	62	121	216	330	469	630	809	1003	1224	1420	1596	1753	1857	1928	1974	2006	2029	2045
WALKER	1	7	23	54	105	188	288	410	554	718	896	1101	1286	1431	1575	1664	1723	1764	1795	1818	1835
WARROAD	0	3	15	38	80	150	239	351	486	639	808	999	1165	1310	1434	1511	1561	1592	1612	1627	1639
WASECA EXP STA	4	15	40	87	162	281	422	590	777	979	1189	1423	1629	1817	1991	2116	2209	2276	2324	2357	2378
WHEATON	7	22	51	100	176	295	436	604	794	1003	1225	1478	1703	1910	2104	2241	2343	2415	2465	2499	2521
WILLMAR ST HOSP	8	23	52	102	177	295	434	601	791	998	1217	1462	1677	1874	2056	2187	2285	2357	2409	2444	2467
WINDOM	10	29	60	110	189	314	463	643	846	1063	1290	1541	1762	1964	2154	2291	2395	2471	2526	2565	2591
WINNEBAGO	10	30	65	123	209	342	495	675	874	1087	1309	1556	1774	1976	2167	2306	2412	2491	2548	2588	2614
WINNIBIGOSHISH DAM	1	6	20	49	98	181	282	408	557	725	906	1112	1291	1447	1582	1667	1723	1759	1785	1804	1818
WINONA	11	35	77	144	240	380	538	721	925	1145	1376	1634	1862	2070	2267	2412	2526	2615	2682	2731	2763
WORTHINGTON	8	25	56	108	188	313	460	634	828	1038	1258	1504	1720	1919	2102	2233	2330	2400	2451	2487	2511
ZUMBROTA	7	22	49	94	165	277	410	572	756	957	1169	1406	1615	1805	1980	2104	2197	2266	2317	2354	2378
FARGO ND WSO	6	19	47	94	166	275	403	556	731	927	1139	1382	1598	1794	1973	2096	2184	2245	2287	2316	2335
SIOUX FALLS SD WSO	11	31	67	126	214	347	502	687	898	1130	1377	1654	1900	2126	2338	2492	2609	2694	2754	2793	2817
LA CROSSE WI WSO	10	33	77	146	245	389	550	736	943	1167	1403	1668	1902	2118	2324	2477	2599	2693	2764	2812	2843

Appendix Table 7. Normal total growing degree days, T_b = 55°F, at selected dates and adjusted to an 8 a.m. observation time.

	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER			OCTOBER		
	10	20	30	10	20	31	10	20	30	10	20	31	10	20	31	10	20	30	10	20	31
ADA	2	7	19	41	79	140	217	314	432	569	721	898	1055	1193	1312	1386	1433	1460	1476	1488	1497
ALBERT LEA	3	9	21	44	87	165	268	399	551	718	894	1092	1265	1420	1557	1645	1703	1742	1770	1792	1808
ALEXANDRIA FAA AP	1	6	18	40	78	142	222	324	450	596	758	943	1104	1245	1367	1443	1492	1521	1539	1551	1559
ARGYLE 4 E	0	3	12	30	63	119	189	275	379	497	630	784	920	1040	1140	1198	1230	1246	1256	1265	1272
ARTICHOKE LAKE	2	8	19	41	79	145	233	346	483	640	811	1005	1174	1324	1456	1540	1595	1629	1651	1665	1675
AUSTIN 3 S	3	9	21	43	82	152	242	356	490	639	796	971	1122	1256	1374	1452	1503	1537	1560	1575	1587
BABBITT 2 SE	0	0	3	17	41	80	127	188	266	360	469	595	702	790	856	891	907	916	922	930	937
BAUDETTE	0	0	5	20	45	84	133	197	280	381	497	628	739	829	900	939	959	970	977	982	986
BEMIDJI AP	0	0	8	24	52	99	158	235	333	451	583	734	861	968	1052	1100	1127	1141	1150	1157	1163
BENSON	2	8	21	47	92	167	261	379	520	679	852	1048	1220	1372	1505	1588	1642	1675	1695	1710	1719
BIG FALLS	0	0	5	18	40	78	127	192	274	373	486	614	723	813	882	918	935	944	951	958	965
BROWNS VALLEY	1	4	13	32	68	133	218	327	461	615	785	981	1153	1307	1443	1530	1587	1622	1643	1657	1667
CAMBRIDGE ST HOSP	1	5	17	40	79	144	226	331	458	603	762	941	1096	1229	1342	1411	1455	1482	1501	1515	1525
CAMPBELL	2	6	16	36	72	137	220	326	451	592	746	923	1081	1223	1346	1423	1469	1495	1510	1521	1529
CANBY	4	12	26	53	99	178	280	410	563	735	920	1131	1317	1484	1633	1731	1799	1843	1873	1895	1910
CASS LAKE	0	3	9	23	48	93	154	233	331	445	570	713	836	942	1027	1075	1100	1112	1120	1128	1135
CHASKA	1	5	16	41	86	165	265	391	539	703	879	1076	1248	1400	1533	1619	1675	1710	1734	1750	1762
CLOQUET FOR RES CEN	0	0	2	10	24	48	82	134	207	303	416	546	655	743	810	845	864	873	880	885	890
COLLEGEVILLE ST JOHN	2	7	21	46	88	156	241	348	476	624	786	971	1132	1274	1396	1473	1523	1555	1575	1590	1601
CROOKSTON NW EXP STA	0	3	10	27	56	110	179	269	378	505	647	813	960	1090	1200	1265	1304	1324	1336	1346	1353
DETROIT LAKES 1 NNE	0	1	4	13	31	68	120	191	281	389	511	652	775	880	964	1009	1030	1038	1041	1046	1051
DULUTH WSO	0	0	3	12	25	49	81	130	201	294	405	533	642	732	803	844	869	884	895	903	909
FAIRMONT	4	13	32	68	125	221	337	479	641	817	1001	1208	1388	1551	1699	1802	1875	1926	1962	1987	2003
FARIBAULT	3	9	22	46	89	164	261	384	530	692	864	1056	1222	1369	1499	1585	1643	1681	1706	1723	1735
FARMINGTON 3 NW	3	10	25	54	101	179	277	397	537	694	861	1050	1215	1361	1488	1570	1625	1661	1688	1708	1722
FERGUS FALLS	0	3	10	28	62	122	201	304	428	571	729	912	1073	1214	1335	1409	1453	1479	1495	1507	1517
FOSSTON	0	4	13	32	63	114	179	263	364	485	620	778	916	1035	1134	1191	1223	1242	1255	1266	1276
GLENWOOD	0	4	14	34	71	134	215	319	445	591	752	936	1097	1237	1357	1431	1478	1506	1523	1537	1546
GRAND MARAIS	0	0	0	1	1	2	6	20	47	93	156	239	315	381	432	457	467	470	471	472	475
GRAND MEADOW	1	6	19	45	89	164	258	374	507	655	812	988	1141	1278	1398	1476	1529	1564	1588	1606	1619
GRAND RAPIDS NC SCHL	0	0	6	19	43	81	131	197	282	385	501	634	746	838	908	946	965	974	981	988	994
GULL LAKE DAM	0	1	9	26	56	109	176	264	373	502	646	810	950	1070	1168	1227	1261	1281	1294	1304	1312
HALLOCK	0	3	11	30	63	119	189	278	385	510	648	807	947	1068	1166	1223	1253	1269	1279	1288	1297
HINCKLEY	0	0	2	12	34	75	132	209	306	423	554	705	834	943	1031	1079	1105	1118	1126	1134	1141
INTERNATIONAL FALLS	0	0	5	20	44	85	137	206	292	398	516	650	762	852	921	957	975	984	991	997	1003
ITASCA ST PARK SCHL	0	1	6	18	39	78	130	200	290	397	518	658	777	878	958	1002	1025	1037	1045	1053	1059
JORDAN 1 S	2	9	22	47	90	161	250	363	495	645	805	985	1141	1276	1393	1467	1515	1547	1570	1588	1600
LEECH LAKE DAM	0	0	6	19	44	86	142	218	313	428	558	705	829	933	1016	1063	1089	1104	1115	1123	1131
LITCHFIELD	2	8	21	45	88	162	255	373	513	670	839	1030	1197	1343	1471	1552	1606	1640	1663	1681	1693
LITTLE FALLS 1 N	0	3	14	35	70	129	204	299	416	553	704	875	1022	1147	1252	1316	1356	1380	1396	1407	1415
LONG PRAIRIE	1	5	14	31	61	113	181	271	383	513	658	822	963	1082	1180	1238	1271	1290	1303	1314	1322
MADISON SEWAGE PLANT	3	10	22	45	87	160	255	377	521	683	858	1057	1230	1383	1517	1602	1656	1690	1713	1729	1741
MAPLE PLAIN	2	7	19	43	85	156	246	359	493	644	807	991	1151	1291	1413	1490	1542	1577	1603	1624	1639
MARSHALL	2	8	20	45	90	170	275	406	560	729	909	1112	1291	1452	1595	1689	1752	1794	1823	1844	1858
MEADOWLANDS	0	0	3	14	33	65	106	162	238	334	445	572	679	767	833	868	886	894	901	907	913
MILACA	0	3	11	29	60	114	184	275	388	521	670	839	984	1109	1211	1272	1307	1326	1339	1348	1356
MILAN	3	9	22	46	87	159	250	366	504	659	827	1017	1183	1332	1461	1544	1597	1629	1648	1662	1671
MINNEAPOLIS-ST PAUL	3	12	32	66	120	208	314	446	601	776	964	1175	1358	1521	1667	1765	1834	1881	1912	1933	1945
MONTEVIDEO 1 SW	1	5	15	38	79	153	249	370	513	671	841	1034	1202	1353	1485	1570	1626	1660	1683	1698	1709
MOOSE LAKE 1 SSE	0	0	2	12	28	57	96	152	232	333	453	592	710	808	885	928	953	967	977	985	991
MORA	0	2	10	29	61	115	183	273	386	519	668	838	983	1107	1209	1270	1306	1326	1339	1349	1356
MORRIS W C SCHOOL	2	8	20	44	85	156	245	357	488	635	793	975	1136	1280	1404	1483	1531	1558	1574	1585	1594
NEW LONDON	1	5	17	40	80	149	237	350	485	640	808	996	1160	1302	1426	1505	1557	1588	1608	1621	[illegible]
NEW ULM	3	9	23	50	97	180	285	418	571	741	919	1119	1293	1449	1589	1681	1744	1786	1813	1833	1846
OLIVIA	4	11	26	54	101	183	285	413	561	725	899	1093	1263	1413	1546	1634	1693	1733	1760	1780	1794
PARK RAPIDS	0	0	5	18	43	89	149	229	329	447	581	736	871	987	1082	1135	1164	1179	1188	1196	1203
PINE RIVER DAM	0	0	6	22	49	95	154	233	333	452	586	739	868	976	1061	1110	1138	1154	1164	1172	1179
PIPESTONE	0	1	6	21	53	116	201	313	447	599	763	950	1115	1262	1389	1468	1517	1544	1560	1571	1579
POKEGAMA DAM	0	1	7	20	44	85	139	210	300	408	531	671	791	892	971	1015	1039	1051	1059	1066	1073
PRESTON	1	5	16	38	77	144	228	334	460	601	753	925	1074	1204	1317	1388	1434	1462	1480	1493	1502
RED LAKE FALLS	1	5	14	33	63	115	181	266	371	494	632	790	928	1047	1146	1205	1240	1260	1272	1282	1289
RED LAKE INDIAN	0	0	6	23	53	103	165	244	341	455	583	732	860	969	1056	1103	1128	1141	1151	1161	1172
ROCHESTER WSO	2	8	21	46	89	164	258	376	514	667	830	1013	1172	1313	1437	1517	1570	1606	1631	1651	1665
ROSEAU 1 E	0	1	7	20	43	82	132	197	280	380	492	621	732	823	895	935	955	965	972	978	984
ROSEMOUNT AGRI EXP	1	6	17	40	79	146	232	342	472	619	779	958	1113	1249	1365	1438	1486	1516	1537	1553	1565
ST CLOUD WSO	1	5	16	39	77	140	219	321	443	585	740	914	1065	1195	1305	1373	1417	1444	1462	1475	1484
ST PETER 2 SW	1	7	20	48	98	183	291	423	576	745	925	1126	1301	1458	1595	1685	1746	1785	1812	1832	1846
SANDY LAKE DAM	0	0	5	18	42	83	137	209	301	412	537	680	801	902	982	1027	1051	1064	1074	1083	1091
SPRINGFIELD 1 NW	1	6	17	43	90	174	282	415	569	735	907	1098	1264	1412	1544	1631	1690	1729	1755	1773	1785
THIEF RIVER FALLS	0	3	11	27	56	105	167	248	346	463	593	744	877	991	1086	1142	1173	1189	1198	1204	1210
TRACY	1	5	15	37	79	157	258	388	539	707	886	1088	1265	1424	1566	1658	1720	1760	1787	1806	1820
TWO HARBORS	0	0	0	3	6	9	17	36	76	140	227	338	438	524	593	632	652	662	667	670	673
VIRGINIA	0	0	3	15	36	73	122	189	273	376	492	626	739	832	904	942	961	970	977	985	992
WADENA 3 S	0	1	8	24	54	107	177	267	377	506	650	816	961	1088	1193	1255	1291	1310	1322	1332	1340
WALKER	0	1	7	22	48	91	150	226	321	455	565	713	841	950	1037	1086	1114	1130	1142	1153	1162
WARROAD	0	0	4	16	37	75	124	190	276	381	499	635	751	847	922	963	985	996	1002	1008	1013
WASECA EXP STA	0	2	11	32	72	144	237	354	491	642	803	982	1138	1275	1396	1473	1524	1556	1578	1593	1604
WHEATON	2	8	20	46	90	165	259	377	517	675	848	1045	1220	1377	1517	1608	1668	1706	1730	1746	1756
WILLMAR ST HOSP	3	8	21	46	88	160	252	369	508	665	834	1024	1189	1335	1463	1547	1602	1639	1663	1680	1692
WINDOM	4	12	25	49	93	171	273	403	555	723	899	1096	1267	1419	1554	1643	1703	1742	1769	1788	1802
WINNEBAGO	3	11	28	58	110	196	301	431	580	742	914	1107	1275	1427	1563	1654	1717	1758	1787	1806	1820
WINNIBIGOSHISH DAM	0	0	6	20	45	90	149	227	326	444	576	726	854	961	1045	1091	1115	1128	1137	1145	1152
WINONA	3	13	34	72	131	224	334	467	620	790	971	1175	1353	1511	1653	1749	1817	1865	1901	1927	1945
WORTHINGTON	3	8	22	48	93	172	271	395	539	698	868	1059	1226	1374	1504	1587	1642	1677	1701	1718	1731
ZUMBROTA	2	7	18	39	77	144	232	344	477	627	789	972	1131	1271	1391	1468	1518	1551	1575	1594	1607
FARGO ND WSO	1	6	19	44	85	152	234	338	464	609	772	959	1125	1271	1397	1476	1526	1556	1575	1589	1599
SIOUX FALLS SD WSO	4	12	27	57	108	193	301	436	597	779	976	1199	1394	1570	1728	1834	1907	1954	1984	2003	2015
LA CROSSE WI WSO	3	12	32	70	130	225	337	473	629	803	990	1200	1384	1550	1701	1804	1879	1932	1970	1995	2012

