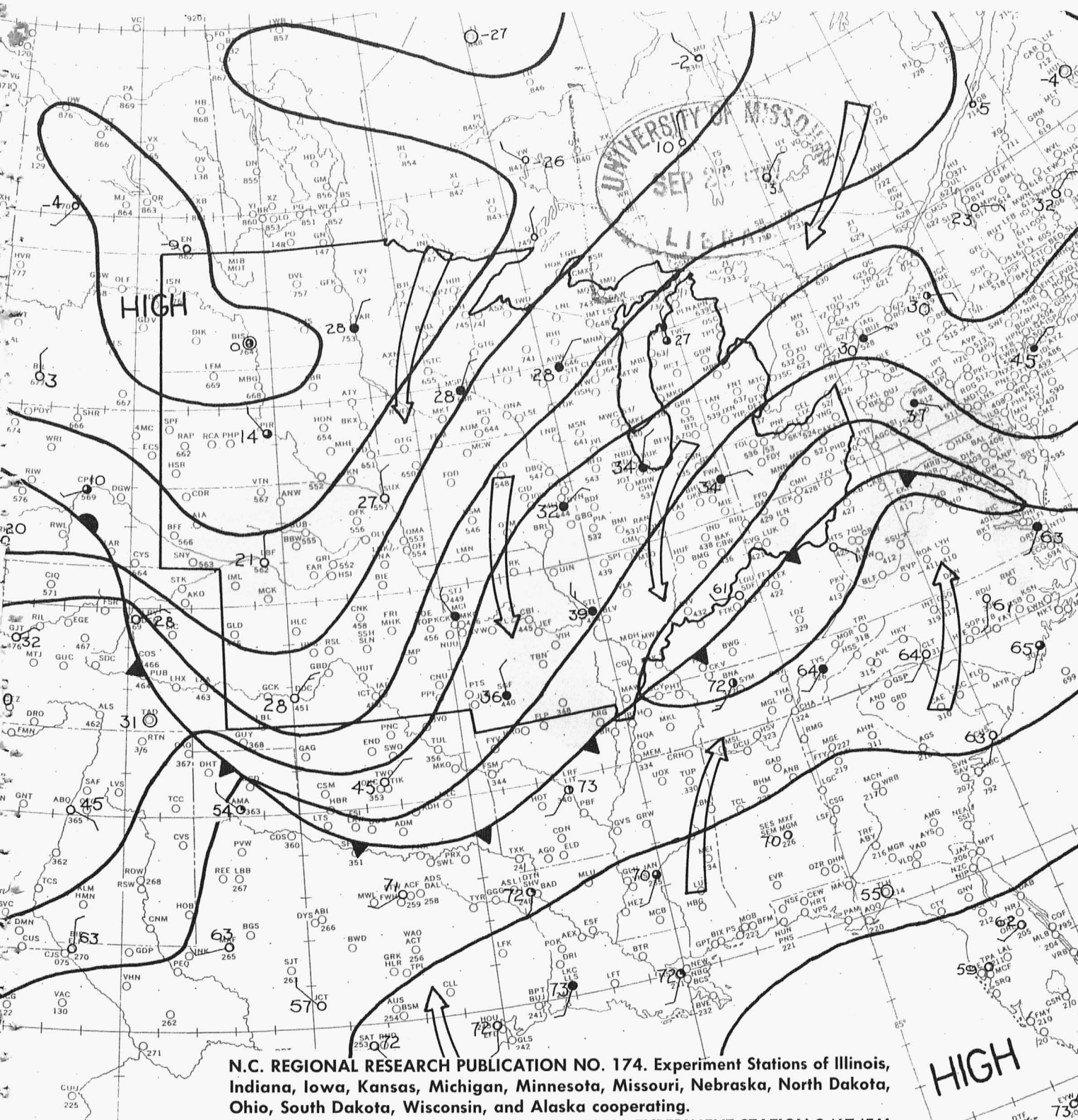
Periods With

Temperatures Critical to Agriculture

Wayne L. Decker



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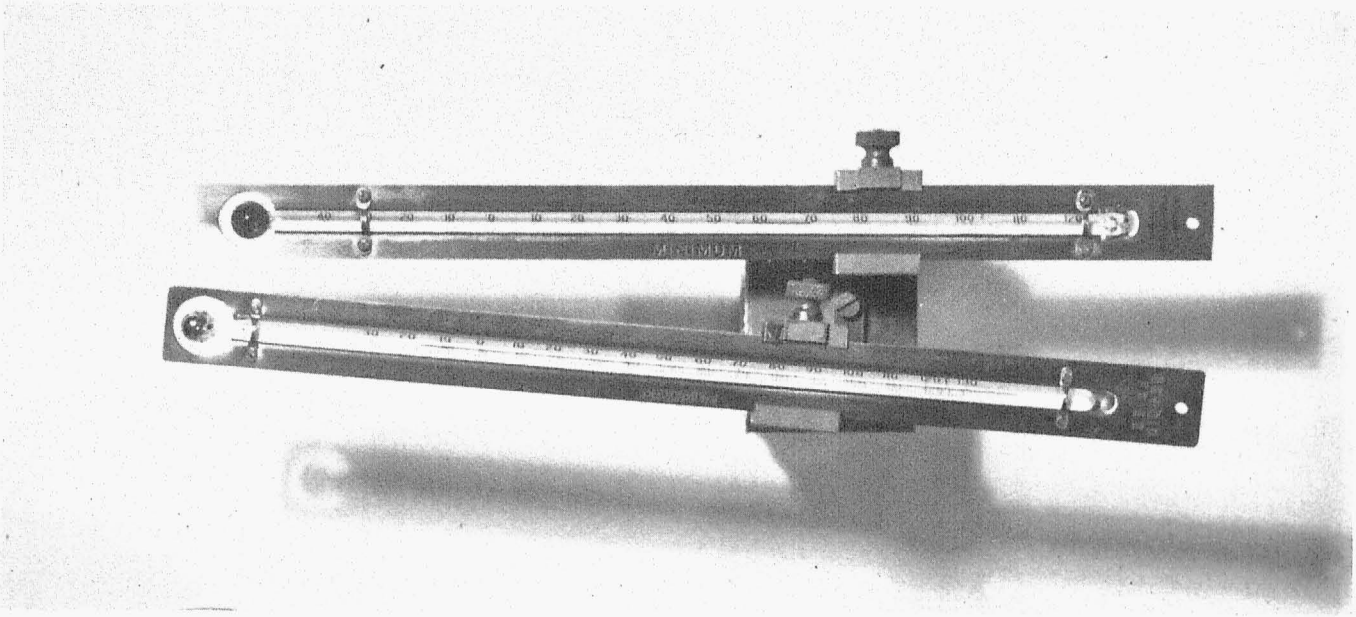


COOPERATORS

Representatives of the following states and federal agencies participated in this study:

Representative	State or Agency	Institution
C. N. Michaelson	Alaska	Alaska Agricultural Experiment Station
R. K. Simons	Illinois	University of Illinois
J. E. Newman	Indiana	Purdue University
R. H. Shaw	Iowa	Iowa State University
L. D. Bark	Kansas	Kansas State University
E. H. Kidder	Michigan	Michigan State University
D. G. Baker	Minnesota	University of Minnesota
W. L. Decker	Missouri	University of Missouri
R. E. Neild	Nebraska	University of Nebraska
E. B. Norum	North Dakota	North Dakota State University
J. B. Jones	Ohio	Ohio Agricultural Experiment Station
W. F. Lytle	South Dakota	South Dakota State University
C. B. Tanner	Wisconsin	University of Wisconsin
S. H. Whittner, Administrative Advisor	Michigan	Michigan State University
A. J. Loustalot	U.S.D.A.	CSRS
D. M. Hershfield	U.S.D.A.	ARS, Soil-Water Conservation Research Division
R. E. Meyers	U.S. Dept. of Commerce	Environmental Data Service (Weather Bureau)

CONTENTS

Temperature Effects in Agriculture

Air temperature on many occasions is either above or below the limits tolerated by agricultural crops and livestock. When these unfavorable temperatures occur, permanent or temporary injury will result; when the temperatures are favorable, plant growth and animal production are stimulated. Periods with these optimal conditions will result in rapid growth and development of plants and profitable gains for livestock.