Appendix Table 8. Normal total growing degree days, T_b = 60°F, at selected dates and adjusted to an 8 a.m. observation time.

	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER			OCTOBER		
	10	20	30	10	20	31	10	20	30	10	20	31	10	20	31	10	20	30	10	20	31
ADA	0	1	6	17	35	66	106	160	232	321	425	547	653	743	814	854	874	884	888	893	897
ALBERT LEA	1	3	5	13	31	70	129	211	312	429	556	699	821	926	1010	1057	1082	1096	1105	1115	1125
ALEXANDRIA FAA AP	0	1	6	16	34	65	107	166	245	343	456	585	695	786	859	899	921	932	938	942	945
ARGYLE 4 E	0	0	3	12	28	55	89	135	193	265	349	448	535	608	665	693	705	708	709	712	716
ARTICHOKE LAKE	1	2	6	14	30	63	110	178	266	374	495	633	752	851	932	978	1003	1015	1022	1027	1032
AUSTIN 3 S	1	2	6	15	32	66	116	185	271	371	479	599	699	783	850	889	910	922	929	936	941
BABBITT 2 SE	0	0	0	8	19	35	55	82	121	172	234	306	367	414	446	460	463	464	465	467	471
BAUDETTE	0	0	1	9	21	37	57	86	128	186	254	333	396	444	477	493	499	502	503	504	506
BEMIDJI AP	0	0	2	10	23	44	72	112	167	240	324	420	498	558	601	621	630	634	636	638	640
BENSON	0	1	7	18	40	79	131	203	295	405	528	670	790	892	974	1019	1043	1055	1061	1066	1071
BIG FALLS	0	0	1	7	17	33	53	83	126	182	248	325	386	434	466	480	484	485	486	489	492
BROWNS VALLEY	0	0	3	10	25	56	100	164	248	353	474	614	736	840	925	974	1001	1014	1020	1025	1029
CAMBRIDGE ST HOSP	0	0	5	14	32	63	105	165	244	340	450	574	678	763	828	862	879	887	893	898	903
CAMPBELL	0	1	5	13	30	61	105	166	242	334	439	561	668	761	835	876	896	904	908	911	916
CANBY	1	4	9	21	42	85	145	228	332	454	590	746	881	998	1095	1153	1187	1206	1218	1228	1235
CASS LAKE	0	0	2	8	19	40	69	111	166	233	310	398	472	531	575	596	604	606	607	609	613
CHASKA	0	0	3	13	33	73	129	206	303	417	544	686	808	910	992	1037	1062	1074	1081	1087	1093
CLOQUET FOR RES CEN	0	0	0	4	9	15	25	45	81	134	199	275	336	381	410	422	426	427	428	430	432
COLLEGEVILLE ST JOHN	0	1	7	19	39	73	117	179	259	358	471	600	710	801	874	914	936	947	954	960	965
CROOKSTON NW EXP STA	0	0	3	10	23	47	81	129	192	271	364	474	571	652	716	750	765	771	773	776	780
DETROIT LAKES 1 NNE	0	0	1	3	9	22	42	75	122	184	257	344	417	476	518	536	539	540	541	541	542
DULUTH WSO	0	0	1	4	9	15	24	41	74	124	187	262	323	370	404	420	427	431	434	437	440
FAIRMONT	1	4	11	27	57	111	183	276	387	513	648	800	930	1043	1139	1198	1235	1258	1273	1284	1293
FARIBAULT	1	2	6	15	34	72	126	202	297	410	532	669	785	882	960	1005	1030	1044	1052	1059	1064
FARMINGTON 3 NW	0	2	8	21	43	84	138	211	301	408	527	660	774	869	945	989	1013	1027	1037	1045	1053
FERGUS FALLS	0	0	2	9	22	50	91	149	226	321	431	558	668	761	834	873	892	899	903	908	913
FOSSTON	0	0	4	13	27	51	83	126	183	256	343	445	533	607	663	690	703	707	710	715	720
GLENWOOD	0	0	3	12	29	58	99	158	236	334	446	575	685	776	847	885	904	913	918	923	927
GRAND MARAIS	0	0	0	0	0	0	0	1	9	25	51	86	117	142	159	162	162	163	163	163	163
GRAND MEADOW	0	0	5	16	38	77	130	199	284	382	490	611	713	799	869	908	930	943	951	959	965
GRAND RAPIDS NC SCHL	0	0	1	8	18	33	53	83	127	185	255	333	397	445	477	490	495	496	497	499	501
GULL LAKE DAM	0	0	2	10	24	48	80	126	189	271	365	473	563	635	688	714	727	732	735	739	742
HALLOCK	0	0	3	12	28	56	92	140	201	277	366	472	566	644	703	732	742	744	746	749	754
HINCKLEY	0	0	0	4	11	25	46	81	134	203	286	380	459	520	563	582	588	590	591	593	597
INTERNATIONAL FALLS	0	0	1	8	20	38	61	94	141	202	273	353	417	466	498	511	516	517	518	520	523
ITASCA ST PARK SCHL	0	0	1	7	15	31	54	87	134	196	269	353	424	480	520	539	546	548	549	552	555
JORDAN 1 S	0	2	7	17	37	72	120	186	270	370	481	606	710	795	861	898	918	929	937	944	951
LEECH LAKE DAM	0	0	1	8	18	36	60	96	149	217	298	390	465	523	564	584	592	595	598	601	604
LITCHFIELD	0	2	6	17	37	75	128	200	292	400	520	655	770	867	944	988	1011	1024	1032	1039	1045
LITTLE FALLS 1 N	0	0	4	14	31	59	95	147	217	305	407	523	618	695	752	783	798	806	811	815	819
LONG PRAIRIE	0	0	4	12	25	48	81	129	195	278	373	482	572	644	697	723	734	738	742	746	750
MADISON SEWAGE PLANT	1	3	7	16	35	72	125	200	295	408	533	676	799	903	986	1032	1056	1068	1075	1081	1087
MAPLE PLAIN	0	1	5	15	34	69	118	186	272	375	488	617	726	817	889	930	954	967	978	987	995
MARSHALL	1	2	5	14	34	75	136	220	323	443	573	721	849	959	1051	1105	1135	1152	1163	1172	1180
MEADOWLANDS	0	0	1	6	13	24	39	62	98	150	214	288	348	394	424	437	441	441	442	444	446
MILACA	0	0	3	10	24	47	80	129	196	281	380	494	588	664	719	747	758	762	764	768	771
MILAN	1	2	7	17	37	74	125	195	284	390	508	643	759	858	937	982	1007	1018	1024	1029	1033
MINNEAPOLIS-ST PAUL	0	3	11	27	55	103	166	250	356	481	619	775	908	1021	1115	1172	1207	1228	1240	1249	1254
MONTEVIDEO 1 SW	0	1	3	11	28	64	118	192	285	395	516	653	771	871	953	999	1024	1036	1043	1048	1053
MOOSE LAKE 1 SSE	0	0	0	5	11	19	31	54	93	151	223	308	378	432	470	487	494	496	499	501	504
MORA	0	0	2	11	24	48	80	128	194	280	380	494	589	666	722	749	762	766	769	772	776
MORRIS W C SCHOOL	0	2	7	17	37	73	123	189	272	369	479	605	715	810	886	928	949	957	961	965	969
NEW LONDON	0	0	5	15	33	68	115	181	268	373	492	625	737	830	904	946	969	980	987	991	994
NEW ULM	1	2	6	16	38	81	143	226	330	449	578	723	846	952	1038	1089	1117	1133	1142	1150	1156
OLIVIA	1	3	9	21	44	87	147	227	326	440	565	704	823	923	1005	1053	1081	1096	1106	1115	1122
PARK RAPIDS	0	0	1	7	17	35	61	99	154	226	311	411	495	563	614	638	647	650	651	654	657
PINE RIVER DAM	0	0	1	9	20	40	66	106	161	234	319	416	495	556	599	619	627	630	632	635	638
PIPESTONE	0	0	1	5	16	44	88	153	238	340	455	587	701	797	873	915	935	943	946	950	953
POKEGAMA DAM	0	0	2	8	18	35	59	93	141	204	278	363	433	489	528	546	552	554	555	558	561
PRESTON	0	0	4	14	32	66	111	172	249	342	446	562	660	741	804	839	856	865	870	874	879
RED LAKE FALLS	0	1	5	13	27	51	84	129	190	266	354	456	544	617	673	702	715	721	724	727	731
RED LAKE INDIAN	0	0	1	10	24	48	79	120	174	242	322	415	494	558	603	624	631	632	634	638	644
ROCHESTER WSO	0	1	6	16	37	76	129	201	290	394	508	636	745	836	909	950	972	984	993	1001	1009
ROSEAU 1 E	0	0	2	8	18	35	57	88	130	185	250	326	390	442	480	497	503	504	505	507	510
ROSEMOUNT AGRI EXP	0	1	5	15	34	67	112	174	256	354	465	590	694	779	845	881	900	911	918	925	930
ST CLOUD WSO	0	0	5	14	32	62	103	160	235	328	434	553	652	733	796	830	847	856	861	866	870
ST PETER 2 SW	0	1	5	16	39	84	147	230	333	452	582	728	853	959	1045	1093	1120	1133	1142	1151	1158
SANDY LAKE DAM	0	0	1	7	17	33	55	90	139	204	281	369	442	498	537	554	561	563	565	568	572
SPRINGFIELD 1 NW	0	1	4	13	35	79	142	227	329	445	569	705	820	917	997	1043	1069	1083	1092	1098	1104
THIEF RIVER FALLS	0	0	3	11	24	47	77	119	175	246	328	425	507	575	628	655	667	671	672	674	677
TRACY	0	1	3	10	28	67	125	206	307	425	555	702	829	938	1028	1081	1111	1126	1136	1144	1151
TWO HARBORS	0	0	0	0	0	0	0	2	16	46	91	152	206	251	283	297	299	300	301	301	302
VIRGINIA	0	0	1	5	14	29	50	81	126	184	253	332	399	450	486	501	505	505	506	509	513
WADENA 3 S	0	0	2	8	21	45	77	124	188	270	365	476	571	650	710	741	754	759	761	765	769
WALKER	0	0	2	8	20	39	65	102	155	223	304	398	477	539	585	607	616	620	623	627	632
WARROAD	0	0	1	7	16	32	53	84	130	189	260	342	410	463	500	518	524	525	526	528	531
WASECA EXP STA	0	0	2	9	26	61	111	181	268	370	481	605	710	798	868	908	929	939	946	952	958
WHEATON	0	1	6	19	41	81	134	206	296	405	528	671	795	903	991	1044	1073	1089	1097	1103	1107
WILLMAR ST HOSP	0	2	7	17	37	73	124	195	285	392	511	646	760	856	933	977	1002	1016	1024	1031	1037
WINDOM	2	4	8	17	37	78	139	222	325	443	570	712	831	933	1017	1066	1093	1108	1118	1126	1133
WINNEBAGO	0	3	9	24	50	98	161	243	342	455	577	715	833	934	1019	1069	1099	1116	1127	1135	1142
WINNIBIGOSHISH DAM	0	0	1	8	19	38	64	103	158	230	313	408	486	546	589	607	614	616	618	621	624
WINONA	0	3	12	31	63	116	184	269	373	494	625	774	901	1009	1098	1152	1184	1205	1220	1232	1241
WORTHINGTON	0	2	6	17	39	81	138	215	310	420	540	676	792	891	970	1015	1039	1052	1060	1067	1074
ZUMBROTA	0	1	5	13	30	63	110	176	260	362	475	603	711	801	871	910	930	941	950	958	965
FARGO ND WSO	0	1	6	18	39	73	117	178	256	354	467	599	714	811	889	933	956	967	973	978	983
SIOUX FALLS SD WSO	1	3	9	21	45	92	157	246	358	491	638	806	951	1076	1182	1246	1284	1305	1317	1324	1330
LA CROSSE WI WSO	0	2	10	28	59	112	181	268	375	499	635	790	925	1040	1138	1198	1235	1259	1274	1286	1295

Appendix Table 9. Normal total growing degree days (or cooling degree days), T_b = 65°F, at selected dates and adjusted to an 8 a.m. observation time.

	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER			OCTOBER		
	10	20	30	10	20	31	10	20	30	10	20	31	10	20	31	10	20	30	10	20	31
ADA	0	0	2	6	14	26	41	65	101	149	208	278	338	386	422	438	445	446	447	448	450
ALBERT LEA	0	1	1	2	7	21	46	87	142	212	290	379	451	509	549	566	571	572	573	577	582
ALEXANDRIA FAA AP	0	0	1	6	13	25	41	68	108	164	231	307	368	416	449	466	473	475	477	478	479
ARGYLE 4 E	0	0	1	4	11	21	34	52	77	110	151	202	246	283	309	319	320	321	322	322	323
ARTICHOKE LAKE	0	0	1	4	9	20	40	72	119	182	255	338	406	460	499	517	525	528	529	530	532
AUSTIN 3 S	0	0	1	4	10	23	44	77	123	180	243	311	363	402	428	441	446	449	451	453	455
BABBITT 2 SE	0	0	0	3	8	13	19	28	41	61	86	117	142	162	175	176	177	178	179	179	180
BAUDETTE	0	0	0	4	9	14	19	28	44	69	99	135	162	181	193	197	198	198	198	199	199
BEMIDJI AP	0	0	0	4	10	17	26	42	67	103	146	194	231	257	272	278	280	280	280	281	282
BENSON	0	0	2	7	15	30	53	87	137	203	279	367	438	493	533	551	559	561	562	563	565
BIG FALLS	0	0	0	3	7	11	17	27	43	68	98	132	159	178	189	191	192	192	193	193	194
BROWNS VALLEY	0	0	0	3	8	18	34	62	107	167	241	327	399	458	501	522	531	534	535	537	538
CAMBRIDGE ST HOSP	0	0	1	5	11	22	37	63	102	155	219	291	349	392	421	433	437	438	438	440	442
CAMPBELL	0	0	1	4	10	22	40	66	103	152	210	280	339	388	425	442	448	448	448	449	451
CANBY	0	1	3	7	15	33	61	105	165	242	331	432	517	586	639	666	680	685	689	693	696
CASS LAKE	0	0	0	3	7	14	25	42	66	96	132	173	206	232	248	254	255	255	256	256	257
CHASKA	0	0	0	4	10	24	47	83	136	204	282	371	443	500	539	557	564	565	566	568	571
CLOQUET FOR RES CEN	0	0	0	2	3	3	4	8	21	42	71	103	127	144	152	153	154	154	155	155	155
COLLEGEVILLE ST JOHN	0	0	2	7	16	28	45	71	112	168	234	310	370	417	449	464	471	474	475	477	479
CROOKSTON NW EXP STA	0	0	0	3	8	16	29	48	76	114	161	219	270	311	342	356	359	359	360	360	361
DETROIT LAKES 1 NNE	0	0	0	1	3	5	9	19	37	63	96	136	169	194	209	211	211	212	212	213	213
DULUTH WSO	0	0	0	2	3	3	3	7	17	36	61	92	117	136	148	152	153	154	154	155	156
FAIRMONT	0	0	3	9	22	46	82	132	198	276	364	461	541	607	657	684	698	705	710	715	719
FARIBAULT	0	0	1	4	10	24	47	83	135	201	276	359	426	477	513	530	537	539	541	542	545
FARMINGTON 3 NW	0	0	2	7	16	32	54	88	136	198	269	348	412	461	496	512	519	523	526	529	532
FERGUS FALLS	0	0	0	2	7	15	31	57	95	148	212	286	350	400	436	452	457	457	457	459	461
FOSSTON	0	0	1	5	11	19	30	47	71	106	149	201	246	283	309	320	323	322	322	324	326
GLENWOOD	0	0	1	5	10	20	34	59	98	154	221	298	361	408	440	454	459	460	461	463	464
GRAND MARAIS	0	0	0	0	0	0	0	0	1	5	11	19	26	31	34	34	34	34	34	34	34
GRAND MEADOW	0	0	1	6	14	30	53	85	129	184	245	313	367	409	438	451	457	460	462	465	467
GRAND RAPIDS NC SCHL	0	0	0	3	7	11	16	25	42	67	97	132	158	176	186	189	189	189	189	189	190
GULL LAKE DAM	0	0	0	4	10	17	28	46	74	115	164	220	265	298	320	328	331	331	331	332	334
HALLOCK	0	0	1	4	11	22	37	57	84	120	166	223	276	320	352	360	362	364	365	366	367
HINCKLEY	0	0	0	2	4	5	9	19	39	70	109	154	189	213	227	230	231	231	232	232	233
INTERNATIONAL FALLS	0	0	0	3	8	14	22	34	53	80	113	149	177	196	207	209	210	210	211	211	212
ITASCA ST PARK SCHL	0	0	0	2	5	10	17	28	47	73	105	142	174	198	214	219	220	220	221	221	221
JORDAN 1 S	0	0	1	6	13	25	44	74	117	173	237	307	363	403	431	443	448	451	453	456	458
LEECH LAKE DAM	0	0	0	3	7	12	19	31	53	84	123	167	201	225	240	245	247	247	247	248	249
LITCHFIELD	0	0	2	6	13	28	52	87	138	202	275	356	422	473	509	527	534	537	539	541	544
LITTLE FALLS 1 N	0	0	1	6	13	22	34	55	88	135	191	254	303	338	361	371	375	377	378	379	380
LONG PRAIRIE	0	0	1	4	9	16	27	47	77	119	170	228	274	307	328	336	338	338	339	340	341
MADISON SEWAGE PLANT	0	0	2	5	11	25	48	85	137	204	282	371	445	503	545	564	572	573	574	576	579
MAPLE PLAIN	0	0	1	4	11	24	45	77	123	181	249	324	386	433	467	484	491	495	498	502	505
MARSHALL	0	0	1	3	9	25	52	95	154	226	309	402	481	544	592	616	627	631	634	637	641
MEADOWLANDS	0	0	0	2	5	7	10	16	28	48	74	105	130	148	159	161	161	161	162	162	162
MILACA	0	0	0	4	8	15	26	45	76	120	174	235	284	319	341	347	348	349	350	351	352
MILAN	0	0	2	6	13	28	50	83	131	193	265	347	415	468	508	527	535	537	538	539	541
MINNEAPOLIS-ST PAUL	0	0	3	10	22	43	72	115	177	256	346	449	532	598	647	674	687	694	698	701	703
MONTEVIDEO 1 SW	0	0	0	2	7	20	42	77	128	193	268	353	422	476	516	535	543	545	546	547	549
MOOSE LAKE 1 SSE	0	0	0	2	4	5	6	11	25	49	82	122	154	177	190	195	195	195	195	196	197
MORA	0	0	0	4	9	16	26	44	75	120	175	238	288	325	349	357	359	359	359	360	361
MORRIS W C SCHOOL	0	0	2	6	13	28	50	81	123	177	240	313	375	426	464	482	488	488	488	489	491
NEW LONDON	0	0	1	6	13	25	43	72	118	180	252	332	396	444	478	494	501	504	506	507	508
NEW ULM	0	0	1	4	12	28	56	98	156	228	309	399	472	529	571	590	599	602	604	606	609
OLIVIA	0	0	2	7	16	34	61	102	157	226	303	388	458	512	552	571	581	585	587	590	593
PARK RAPIDS	0	0	0	3	6	11	17	30	52	85	127	177	218	249	269	276	277	277	278	278	279
PINE RIVER DAM	0	0	0	3	8	14	22	36	59	93	135	181	218	244	259	264	265	265	266	266	267
PIPESTONE	0	0	0	1	4	11	27	55	98	156	225	303	367	417	452	467	473	473	473	474	475
POKEGAMA DAM	0	0	0	3	6	12	19	32	51	78	110	148	178	201	215	219	220	220	221	221	222
PRESTON	0	0	1	5	13	25	43	70	109	160	219	284	335	373	398	409	412	414	414	416	417
RED LAKE FALLS	0	0	1	4	9	19	32	51	78	113	155	206	250	286	313	324	326	327	328	329	330
RED LAKE INDIAN	0	0	0	4	10	20	31	48	71	102	140	185	222	251	271	274	275	276	278	279	280
ROCHESTER WSO	0	0	1	5	13	28	52	87	135	196	264	339	400	446	478	493	498	500	502	505	508
ROSEAU 1 E	0	0	0	3	6	12	20	31	46	67	94	127	156	181	198	202	203	203	204	204	205
ROSEMOUNT AGRI EXP	0	0	1	6	13	25	41	68	109	165	231	303	359	400	426	438	443	445	448	450	451
ST CLOUD WSO	0	0	1	5	11	22	37	62	99	149	208	274	327	367	394	406	411	412	413	414	416
ST PETER 2 SW	0	0	1	5	13	31	58	100	157	228	310	402	477	536	578	597	604	605	607	609	613
SANDY LAKE DAM	0	0	0	3	6	10	16	27	47	76	113	155	188	211	225	229	230	230	230	230	232
SPRINGFIELD 1 NW	0	0	1	3	10	28	56	99	156	225	300	382	447	498	534	551	559	561	563	565	567
THIEF RIVER FALLS	0	0	1	4	9	17	29	46	71	105	146	194	235	267	290	300	303	303	303	303	304
TRACY	0	0	0	2	7	21	46	86	142	214	296	389	467	530	578	601	612	615	618	620	623
TWO HARBORS	0	0	0	0	0	0	0	0	1	12	29	52	73	90	102	103	103	103	104	104	104
VIRGINIA	0	0	0	2	5	9	16	27	44	68	99	135	164	187	201	202	203	204	205	206	206
WADENA 3 S	0	0	0	3	7	14	25	43	71	112	162	223	274	314	342	353	356	356	356	356	358
WALKER	0	0	0	3	7	13	21	35	57	89	129	175	213	241	259	266	268	268	269	270	271
WARROAD	0	0	0	3	7	11	18	29	46	72	104	141	171	193	208	212	213	213	214	214	215
WASECA EXP STA	0	0	0	2	7	19	39	71	115	170	234	304	361	406	437	452	457	459	460	462	464
WHEATON	0	0	2	7	17	34	57	92	141	205	280	369	444	506	553	577	588	592	594	596	598
WILLMAR ST HOSP	0	0	2	6	13	27	48	81	129	192	263	344	408	458	493	510	518	521	524	526	528
WINDOM	1	1	2	4	11	28	57	101	161	234	313	400	470	525	566	586	595	598	601	603	607
WINNEBAGO	0	0	2	9	20	42	72	114	169	236	311	396	465	520	561	583	594	598	601	604	607
WINNIBIGOSHISH DAM	0	0	0	3	8	13	21	35	58	92	133	179	215	241	256	261	262	262	262	262	263
WINONA	0	0	3	12	27	52	86	132	192	267	351	444	521	581	625	648	659	665	670	675	679
WORTHINGTON	0	0	1	5	14	31	57	96	148	213	286	367	435	488	527	546	553	555	557	559	562
ZUMBROTA	0	0	1	4	10	22	41	71	115	172	239	314	374	419	450	463	469	470	473	475	478
FARGO ND WSO	0	0	2	7	16	30	48	76	116	171	237	316	383	438	479	498	506	508	509	511	513
SIOUX FALLS SD WSO	0	0	2	6	16	36	68	117	186	273	372	486	580	658	717	749	765	772	775	777	779
LA CROSSE WI WSO	0	0	2	10	23	47	80	126	188	265	353	453	537	605	657	684	697	704	709	713	717