Many summaries exist which present the geographic distribution of average temperature, average daily high temperatures, and average daily low temperatures. These are often displayed on maps, showing the variation of temperature with latitude, altitude, and continentality. Examples of such summaries are those prepared by the Environmental Science Service Administration (E.S.S.A.)[1, 2] In addition, there are many presentations showing the likelihood of lethal temperatures during critical periods. In most cases, these statistics indicate the distribution of the first occurrence or the last occurrence of the season. Examples of this type of presentation are probabilities of dates for the first killing freeze in the fall and the last freeze in the spring. These tabulations have been prepared by the Agricultural Experiment Stations in most states and by E.S.S.A.[3]

Few, if any, summaries exist showing geographic distribution of the likelihood for extended periods with optimum or favorable temperatures or periods with lethal or unfavorable temperatures. This publication will show the distribution over the North Central Region of runs of days with critically high, critically low, and favorable temperature conditions.

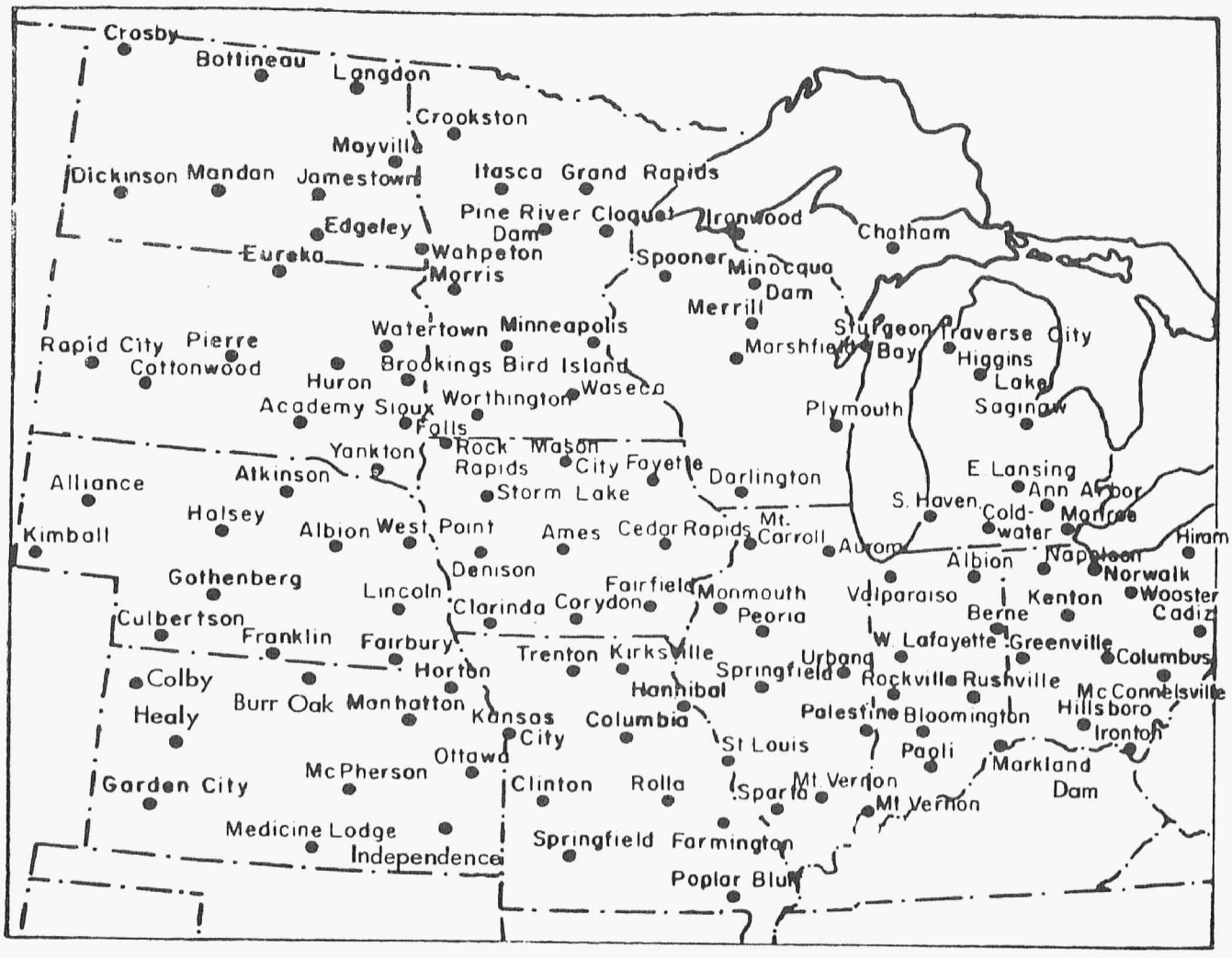
The Measurement of Temperature

Thermometers used to measure air temperature must be protected from the direct exposure to radiation from the sun or from the earth. To accomplish this protection, a special box is used which is louvered on all sides and is provided with a double roof for further protection from the sun's rays. The instrument shelter is painted white to permit the reflection of most of the sun's energy. The box is placed on legs to elevate it about five feet above the surface. At this level, the temperatures do not fluxuate as rapidly as they do closer to the surface.

It is an accepted practice at many locations to record the highest and lowest temperatures for 24-hour periods. These maximum and minimum temperatures are obtained from special thermometers and are the basic data from which the summaries in this bulletin have been computed. (The temperatures are recorded daily in degrees Fahrenheit.) The locations in the North Central Region from which temperature data were obtained for this bulletin are shown in Figure 1. The period of record used in the study varied from 30 to 50 years. In general, the study covered the period from the establishment of each weather station through 1956