Appendix Table 10. Normal total growing degree days, T_b = 70°F, at selected dates and adjusted to an 8 a.m. observation time.

	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER			OCTOBER		
	10	20	30	10	20	31	10	20	30	10	20	31	10	20	31	10	20	30	10	20	31
ADA	0	0	0	2	5	8	12	20	33	53	78	108	134	154	167	172	173	173	173	173	174
ALBERT LEA	0	0	0	0	1	4	10	24	47	78	115	156	187	209	221	223	223	223	224	225	226
ALEXANDRIA FAA AP	0	0	0	2	5	7	11	20	36	60	90	124	149	167	178	182	183	184	184	184	184
ARGYLE 4 E	0	0	0	1	3	7	10	15	22	32	46	63	80	93	103	105	105	105	105	105	105
ARTICHOKE LAKE	0	0	0	1	2	4	10	21	40	67	100	136	165	185	198	203	205	205	205	205	205
AUSTIN 3 S	0	0	0	1	3	6	11	23	42	68	96	124	143	153	157	159	159	161	162	162	162
BABBITT 2 SE	0	0	0	1	2	4	5	7	10	14	21	29	36	42	46	46	46	46	47	47	47
BAUDETTE	0	0	0	2	3	4	5	7	11	17	27	37	45	50	53	54	54	54	54	54	54
BEMIDJI AP	0	0	0	2	4	5	7	11	20	33	48	65	78	85	89	89	89	90	90	90	90
BENSON	0	0	0	3	5	9	15	27	48	79	117	158	190	211	224	229	230	230	231	231	231
BIG FALLS	0	0	0	1	2	3	4	6	10	18	27	38	46	51	53	53	53	53	54	54	54
BROWNS VALLEY	0	0	0	1	3	4	7	15	33	59	94	135	167	192	208	214	216	217	217	217	217
CAMBRIDGE ST HOSP	0	0	0	2	4	5	9	16	30	52	79	111	134	150	160	162	162	162	163	163	163
CAMPBELL	0	0	0	1	3	6	11	19	31	50	73	101	125	144	158	163	163	163	163	163	163
CANBY	0	0	1	2	5	10	19	37	65	105	153	206	248	280	301	310	314	315	316	317	318
CASS LAKE	0	0	0	1	2	4	7	12	19	28	39	51	61	68	73	74	74	74	74	74	74
CHASKA	0	0	0	2	3	6	10	22	43	73	111	153	186	209	222	227	227	227	227	227	228
CLOQUET FOR RES CEN	0	0	0	0	0	0	0	0	3	9	16	25	31	35	36	36	36	36	37	37	37
COLLEGEVILLE ST JOHN	0	0	0	3	6	8	12	19	35	59	88	121	145	160	169	172	173	174	175	176	176
CROOKSTON NW EXP STA	0	0	0	1	2	4	8	13	21	33	48	68	87	103	115	116	117	118	118	119	119
DETROIT LAKES 1 NNE	0	0	0	0	1	1	1	2	6	13	23	35	44	51	55	55	55	55	55	55	56
DULUTH WSO	0	0	0	0	0	0	0	0	2	6	12	20	27	31	34	35	35	35	35	35	36
FAIRMONT	0	0	1	3	7	15	28	49	79	118	163	212	251	279	299	307	310	312	313	314	316
FARIBAULT	0	0	0	1	3	6	11	24	45	75	110	148	176	195	205	208	209	209	209	210	210
FARMINGTON 3 NW	0	0	0	3	6	9	15	25	44	71	103	138	164	181	191	194	195	196	197	198	199
FERGUS FALLS	0	0	0	1	2	3	7	15	29	51	79	113	141	162	175	180	180	180	180	180	180
FOSSTON	0	0	0	1	3	6	9	13	20	30	44	63	80	94	104	105	106	106	107	107	107
GLENWOOD	0	0	0	2	4	5	7	13	29	53	85	121	148	165	175	178	179	179	179	179	179
GRAND MARAIS	0	0	0	0	0	0	0	0	0	1	1	2	3	3	3	3	3	3	3	3	3
GRAND MEADOW	0	0	0	2	5	9	16	27	44	66	92	118	138	150	157	160	160	161	162	162	163
GRAND RAPIDS NC SCHL	0	0	0	1	2	3	3	5	9	16	24	34	41	45	47	47	47	47	47	47	47
GULL LAKE DAM	0	0	0	2	3	5	7	11	20	34	51	71	86	96	103	104	104	104	104	104	105
HALLOCK	0	0	0	1	3	7	12	18	26	37	53	76	100	121	137	138	138	139	139	140	140
HINCKLEY	0	0	0	0	0	0	0	1	6	15	26	40	49	55	57	58	58	58	58	58	58
INTERNATIONAL FALLS	0	0	0	1	3	4	6	9	15	23	33	43	51	57	59	60	60	60	60	60	60
ITASCA ST PARK SCHL	0	0	0	1	1	2	4	7	11	18	26	37	46	53	58	58	58	58	59	59	59
JORDAN 1 S	0	0	0	2	4	7	11	20	36	59	86	114	134	146	153	154	155	156	157	157	158
LEECH LAKE DAM	0	0	0	1	2	3	4	7	12	22	34	48	58	65	68	69	69	69	69	69	70
LITCHFIELD	0	0	0	2	4	8	15	29	50	80	114	151	179	198	209	213	214	215	215	216	217
LITTLE FALLS 1 N	0	0	0	2	5	7	9	14	25	42	64	88	106	117	122	124	124	125	125	126	126
LONG PRAIRIE	0	0	0	1	3	4	6	12	21	37	56	77	93	104	110	111	111	111	111	111	112
MADISON SEWAGE PLANT	0	0	0	1	3	6	13	26	48	79	117	159	193	218	234	240	240	240	241	241	241
MAPLE PLAIN	0	0	0	1	3	6	12	23	42	67	98	131	157	175	186	190	191	192	193	194	196
MARSHALL	0	0	0	1	2	6	14	30	55	90	131	177	214	241	259	267	269	269	270	271	272
MEADOWLANDS	0	0	0	1	1	2	2	2	5	9	16	24	31	36	39	39	39	39	39	39	39
MILACA	0	0	0	1	3	4	5	10	20	37	57	80	97	108	114	115	115	115	115	115	115
MILAN	0	0	0	2	4	8	14	26	46	74	108	147	177	198	212	218	219	219	219	220	220
MINNEAPOLIS-ST PAUL	0	0	1	4	8	14	23	40	68	109	158	213	255	284	303	311	315	317	318	319	319
MONTEVIDEO 1 SW	0	0	0	1	2	4	9	21	42	73	110	151	182	203	216	221	222	222	223	223	223
MOOSE LAKE 1 SSE	0	0	0	0	0	0	0	0	3	10	21	33	43	49	53	53	53	53	54	54	54
MORA	0	0	0	2	3	4	5	10	20	37	59	84	103	116	123	124	124	124	124	124	124
MORRIS W C SCHOOL	0	0	0	2	4	9	15	26	42	64	90	121	147	167	182	187	187	187	188	188	188
NEW LONDON	0	0	0	2	5	7	10	19	37	65	100	137	164	181	191	194	196	197	198	198	198
NEW ULM	0	0	0	1	3	7	15	30	54	88	128	170	201	222	234	238	239	240	240	241	241
OLIVIA	0	0	0	2	5	10	19	34	58	90	127	167	197	218	231	236	238	239	240	241	241
PARK RAPIDS	0	0	0	1	2	2	3	5	10	21	34	51	64	74	80	81	81	81	81	81	81
PINE RIVER DAM	0	0	0	1	2	4	5	8	15	25	38	52	63	70	74	75	75	75	75	75	75
PIPESTONE	0	0	0	1	1	2	4	12	28	53	84	119	145	162	172	175	175	175	175	175	175
POKEGAMA DAM	0	0	0	1	2	3	5	8	13	20	28	38	47	53	57	57	57	57	57	57	57
PRESTON	0	0	0	2	5	8	12	20	35	56	81	108	126	137	143	144	144	145	145	145	145
RED LAKE FALLS	0	0	0	1	2	5	10	16	23	33	45	62	77	91	101	104	104	104	104	104	104
RED LAKE INDIAN	0	0	0	1	4	7	10	15	22	31	42	57	69	79	85	85	85	85	86	86	86
ROCHESTER WSO	0	0	0	2	4	8	15	28	48	75	107	140	165	181	190	192	193	193	193	194	195
ROSEAU 1 E	0	0	0	1	2	4	6	8	12	16	23	32	42	50	57	58	58	58	58	58	58
ROSEMOUNT AGRI EXP	0	0	0	3	5	7	10	17	33	57	87	119	140	152	157	159	159	160	162	162	162
ST CLOUD WSO	0	0	0	2	3	6	9	17	30	49	73	99	119	133	141	143	144	144	144	144	145
ST PETER 2 SW	0	0	0	2	4	8	15	30	54	87	127	171	205	229	243	244	245	246	247	247	248
SANDY LAKE DAM	0	0	0	1	2	2	3	5	10	19	31	44	54	61	64	64	64	64	65	65	65
SPRINGFIELD 1 NW	0	0	0	1	3	7	15	30	54	85	120	156	182	199	209	212	213	214	214	214	215
THIEF RIVER FALLS	0	0	0	1	3	5	8	13	21	33	47	64	78	89	96	99	99	99	99	99	99
TRACY	0	0	0	1	1	4	11	24	48	82	123	170	208	236	255	263	265	265	265	266	267
TWO HARBORS	0	0	0	0	0	0	0	0	0	3	7	13	18	22	25	25	25	25	25	25	25
VIRGINIA	0	0	0	0	1	2	4	6	11	17	26	36	46	53	58	58	58	58	58	58	58
WADENA 3 S	0	0	0	1	2	3	5	9	18	32	51	74	94	110	120	121	122	122	123	123	123
WALKER	0	0	0	1	2	3	5	8	15	25	38	54	66	78	81	82	82	82	82	82	83
WARROAD	0	0	0	1	2	3	5	7	11	18	28	39	48	55	59	60	60	60	60	60	60
WASECA EXP STA	0	0	0	1	2	4	9	19	34	55	80	108	129	145	155	158	158	158	158	159	159
WHEATON	0	0	0	3	6	12	19	31	51	80	116	159	195	222	241	250	252	253	253	253	254
WILLMAR ST HOSP	0	0	0	2	4	8	13	24	43	71	103	139	165	182	192	196	197	198	199	199	200
WINDOM	0	0	0	1	2	7	18	36	64	99	138	179	209	230	243	248	250	250	251	252	252
WINNEBAGO	0	0	0	3	8	15	25	41	64	96	132	171	202	223	237	243	245	246	247	248	249
WINNIBIGOSHISH DAM	0	0	0	1	2	4	5	8	15	25	38	53	64	72	75	76	76	76	76	76	76
WINONA	0	0	1	5	11	20	32	51	79	117	159	205	239	263	278	283	286	287	288	290	291
WORTHINGTON	0	0	0	1	4	9	18	33	55	83	116	153	182	204	218	223	224	224	224	224	225
ZUMBROTA	0	0	0	2	3	6	10	20	37	62	92	125	149	164	172	175	175	176	176	177	178
FARGO ND WSO	0	0	0	2	5	11	15	25	40	63	93	128	159	183	200	207	208	208	208	208	209
SIOUX FALLS SD WSO	0	0	0	2	5	11	22	44	79	128	185	249	300	338	364	375	380	381	382	383	383
LA CROSSE WI WSO	0	0	0	4	8	16	27	45	73	111	157	208	248	278	298	306	309	310	311	312	314

Appendix Table 11. Normal total heating degree days, T_b = 65°F, for selected dates during the heating season and adjusted to a midnight observation time.

	JUL 31	AUG 31	SEP 30	OCT 31	NOV 30	DEC 31	JAN 31	FEB 28	MAR 31	APR 30	MAY 31	JUN 30
ADA	24	68	318	907	2019	3652	5579	7127	8400	9097	9432	9522
ALBERT LEA	6	23	188	686	1645	3068	4721	6063	7190	7785	8028	8063
ALEXANDRIA FAA AP	18	49	288	861	1938	3513	5357	6849	8114	8815	9135	9216
ARGYLE 4 E	34	103	405	1044	2218	3946	5944	7586	8951	9700	10067	10171
ARTICHOKE LAKE	8	30	236	771	1810	3336	5129	6583	7797	8455	8741	8806
AUSTIN 3 S	21	47	249	773	1753	3196	4894	6270	7412	8026	8311	8375
BABBITT 2 SE	63	188	566	1258	2433	4098	5990	7541	8857	9671	10118	10281
BAUDETTE	59	169	539	1229	2419	4165	6196	7870	9280	10099	10545	10695
BEMIDJI AP	42	119	446	1105	2272	3974	5933	7521	8879	9662	10072	10203
BENSON	13	34	244	783	1813	3323	5106	6541	7726	8363	8643	8698
BIG FALLS	67	180	556	1244	2432	4143	6120	7719	9052	9844	10284	10439
BROWNS VALLEY	12	36	245	771	1798	3316	5080	6500	7686	8324	8619	8681
CAMBRIDGE ST HOSP	18	62	297	857	1892	3408	5181	6610	7801	8447	8740	8808
CAMPBELL	16	52	295	878	1960	3553	5390	6881	8101	8767	9086	9155
CANBY	10	27	207	704	1689	3137	4825	6187	7327	7949	8220	8269
CASS LAKE	41	120	451	1112	2266	3977	5917	7506	8835	9601	10015	10143
CHASKA	9	32	221	729	1701	3152	4868	6252	7379	7973	8221	8258
CLOQUET FOR RES CEN	61	168	521	1193	2320	3927	5775	7300	8601	9403	9869	10047
COLLEGEVILLE ST JOHN	15	42	266	809	1836	3352	5142	6588	7800	8462	8761	8826
CROOKSTON NW EXP STA	20	72	351	972	2129	3810	5785	7395	8734	9471	9833	9931
DETROIT LAKES 1 NNE	45	124	457	1114	2271	3937	5888	7486	8827	9586	9983	10110
DULUTH WSO	59	167	502	1149	2253	3840	5660	7157	8462	9263	9722	9904
FAIRMONT	7	23	176	644	1586	2999	4643	5959	7067	7637	7859	7891
FARIBAULT	10	33	212	706	1673	3106	4797	6169	7305	7906	8166	8212
FARMINGTON 3 NW	11	33	233	748	1730	3194	4918	6313	7464	8066	8325	8372
FERGUS FALLS	20	61	306	893	1981	3571	5435	6936	8182	8868	9179	9257
FOSSTON	30	100	405	1032	2179	3834	5774	7353	8669	9411	9788	9899
GLENWOOD	22	56	287	845	1885	3425	5218	6672	7884	8552	8857	8927
GRAND MARAIS	156	301	672	1335	2375	3835	5524	6960	8209	9041	9629	9972
GRAND MEADOW	15	43	243	754	1715	3154	4806	6152	7276	7880	8162	8220
GRAND RAPIDS NC SCHL	54	154	507	1171	2307	3946	5835	7371	8666	9436	9857	10002
GULL LAKE DAM	22	79	359	958	2040	3621	5466	6964	8228	8967	9337	9436
HALLOCK	31	129	442	1110	2297	4045	6061	7712	9096	9855	10231	10335
HINCKLEY	31	94	397	1012	2074	3627	5435	6907	8122	8814	9174	9280
INTERNATIONAL FALLS	54	165	534	1223	2426	4187	6199	7826	9206	10010	10448	10601
ITASCA ST PARK SCHL	43	134	477	1139	2302	3976	5913	7481	8808	9600	10025	10166
JORDAN 1 S	13	41	257	788	1785	3251	4973	6376	7541	8156	8430	8488
LEECH LAKE DAM	37	118	435	1071	2189	3779	5667	7201	8492	9261	9672	9795
LITCHFIELD	13	38	248	777	1796	3287	5042	6469	7656	8297	8582	8643
LITTLE FALLS 1 N	19	64	326	912	1982	3554	5392	6889	8136	8830	9170	9252
LONG PRAIRIE	25	82	363	971	2065	3654	5521	7048	8326	9041	9399	9496
MADISON SEWAGE PLANT	10	36	238	758	1759	3195	4921	6318	7477	8105	8380	8433
MAPLE PLAIN	16	50	269	802	1796	3273	5000	6403	7564	8184	8461	8526
MARSHALL	8	26	209	709	1683	3116	4777	6123	7247	7842	8088	8127
MEADOWLANDS	60	179	541	1220	2361	4005	5900	7448	8783	9575	10021	10184
MILACA	22	69	330	922	1975	3511	5308	6766	7986	8668	9003	9095
MILAN	15	44	264	814	1854	3370	5150	6590	7779	8425	8718	8779
MINNEAPOLIS-ST PAUL	10	29	202	687	1641	3061	4729	6071	7181	7754	7995	8036
MONTEVIDEO 1 SW	16	40	241	746	1751	3231	4972	6374	7526	8135	8391	8441
MOOSE LAKE 1 SSE	53	150	472	1117	2220	3823	5677	7203	8486	9260	9702	9862
MORA	24	79	341	930	1989	3533	5338	6806	8026	8708	9046	9139
MORRIS W C SCHOOL	15	49	285	855	1910	3469	5271	6739	7956	8613	8915	8981
NEW LONDON	15	44	266	803	1832	3350	5129	6575	7783	8442	8737	8795
NEW ULM	7	20	186	664	1621	3042	4714	6071	7184	7758	7998	8034
OLIVIA	10	33	223	728	1726	3204	4935	6337	7501	8120	8381	8427
PARK RAPIDS	32	94	401	1037	2179	3833	5751	7296	8593	9343	9723	9829
PINE RIVER DAM	29	102	403	1020	2109	3709	5579	7091	8361	9113	9499	9616
PIPESTONE	14	36	254	806	1833	3320	5041	6429	7582	8216	8509	8565
POKEGAMA DAM	40	127	458	1101	2220	3859	5754	7297	8592	9355	9769	9909
PRESTON	23	58	280	822	1798	3208	4859	6210	7333	7955	8266	8337
RED LAKE FALLS	22	90	387	1018	2184	3875	5868	7487	8836	9579	9952	10066
RED LAKE INDIAN	37	118	442	1089	2227	3920	5864	7455	8797	9586	10000	10128
ROCHESTER WSO	17	45	237	750	1722	3163	4843	6199	7347	7960	8238	8297
ROSEAU 1 E	56	184	561	1268	2500	4280	6351	8041	9491	10308	10751	10907
ROSEMOUNT AGRI EXP	20	49	270	810	1817	3300	5049	6473	7653	8297	8603	8663
ST CLOUD WSO	17	60	303	871	1927	3470	5269	6718	7936	8597	8903	8980
ST PETER 2 SW	7	25	193	679	1626	3051	4727	6071	7174	7746	7981	8014
SANDY LAKE DAM	45	131	450	1080	2178	3782	5640	7158	8440	9197	9598	9727
SPRINGFIELD 1 NW	8	26	203	695	1661	3105	4784	6142	7264	7852	8093	8127
THIEF RIVER FALLS	40	111	432	1091	2281	3999	6003	7642	9025	9798	10190	10318
TRACY	9	33	221	722	1700	3145	4813	6167	7302	7910	8162	8201
TWO HARBORS	114	232	559	1192	2214	3674	5363	6790	8025	8845	9407	9708
VIRGINIA	55	170	524	1201	2357	4019	5910	7462	8767	9551	9977	10132
WADENA 3 S	26	84	367	979	2077	3670	5541	7056	8324	9037	9384	9476
WALKER	41	120	438	1065	2182	3809	5696	7216	8502	9258	9651	9780
WARROAD	51	155	514	1206	2415	4170	6208	7885	9309	10160	10626	10778
WASECA EXP STA	10	42	251	784	1770	3239	4946	6328	7489	8107	8376	8424
WHEATON	12	37	240	766	1796	3312	5078	6511	7695	8338	8641	8698
WILLMAR ST HOSP	11	33	232	753	1771	3278	5053	6488	7687	8329	8613	8668
WINDOM	10	29	215	716	1671	3072	4747	6098	7227	7837	8102	8153
WINNEBAGO	12	33	216	710	1665	3107	4762	6094	7206	7794	8058	8102
WINNIBIGOSHISH DAM	34	111	435	1086	2222	3840	5766	7333	8659	9439	9845	9964
WINONA	9	23	182	640	1533	2906	4493	5779	6826	7373	7616	7660
WORTHINGTON	10	38	240	761	1737	3182	4834	6165	7290	7892	8162	8214
ZUMBROTA	16	46	252	776	1756	3198	4897	6287	7443	8066	8363	8425
FARGO ND WSO	16	55	296	881	1985	3606	5488	7013	8285	8973	9293	9373
SIOUX FALLS SD WSO	10	24	192	682	1642	3047	4677	5974	7048	7611	7855	7903
LA CROSSE WI WSO	7	20	163	612	1503	2852	4433	5713	6770	7306	7525	7560

Appendix Table 12. Normal total freezing degree days, $T_b = 32°F$, for selected dates and adjusted to an 8 a.m. observation time.