Lethal Temperatures in Agriculture

Temperatures which fall below freezing offer a special hazard to the agriculture of the North Central Region during spring and in the autumn. There are degrees of severity of freezes, depending on the extent of the temperature fall. One characterization for the severity of freeze recognizes three types of occurrence, (1) the light freeze, when temperatures



Locations in the North Central Region where the temperature data were obtained.

dip into the range from 28° to 32°F., (2) the moderate freeze when night-time temperatures are in the range of 24° to 28°F., and (3) the severe freeze when temperatures fall below 24°F. Since many plants can withstand a light freeze, for purposes of this study the occurrence of 30°F. was selected as a critical value. In some cases the horticulturist or gardener may attempt to protect his plants from a single night of freezing temperature, but would find it difficult to continue the protection for extended periods of time. The likelihood of periods of days with minimum temperatures below 30°F. has been calculated; similarly, the probability of runs of days with maximum temperatures above 30°F. have been computed.

Considerable injury to field crops can result from extended periods with high temperatures. For most crops adapted for planting in the North Central Region, temperatures are usually below those generally considered lethal highs. However, extremely high temperatures sometimes occur during prolonged rainless periods and water stresses are induced by rapid evapotranspiration associated with the high temperatures. It is generally conceded that temperatures in excess of 100°F. are detrimental to crop production. When these temperatures occur for periods

of a week or more, they reduce yields and may result in the death of the crop. To provide estimates of the geographic distribution of periods with these temperatures, the chances for runs of days with temperatures above 100°F. were computed. Similarly, the chances of runs of days with temperatures in excess of 90°F. were figured.