	OCTOBER			NOVEMBER			DECEMBER			JANUARY			FEBRUARY			MARCH			APRIL		
	10	20	31	10	20	30	10	20	31	10	20	31	10	20	28	10	20	31	10	20	30
ADA	0	0	11	50	119	225	375	576	856	1152	1464	1796	2064	2292	2446	2604	2723	2807	2844	2848	2853
ALBERT LEA	0	0	6	24	59	120	215	351	548	760	984	1220	1409	1567	1672	1778	1855	1907	1925	1925	1925
ALEXANDRIA FAA AP	0	0	9	42	102	194	327	507	763	1034	1319	1620	1862	2069	2211	2362	2480	2567	2605	2607	2613
ARGYLE 4 E	0	0	16	61	144	273	451	683	994	1314	1648	2005	2302	2563	2745	2935	3080	3182	3227	3234	3238
ARTICHOKE LAKE	0	0	5	33	85	168	289	456	695	950	1218	1502	1732	1928	2061	2199	2305	2380	2407	2410	2414
AUSTIN 3 S	0	0	6	26	64	128	227	369	576	800	1039	1291	1494	1665	1780	1895	1981	2039	2055	2062	2063
BABBITT 2 SE	0	4	26	71	149	267	430	639	919	1206	1505	1823	2086	2315	2472	2632	2751	2836	2876	2889	2890
BAUDETTE	0	0	19	67	152	282	462	698	1016	1345	1689	2059	2367	2640	2830	3030	3184	3296	3348	3364	3365
BEMIDJI AP	0	0	17	63	143	265	435	657	958	1268	1590	1929	2205	2447	2615	2794	2935	3039	3086	3096	3100
BENSON	0	0	6	32	82	160	276	438	671	922	1188	1468	1692	1881	2008	2138	2237	2306	2328	2334	2336
BIG FALLS	0	1	24	73	158	283	456	681	985	1299	1627	1974	2259	2504	2671	2844	2976	3070	3113	3122	3125
BROWNS VALLEY	0	0	4	28	75	154	272	437	671	918	1177	1448	1665	1847	1970	2094	2187	2249	2263	2272	2272
CAMBRIDGE ST HOSP	0	0	9	35	85	164	282	445	678	927	1189	1465	1686	1872	1996	2122	2216	2281	2301	2306	2309
CAMPBELL	0	0	9	41	102	200	342	532	793	1063	1345	1643	1885	2094	2235	2378	2484	2555	2581	2584	2588
CANBY	0	0	6	27	67	134	236	381	591	814	1049	1295	1492	1657	1769	1886	1975	2038	2061	2064	2067
CASS LAKE	0	1	18	60	138	262	436	662	963	1268	1582	1915	2191	2434	2602	2777	2909	3002	3044	3054	3055
CHASKA	0	0	4	20	53	113	211	354	565	794	1037	1293	1498	1666	1776	1883	1958	2006	2014	2022	2022
CLOQUET FOR RES CEN	0	0	16	53	119	221	365	555	815	1086	1370	1675	1928	2148	2299	2453	2569	2651	2687	2696	2698
COLLEGEVILLE ST JOHN	0	0	7	33	81	159	276	439	674	927	1195	1477	1704	1895	2024	2157	2259	2331	2361	2362	2367
CROOKSTON NW EXP STA	0	0	13	59	139	258	421	635	930	1240	1568	1918	2206	2456	2628	2807	2945	3043	3085	3087	3093
DETROIT LAKES 1 NNE	0	0	9	53	130	246	405	614	901	1203	1522	1864	2145	2389	2556	2730	2862	2955	2993	2994	3001
DULUTH WSO	0	1	17	51	113	210	348	533	787	1050	1326	1618	1859	2069	2213	2365	2482	2568	2607	2618	2619
FAIRMONT	0	0	5	21	54	112	204	339	535	747	968	1198	1379	1530	1631	1737	1819	1876	1889	1897	1898
FARIBAULT	0	0	3	19	52	111	206	344	548	770	1005	1255	1455	1622	1732	1843	1923	1977	1990	1997	1998
FARMINGTON 3 NW	0	0	8	28	66	133	237	386	602	835	1082	1343	1553	1729	1846	1964	2050	2108	2124	2130	2131
FERGUS FALLS	0	0	11	45	106	201	338	524	786	1063	1354	1662	1910	2121	2262	2407	2515	2590	2615	2620	2623
FOSSTON	0	0	18	63	139	253	410	616	901	1201	1517	1854	2131	2369	2531	2700	2829	2921	2963	2972	2975
GLENWOOD	0	0	7	33	83	166	289	460	701	957	1225	1507	1734	1927	2057	2191	2291	2360	2384	2387	2391
GRAND MARAIS	0	0	4	24	65	135	241	386	590	807	1039	1293	1508	1697	1827	1957	2051	2113	2137	2139	2142
GRAND MEADOW	0	0	6	23	58	121	220	360	560	772	995	1229	1419	1579	1686	1793	1871	1922	1934	1940	1941
GRAND RAPIDS NC SCHL	0	0	16	55	125	232	385	586	861	1147	1446	1763	2021	2244	2396	2553	2672	2757	2795	2802	2805
GULL LAKE DAM	0	0	10	41	99	191	326	509	766	1037	1322	1624	1869	2079	2221	2367	2478	2557	2592	2598	2601
HALLOCK	0	2	25	74	159	291	474	711	1029	1355	1695	2057	2357	2621	2804	2995	3139	3242	3288	3298	3301
HINCKLEY	0	0	9	36	87	171	297	470	713	970	1242	1532	1768	1968	2100	2228	2318	2375	2385	2393	2394
INTERNATIONAL FALLS	0	0	23	73	162	296	482	723	1044	1372	1711	2068	2361	2616	2792	2978	3122	3226	3273	3285	3288
ITASCA ST PARK SCHL	0	0	18	63	142	259	422	634	924	1225	1539	1872	2144	2378	2539	2707	2837	2931	2976	2987	2989
JORDAN 1 S	0	0	8	29	70	138	243	391	605	837	1083	1343	1554	1734	1855	1978	2070	2133	2150	2157	2158
LEECH LAKE DAM	0	0	15	53	119	220	363	555	823	1107	1406	1724	1983	2205	2356	2512	2632	2718	2756	2763	2766
LITCHFIELD	0	0	7	32	78	151	262	418	643	885	1141	1412	1631	1817	1943	2074	2173	2242	2265	2270	2273
LITTLE FALLS 1 N	0	0	10	39	94	183	314	494	748	1016	1298	1598	1842	2051	2194	2341	2451	2529	2561	2564	2567
LONG PRAIRIE	0	0	13	48	110	205	343	528	788	1064	1356	1667	1921	2141	2292	2450	2571	2657	2695	2697	2703
MADISON SEWAGE PLANT	0	0	5	27	68	138	244	395	613	847	1094	1354	1563	1741	1861	1985	2080	2146	2166	2172	2174
MAPLE PLAIN	0	1	11	34	76	147	255	408	627	861	1108	1368	1578	1754	1872	1990	2076	2134	2150	2156	2157
MARSHALL	0	0	6	25	63	129	231	374	578	794	1019	1254	1441	1599	1704	1810	1888	1940	1951	1956	1959
MEADOWLANDS	0	0	19	60	131	239	391	594	872	1162	1463	1779	2038	2264	2425	2598	2737	2839	2884	2887	2894
MILACA	0	0	8	34	84	165	287	456	695	950	1219	1504	1735	1931	2061	2194	2291	2358	2382	2384	2388
MILAN	0	0	7	34	84	164	283	447	681	931	1196	1476	1702	1894	2023	2155	2255	2325	2351	2353	2357
MINNEAPOLIS-ST PAUL	0	0	4	21	54	111	204	340	539	755	983	1223	1413	1571	1675	1780	1856	1908	1922	1928	1929
MONTEVIDEO 1 SW	0	0	3	25	67	138	246	399	621	859	1110	1374	1584	1758	1873	1988	2072	2128	2148	2147	2138
MOOSE LAKE 1 SSE	0	1	16	49	111	209	351	541	803	1076	1363	1670	1923	2143	2294	2449	2564	2644	2677	2684	2679
MORA	0	0	8	35	86	170	294	465	707	964	1236	1525	1759	1959	2092	2228	2328	2395	2422	2425	2419
MORRIS W C SCHOOL	0	0	7	35	89	178	308	486	733	991	1261	1548	1781	1980	2115	2251	2352	2421	2450	2455	2449
NEW LONDON	0	0	5	28	76	154	272	437	671	920	1182	1461	1686	1877	2006	2135	2231	2297	2323	2327	2322
NEW ULM	0	0	3	20	55	115	208	342	540	756	985	1228	1421	1583	1690	1798	1878	1931	1949	1948	1939
OLIVIA	0	0	6	29	73	144	251	402	621	857	1106	1369	1580	1759	1880	2005	2101	2169	2196	2198	2190
PARK RAPIDS	0	0	13	54	127	238	393	599	881	1176	1485	1811	2074	2299	2451	2607	2725	2807	2842	2849	2843
PINE RIVER DAM	0	0	10	43	103	198	337	526	791	1070	1363	1673	1924	2139	2284	2433	2546	2627	2662	2670	2666
PIPESTONE	0	0	4	28	73	147	257	410	629	861	1105	1361	1565	1734	1845	1956	2036	2088	2106	2104	2095
POKEGAMA DAM	0	0	14	49	115	220	371	572	848	1135	1436	1755	2016	2242	2396	2555	2676	2761	2799	2809	2806
PRESTON	0	0	5	22	56	115	207	339	532	740	963	1201	1394	1558	1666	1774	1852	1903	1922	1923	1917
RED LAKE FALLS	0	0	16	64	147	269	436	654	954	1271	1604	1960	2252	2504	2678	2860	3001	3103	3149	3161	3157
RED LAKE INDIAN	0	3	21	62	136	253	420	640	937	1241	1557	1893	2171	2415	2583	2759	2892	2987	3031	3045	3044
ROCHESTER WSO	0	0	7	25	62	125	224	357	574	796	1029	1274	1469	1634	1744	1856	1940	1997	2019	2021	2013
ROSEAU 1 E	0	0	29	88	187	330	522	768	1100	1444	1803	2184	2497	2775	2970	3182	3351	3477	3536	3554	3550
ROSEMOUNT AGRI EXP	0	0	8	30	72	142	250	403	624	863	1117	1387	1607	1792	1917	2043	2137	2201	2226	2229	2222
ST CLOUD WSO	0	0	9	37	90	174	299	471	715	973	1243	1526	1753	1946	2077	2213	2317	2390	2419	2423	2414
ST PETER 2 SW	0	0	4	20	52	110	203	339	539	756	986	1227	1418	1574	1674	1772	1840	1884	1899	1898	1890
SANDY LAKE DAM	0	0	14	47	108	206	347	538	801	1077	1366	1672	1922	2139	2287	2441	2557	2638	2673	2681	2677
SPRINGFIELD 1 NW	0	0	3	20	56	119	217	359	564	784	1016	1259	1452	1612	1718	1823	1899	1949	1966	1965	1956
THIEF RIVER FALLS	0	0	16	67	153	282	456	682	988	1307	1644	2004	2300	2559	2738	2925	3068	3173	3221	3236	3233
TRACY	0	0	5	21	56	119	219	363	568	786	1012	1249	1438	1598	1704	1811	1890	1942	1961	1960	1952
TWO HARBORS	0	0	5	22	60	128	233	379	585	802	1034	1286	1499	1686	1814	1943	2038	2102	2130	2138	2136
VIRGINIA	0	3	22	65	139	253	413	622	904	1195	1496	1816	2078	2304	2459	2619	2739	2824	2861	2871	2868
WADENA 3 S	0	0	12	47	110	208	347	535	798	1076	1369	1681	1933	2148	2292	2439	2547	2622	2653	2658	2652
WALKER	0	0	16	54	122	226	374	571	845	1130	1429	1743	1998	2215	2363	2515	2631	2714	2751	2761	2758
WARROAD	0	0	22	75	166	301	487	725	1045	1376	1723	2096	2406	2679	2869	3069	3225	3340	3396	3418	3420
WASECA EXP STA	0	0	6	24	62	127	231	380	594	822	1062	1314	1515	1684	1796	1907	1988	2040	2058	2057	2049
WHEATON	0	0	6	31	80	161	283	450	685	933	1193	1467	1688	1877	2005	2138	2238	2307	2334	2338	2330
WILLMAR ST HOSP	0	0	6	32	79	156	270	430	660	909	1172	1450	1673	1862	1990	2123	2224	2296	2324	2328	2320
WINDOM	0	0	5	29	71	138	237	376	578	796	1027	1269	1461	1623	1731	1843	1929	1989	2013	2015	2008
WINNEBAGO	0	0	5	21	55	118	217	360	564	779	1003	1237	1424	1582	1688	1797	1878	1932	1953	1954	1947
WINNIBIGOSHISH DAM	0	0	17	57	127	233	383	583	862	1157	1468	1799	2070	2304	2464	2631	2759	2852	2894	2906	2903
WINONA	1	1	5	15	40	89	173	296	476	669	873	1088	1261	1403	1494	1581	1639	1675	1688	1688	1685
WORTHINGTON	0	0	6	26	65	131	231	373	576	790	1013	1245	1430	1586	1692	1804	1889	1949	1971	1971	1962
ZUMBROTA	0	0	8	27	65	129	228	369	576	799	1038	1293	1500	1676	1794	1913	2000	2058	2080	2081	2074
FARGO ND WSO	0	0	13	51	119	223	372	569	840	1124	1421	1736	1992	2213	2364	2522	2643	2729	2765	2773	2767
SIOUX FALLS SD WSO	0	0	4	22	57	115	205	335	526	733	951	1177	1355	1501	1598	1698	1773	1824	1843	1843	1834
LA CROSSE WI WSO	0	0	4	14	38	84	160	275	448	637	838	1050	1218	1356	1446	1533	1596	1636	1650	1649	1643

Appendix Table 13. Normal total melting degree days (or growing degree days), T_b = 32°F, for selected dates and adjusted to an 8 a.m. observation time.

STATION NAME	MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER	
	15	31	15	30	15	31	15	30	15	31	15	31	15	30	15	31	15	31
ADA	21	77	193	397	696	1110	1571	2084	2640	3263	3838	4388	4818	5168	5440	5625	5699	5716
ALBERT LEA	24	96	244	489	829	1289	1799	2364	2963	3618	4216	4796	5263	5658	5977	6208	6315	6351
ALEXANDRIA FAA AP	22	79	193	395	699	1122	1590	2114	2683	3319	3901	4456	4891	5249	5528	5719	5797	5816
ARGYLE 4 E	16	60	157	338	618	1017	1464	1957	2485	3075	3621	4140	4539	4858	5102	5267	5329	5338
ARTICHOKE LAKE	28	94	221	440	757	1195	1679	2219	2803	3453	4048	4617	5069	5446	5744	5951	6039	6063
AUSTIN 3 S	30	107	252	485	808	1245	1731	2270	2841	3463	4029	4579	5025	5403	5706	5922	6020	6053
BABBITT 2 SE	10	36	106	252	492	845	1247	1699	2191	2740	3239	3702	4053	4335	4556	4703	4755	4757
BAUDETTE	12	44	119	268	510	864	1271	1732	2234	2792	3297	3768	4126	4412	4629	4774	4828	4835
BEMIDJI AP	15	54	140	305	563	937	1363	1845	2371	2957	3488	3985	4367	4674	4909	5065	5125	5134
BENSON	30	101	237	464	789	1236	1729	2276	2865	3518	4116	4687	5137	5511	5806	6013	6102	6126
BIG FALLS	16	54	136	290	533	887	1294	1753	2250	2803	3307	3775	4128	4411	4631	4780	4835	4840
BROWNS VALLEY	20	82	212	434	749	1180	1658	2195	2776	3427	4027	4602	5055	5432	5733	5945	6034	6056
CAMBRIDGE ST HOSP	21	83	211	434	753	1185	1659	2186	2754	3382	3952	4494	4922	5281	5566	5766	5852	5875
CAMPBELL	24	89	214	425	728	1151	1625	2151	2712	3337	3915	4472	4906	5257	5529	5717	5795	5815
CANBY	36	117	263	497	826	1280	1786	2352	2959	3633	4252	4847	5320	5717	6038	6268	6369	6398
CASS LAKE	15	59	153	321	576	946	1374	1858	2378	2952	3478	3975	4357	4659	4891	5050	5114	5128
CHASKA	22	91	237	480	821	1280	1784	2343	2938	3593	4191	4763	5220	5605	5916	6138	6235	6263
CLOQUET FOR RES CEN	10	39	112	258	488	821	1204	1648	2142	2698	3200	3669	4031	4326	4553	4702	4759	4768
COLLEGEVILLE ST JOHN	22	82	208	428	745	1179	1656	2186	2757	3393	3976	4531	4970	5337	5630	5838	5927	5951
CROOKSTON NW EXP STA	18	65	165	347	626	1025	1474	1975	2516	3124	3686	4221	4634	4966	5221	5392	5458	5468
DETROIT LAKES 1 NNE	10	46	133	300	559	931	1353	1825	2336	2908	3433	3929	4308	4608	4837	4991	5050	5060
DULUTH WSO	9	37	112	262	496	830	1211	1651	2142	2695	3198	3671	4042	4350	4591	4754	4818	4831
FAIRMONT	37	126	288	548	908	1391	1920	2500	3112	3780	4391	4985	5469	5883	6220	6464	6578	6618
FARIBAULT	24	97	243	485	821	1272	1771	2326	2918	3565	4153	4721	5180	5572	5890	6118	6218	6248
FARMINGTON 3 NW	26	99	246	491	830	1285	1782	2331	2915	3557	4144	4708	5159	5540	5850	6073	6173	6204
FERGUS FALLS	18	70	181	385	689	1113	1582	2103	2667	3300	3881	4434	4865	5216	5489	5675	5750	5765
FOSSTON	16	62	164	347	623	1014	1453	1944	2474	3069	3617	4134	4530	4850	5103	5276	5343	5352
GLENWOOD	21	79	199	410	720	1147	1619	2145	2714	3349	3929	4482	4917	5277	5562	5762	5847	5869
GRAND MARAIS	6	25	80	194	374	630	925	1276	1687	2171	2629	3071	3421	3710	3932	4081	4144	4161
GRAND MEADOW	26	100	246	484	812	1254	1744	2285	2855	3478	4047	4600	5048	5428	5736	5961	6067	6104
GRAND RAPIDS NC SCHL	14	53	140	304	557	919	1330	1794	2298	2858	3365	3840	4203	4498	4727	4883	4943	4952
GULL LAKE DAM	17	61	158	338	614	1009	1455	1956	2500	3106	3656	4175	4580	4914	5177	5359	5431	5446
HALLOCK	7	41	134	314	591	985	1431	1931	2469	3065	3610	4124	4517	4830	5065	5220	5278	5288
HINCKLEY	8	49	152	342	623	1011	1443	1928	2453	3039	3573	4077	4467	4786	5037	5213	5285	5300
INTERNATIONAL FALLS	11	42	119	273	518	875	1285	1750	2257	2819	3326	3795	4152	4438	4658	4804	4857	4863
ITASCA ST PARK SCHL	16	54	136	293	540	902	1318	1787	2298	2868	3388	3875	4247	4547	4779	4936	4995	5002
JORDAN 1 S	28	102	245	481	811	1254	1740	2276	2849	3479	4052	4600	5038	5409	5710	5924	6019	6047
LEECH LAKE DAM	18	59	146	311	566	937	1361	1842	2365	2946	3473	3966	4349	4664	4911	5077	5139	5152
LITCHFIELD	29	100	235	459	782	1225	1717	2263	2847	3493	4083	4646	5093	5469	5771	5985	6076	6098
LITTLE FALLS 1 N	20	75	190	390	685	1096	1554	2068	2624	3240	3799	4329	4745	5090	5361	5548	5623	5639
LONG PRAIRIE	21	75	185	376	659	1057	1505	2009	2555	3161	3711	4231	4635	4967	5227	5406	5478	5493
MADISON SEWAGE PLANT	37	115	255	485	810	1256	1752	2304	2896	3553	4154	4725	5177	5557	5864	6079	6168	6199
MAPLE PLAIN	23	90	229	462	790	1232	1717	2255	2831	3466	4045	4600	5041	5414	5715	5933	6032	6063
MARSHALL	27	101	249	493	833	1295	1806	2373	2975	3638	4247	4834	5301	5695	6012	6241	6344	6379
MEADOWLANDS	23	68	149	299	537	885	1281	1731	2224	2776	3275	3740	4099	4389	4612	4761	4819	4829
MILACA	15	64	179	383	680	1086	1537	2044	2595	3207	3764	4292	4706	5047	5314	5496	5571	5589
MILAN	30	102	236	459	777	1216	1704	2247	2829	3473	4064	4630	5076	5444	5734	5935	6020	6042
MINNEAPOLIS-ST PAUL	30	111	271	531	885	1353	1865	2434	3046	3721	4335	4925	5400	5803	6128	6361	6467	6503
MONTEVIDEO 1 SW	23	91	231	468	801	1254	1752	2302	2887	3535	4130	4700	5151	5532	5843	6065	6160	6184
MOOSE LAKE 1 SSE	16	55	137	291	532	879	1273	1727	2232	2799	3314	3798	4177	4489	4731	4893	4958	4972
MORA	18	71	185	388	684	1089	1539	2044	2595	3209	3765	4291	4704	5046	5315	5498	5573	5589
MORRIS W C SCHOOL	18	77	206	425	740	1174	1657	2192	2761	3392	3974	4534	4971	5328	5605	5799	5882	5903
NEW LONDON	17	72	195	413	730	1166	1650	2190	2771	3414	3999	4556	4997	5366	5661	5868	5955	5977
NEW ULM	31	116	275	527	873	1337	1850	2418	3020	3678	4279	4861	5331	5731	6056	6293	6401	6437
OLIVIA	34	114	259	495	830	1289	1796	2355	2949	3600	4194	4766	5225	5614	5928	6154	6253	6281
PARK RAPIDS	11	48	137	309	578	964	1400	1887	2416	3008	3551	4064	4457	4773	5017	5183	5246	5255
PINE RIVER DAM	18	60	151	324	592	976	1407	1893	2422	3012	3544	4044	4435	4757	5010	5184	5255	5271
PIPESTONE	17	78	207	426	738	1168	1649	2188	2765	3403	3991	4555	4999	5363	5650	5849	5933	5953
POKEGAMA DAM	16	58	149	316	572	939	1355	1826	2339	2910	3430	3919	4295	4601	4840	5004	5068	5079
PRESTON	29	103	244	471	784	1208	1681	2209	2771	3387	3949	4491	4926	5291	5582	5789	5881	5912
RED LAKE FALLS	17	65	167	351	629	1021	1461	1954	2489	3086	3633	4152	4552	4876	5127	5296	5360	5371
RED LAKE INDIAN	14	50	133	293	550	926	1356	1838	2360	2942	3474	3974	4356	4664	4905	5073	5141	5154
ROCHESTER WSO	25	95	237	474	803	1246	1738	2283	2862	3495	4072	4631	5083	5467	5777	6000	6101	6134
ROSEAU 1 E	12	45	123	276	518	872	1278	1738	2237	2792	3294	3762	4117	4399	4613	4753	4805	4811
ROSEMOUNT AGRI EXP	25	92	224	445	758	1187	1666	2200	2771	3399	3971	4518	4955	5323	5618	5827	5918	5943
ST CLOUD WSO	23	83	207	423	736	1162	1630	2150	2712	3334	3900	4437	4862	5218	5500	5694	5773	5792
ST PETER 2 SW	21	94	249	505	856	1323	1837	2405	3009	3668	4269	4850	5318	5714	6036	6270	6380	6418
SANDY LAKE DAM	16	56	146	314	574	948	1369	1844	2360	2934	3456	3946	4326	4639	4887	5058	5126	5139
SPRINGFIELD 1 NW	23	97	246	492	836	1301	1817	2385	2981	3628	4216	4786	5248	5641	5960	6189	6294	6327
THIEF RIVER FALLS	8	41	130	304	571	954	1385	1868	2392	2978	3518	4029	4419	4729	4963	5118	5175	5182
TRACY	23	92	233	469	804	1261	1769	2332	2932	3594	4201	4784	5248	5639	5955	6181	6279	6305
TWO HARBORS	13	42	106	231	422	693	1005	1381	1825	2349	2838	3308	3682	3992	4232	4395	4465	4485
VIRGINIA	14	47	126	283	531	891	1298	1759	2263	2823	3330	3803	4166	4461	4688	4839	4895	4901
WADENA 3 S	10	50	151	342	630	1033	1484	1987	2531	3139	3697	4226	4633	4964	5221	5398	5468	5483
WALKER	15	54	145	317	582	961	1387	1865	2386	2970	3502	4001	4385	4700	4950	5125	5193	5205
WARROAD	9	35	102	239	467	813	1219	1684	2191	2755	3268	3747	4112	4402	4620	4764	4816	4823
WASECA EXP STA	14	72	205	437	766	1211	1703	2247	2823	3451	4024	4577	5022	5396	5694	5906	6000	6029
WHEATON	31	106	242	464	779	1217	1708	2256	2843	3497	4100	4681	5140	5521	5824	6037	6127	6152
WILLMAR ST HOSP	26	95	229	455	777	1219	1710	2255	2839	3484	4071	4636	5088	5470	5776	5993	6086	6112
WINDOM	36	118	267	504	835	1287	1794	2359	2958	3612	4209	4784	5245	5635	5948	6178	6292	6344
WINNEBAGO	36	121	277	525	865	1324	1833	2396	2989	3636	4229	4805	5270	5663	5981	6213	6322	6359
WINNIBIGOSHISH DAM	15	50	134	297	554	929	1358	1843	2370	2956	3488	3984	4365	4674	4913	5072	5130	5141
WINONA	33	122	294	563	923	1393	1908	2477	3083	3745	4349	4936	5412	5821	6157	6411	6540	6592
WORTHINGTON	36	120	270	509	840	1292	1792	2346	2934	3580	4169	4736	5189	5567	5871	6091	6194	6227
ZUMBROTA	26	97	237	466	783	1214	1695	2233	2809	3441	4018	4573	5017	5393	5697	5915	6014	6045
FARGO ND WSO	23	82	200	408	716	1141	1611	2136	2705	3344	3933	4493	4931	5287	5563	5752	5829	5846
SIOUX FALLS SD WSO	45	141	308	565	913	1378	1892	2469	3092	3783	4416	5025	5510	5914	6236	6466	6571	6606
LA CROSSE WI WSO	32	121	294	569	938	1419	1939	2513	3124	3796	4411	5010	5499	5918	6261	6515	6642	6693

REFERENCES

American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. 1962. Guide and Data Book Applications. Amer. Soc. Heating, Refrig., and Air-Conditioning. Eng., Inc. New York. 864 pp.

Asquith, D., B. A. Croft, S. C. Hoyt, E. H. Glass, and R. E. Rice. 1980. The systems approach and general accomplishments toward better insect control in pome and stone fruits. In: New Technology of Pest Control, C. B. Huffaker (Ed.). John Wiley and Sons, N. Y. 500 pp.

Baker, C. K., and J. N. Gallagher. 1983. The development of winter wheat in the field. 2. The control of promordium initiation rate by temperature and photoperiod. Jour. Agric. Sci. 101:337-344.

Baker, D. G. 1983. Climate of Minnesota. Part XIV. Wind climatology and wind power. Minn. Agric. Exp. Sta. Tech. Bull. AD-TB-1955.

Baker, D. G. 1975. Effect of observation time on mean temperature estimation. Jour. Appl. Meteor., 14:471-476.

Baker, D. G., B. F. Watson, and R. H. Skaggs. 1985. The Minnesota long-term temperature record. Climatic Change. 7:225-236.

Baker, D. G., B. S. Sharratt, H. C. Chiang, J. A. Zandlo, and D. R. Ruschy. 1984. Base temperature selection for the prediction of European corn borer instars by the growing degree day method. Agric. and For. Meteor. 32:55-60.

Baker, D. G., and J. H. Strub, Jr. 1965. Climate of Minnesota. Part III. Temperature and its application. Minn. Agric. Exp. Sta. Tech. Bull. 248.

Bauer, A., A. B. Frank, and A. L. Black. 1984. Estimation of spring wheat leaf growth rates and anthesis from air temperature. Agron. Jour. 76:829-835.

Berkett, L. P., P. D. Mowery, and W. M. Bode. 1976. Rate of development of Platynota idaeusalis at constant temperatures. Ann. Entomol. Soc. Amer. 69:1091-1094.

Bigelow, F. H. 1909. Report on the temperatures and vapor tensions of the United States. Bull. U.S.W.B. No. 408, U.S. Weather Bureau, Washington D.C.

Borchert, J. R. 1948. Unpublished maps. Dept. of Geog., Univ. of Minn.

Bryson, R. A. 1966. Airmass, streamlines, and the boreal forest. Tech. Rept. No. 24. Task No. NR 387-022, ONR Contract No. 1202 (07) and NSF 6P-444. Univ. of Wisc., Madison, Wisc.

Byrd, G. P. 1985. An adjustment for the effects of observation time on mean temperature and degree-day computations. Jour. Climate and Appl. Meteor. 24:869-874.

Davidson, H. R., and C. A. Campbell. 1983. The effect of temperature, moisture and nitrogen on the rate of development of spring wheat as measured by degree days. Can. Jour. Plant Sci. 63:833-846.

Daughtry, C. S. T., J. C. Cochran, and E. S. Hollinger. 1984. Estimating silking and maturity dates of corn for large areas. Agron. Jour. 76:415-420.

Enger, I. 1959. Optimum length of record for climatological estimates of temperature. Jour. Geophys. Res. 64:779-787.

Felch, R. E., R. H. Shaw, and R. E. Duncan. 1972. The climatology of growing degrees in Iowa. Ia. State Jour. Sci. 46:443-461.

Gage, S. H., and D. R. Smitley. 1985. Bioschedule tables for vegetables; field, forage and grain; fruit; and turf and ornamentals (Mimeo.). Entomol. Dept., Mich. St. Univ., East Lansing, Mich.

Head, D. E. 1985. Mean temperature biases as a function of the time of observation. No. Central Reg. Climate Ctr., NCRCC Paper No. 6. Illinois Water Survey, Champaign, Ill.

Hodson, A. C., and E. L. Kuehnast. 1981. Minnesota springs. A forty year record. The Minn. Horticulturist 109:80-83.

Joselyn, G. B. 1985. Personal communication. Wildlife Res. Supervisor, Dept. Nat. Res., St. Paul.

Katz, Y. H. 1952. The relationship between heat unit accumulation and the planting and harvesting of canning peas. Agron. Jour. 44:74-78.

Kitts, J. 1985. Personal communication. Wildlife and Fisheries Ext. Spec., Fish. and Wildlife Dept., Univ. of Minn., St. Paul.

Krafsur, E. S., R. D. Moon, and C. J. Church. 1985. Age structure and reproductive history of some overwintering face fly (Musca autumnalis De Geer, Diptera: Muscidae) populations in North America. Ann. Entomol. Soc. Amer. (In press).

Kuehnast, E. L. 1985. Personal communication. State Climatologist, Dept. Nat. Res., St. Paul.

Lana, E. P., and E. S. Haber. 1951. The value of the degree-hour summation system for estimating planting schedules and harvest dates with sweet corn in Iowa. Ia. St. Coll. Jour. Sci. 26:99-109.

Lablans, W. N. 1980. Meteorology and integrated pest control. In: Integrated Control of Insect Pests in the Netherlands. A. K. Minks and P. Gruys (Ed.). Centre for Agric. Public. and Documentation, Wageningen, Netherlands. 304 pp.

Landsberg, H. E. 1969. Weather and Health. Doubleday and Co., N. Y. 148 pp.

Lunardini, V. J. 1981. Heat Transfer in Cold Climates. Van Norstrand Reinhold, New York, 731 pp.

Mitchell, J. M., Jr. 1958. Effect of changing observation time on mean temperature. Bull. Amer. Meteor. Soc. 39:83-89.

Munn, R.E. 1966. Descriptive Microclimatology. Academic Press, New York. 245 pp.

Rumbaugh, W. F. 1934. The effect of time of observation on mean temperature. Monthly Weather Rev. 62:375-376.

Ruesink, W. G. 1981. Some insect pest management systems that utilize weather data. In Weiss, A. (Ed.) Computer Techniques and Meteorological Data Applied to Problems of Agriculture and Forestry: A Workshop. Agric. and Forest Meteor. Meeting. Amer. Meteor. Soc., Anaheim, Calif., 30-31. March, 1981. 386 pp.

Sabin, T. E., and M. D. Shulman. 1985. A statistical evaluation of the efficiency of the climatic normal as a predictor. Jour. Climat. 5:63-67.

Schall, L. A., and R. F. Dale. 1977. Time of observation temperature bias and climatic change. Jour. Appl. Meteor. 16:215-222.

Shaw, R. H. 1975. Growing degree units for corn in the North Central region. No. Central Reg. Res. Pub. 229. Iowa. St. Exp. Sta. Res. Bull. 581.

Tanigoshi, L. K., S. C. Hoyt, R. W. Browne, and J. A. Logan. 1975a. Influence of temperature on population increase of Tetranychus mcdaneili (Acarina:Tetranyseiidae). Ann. Entomol. Soc. Amer. 68:972-978.

Tanigoshi, L. K., S. C. Hoyt, R. W. Browne, and J. A. Logan. 1975b. Influence of temperature on the population increase of Metaseiulus occidentalis (Acarina:Phytoseiidae). Ann. Entomol. Soc. Amer. 68:979-986.

Thom, H. C. 1954. The rational relationship between heating degree days and temperature. Monthly Weather Rev. 82:1-6.

Trpis, M., and J. A. Shemancuk. 1970. Effect of constant temperature on larval development of Aedes vexans (Diptera: Culicidae). Canad. Entomol. 102:1048-1051.

U.S. Dept. of Commerce. Weather Bureau. 1963. Climatology of the United States No. 82-21. Decennial census of the United States climate. Summary of Hourly Observations, Duluth, Minn. U.S. Govt. Print. Office, Washington, D. C.

U.S. Dept. of Commerce. Environmental Data Service. 1975. Summary of synoptic meteorological observations for Great Lakes areas. Vol. 4. Lake Superior. National Climatic Data Center, Asheville, N. C.

U.S. Dept. of Commerce (NOAA). 1979. Climatological Data Minnesota. Annual Summary. 85:13. Environmental Data Service, National Oceanic and Atmos. Admin. National Climatic Data Center, Asheville, N. C.

U.S. Dept. of Commerce (NOAA). 1982. Climatography of the United States No. 81. Monthly normals of temperature, precipitation, and heating and cooling degree days 1951-80 Minnesota. National Climatic Data Center, Asheville, N. C.

Waters Section. 1968. An inventory of Minnesota lakes. Minn. Conserv. Dept., Div. of Waters, Soil and Minerals. Bull 25. St. Paul, Minn.

Weaver, C. R., and M. E. Miller. 1970. Temperature adjustments for discrepancies due to time of observation. Typewritten communication directed to Director, National Climatic Center. 7 pp. plus attachments, dated 23 November.

Went, F. W. 1957. The Experimental Control of Plant Growth. Chronica Botanica Co., Waltham, Mass. 343 pp.

Winkler, J. A., R. A. Skaggs, and D. G. Baker. 1981. Effect of temperature adjustments on the Minneapolis-St. Paul urban heat island. Jour. Appl. Meteor. 20:1295-1300.

Zandlo, J. A. 1985. Use of the Fourier transform with monthly normal climatic data. Paper presented at the 4th Conference on Applied Climatology of the Amer. Meteor. Soc., Scottsdale, Ariz., May 21-24.

OTHER PUBLICATIONS IN THE CLIMATE OF MINNESOTA SERIES

* Part I. Probability of Occurrence in The Spring and Fall Selected Low Temperatures. 1963. Technical Bulletin 243.
* Part II. The Agricultural and Minimum-Temperature-Free Seasons. 1963. Technical Bulletin 245.
* Part III. Temperature and Its Application. 1965. Technical Bulletin 248.
* Part IV. Spring Soil Temperatures. 1966. Miscellaneous Report 67.
* Part V. Precipitation Facts, Normals, and Extremes. 1967. Technical Bulletin 254.
Part VI. Solar Radiation at St. Paul. 1971. Technical Bulletin 280.
Part VII. Areal Distribution and Probabilities of Precipitation in the Minneapolis-St. Paul Metropolitan Area. 1973. Technical Bulletin 293.
Part VIII. Precipitation Patterns in the Minneapolis-St. Paul Metropolitan Area and Surrounding Counties. 1975. Technical Bulletin 301.
* Part IX. A Brief Climatology of Solar Radiation and Wind in Minnesota. 1978. Technical Bulletin 312.
* Part X. Precipitation Normals for Minnesota: 1941-1970. 1978. Technical Bulletin 314.
Part XI. The Availability and Dependability of Solar Radiation at St. Paul, Minnesota. 1979. Technical Bulletin 316.
Part XII. The Hydrologic Cycle and Soil Water. 1979. Technical Bulletin 322.
Part XIII. Duration and Depth of Snow Cover. 1982. Technical Bulletin 333.
Part XIV. Wind Climatology and Wind Power. 1983. Technical Bulletin AD-TB 1955.

* Out of print.