Comfort of Animals

The rate of milk and egg production and the amount of gain by meat producing animals is influenced by temperature. Decline in production is associated with the occurrence of temperatures outside those considered optimum for the type of livestock. Under extreme conditions, death will result from prolonged periods.

Cold temperatures in the winter offer hazards to livestock in pastures. This is particularly true when the low temperatures are accompanied by blizzards. These conditions are most frequent in Minnesota, the Dakotas, Nebraska, and Iowa. To show the geographic distribution of periods with these low temperatures, the likelihood of runs of days with temperatures below 0°F. have been tabulated.

Research indicates that declines in production and rate of gain in cattle and other livestock are associated with the occurrence of high temperatures in summer. When temperatures climb above the mid-80's, the intake of food by cattle is reduced and production falls. The tabulation of the chances of prolonged periods with temperatures rising above 90°F. and above 100°F is of special interest to the livestock producer.

Temperatures and Growth Rates of Plants

In spring, plant growth does not begin until temperatures rise above a minimum value. This minimum value varies with the type of crop. For many cool season plants, such as small grains and most grasses, growth and development begin when temperatures rise above 40°F. For many other plants, such as corn, soybeans, and bermuda grass, growth does not begin until temperatures become higher than 50°F. In general, most of the spring and summer growing plants in the North Central Region have a minimum for growth near the 40° or 50°F. level.

The Likelihood for Runs of Days with Specified Temperatures

The method developed for computing the probability of days with temperatures was flexible and permitted the computation of the probability of a period of days of any length. It was necessary to perform a geographic smoothing of these probabilities and only a limited number of maps could be presented. An effort was made to prepare representative maps giving the patterns for probabilities of runs of days.

For each week the probabilities of five-day periods with the various critical limits are presented. There are seasons when five days with a given temperature is a certainty; during other seasons the temperature never occurs. For example, subfreezing temperatures never occur in the summer so maps showing the likelihood of minimum temperatures below 30°F. or maximum temperatures above 30°F. in summer would not provide useful information.

The probability of runs of 15 days' length are presented for every other week. The 25-day periods are present for every third week while the chances of 35-day periods are given for every fourth week. Figures for periods between these maps may be interpolated.

RUNS OF DAYS OF VARYING LENGTH WITH MAXIMUM TEMPERATURES ABOVE 30°F. (-1.1°C.)

A temperature of 30°F. was chosen as a critical temperature representing near freezing conditions. Freezing temperatures are certainly important to the production of plants and to human and animal comfort. The choice of 30°F. was arbitrary since water freezes under normal conditions at 32°F. But tem-

perature recorded in an instrument shelter is often several degrees different from the temperature within a plant canopy near the surface. On clear nights the temperature in the instrument shelter is usually higher than that occurring near the surface. On the other hand, the maximum temperature of late afternoon as measured by the thermometer in the instrument shelter is often a bit lower than the temperatures found near the plant surface.

The occurrence of a temperature near 30°F. at midafternoon on winter days represents a mild weather condition in many areas in the North Central Region. Across the Dakotas, Minnesota, Wisconsin, and Michigan, an extended period with temperatures above 30°F. marks a break in the usual winter weather. The occurrence of periods with these temperatures in early spring and late fall in all portions of the North Central Region offers periods favorable for outdoor activities. Outdoor construction and similar weather-sensitive activities may be conducted during these periods with above freezing temperatures. For some of these periods during winter, early spring, and late fall frost will leave the surface layers of the soil. This condition will produce unfavorable footing for man, animals and machines. In this respect, at least, the occurrence of periods with temperatures above 30°F. must be considered unfavorable for some outdoor activities.

The maps on pages 8, 9, and 10 of this bulletin display the probability of five or more consecutive days with temperatures above 30°F. In winter, runs of days of this length occur on more than 60 percent of the years in the southern two-thirds of the region. In the extreme northern localities a period of this length will begin during any week of winter on 10 to 20 percent of the years. By late February, southeastern Kansas, southern Missouri, and Illinois experience five or more consecutive days with temperatures above 30°F. 80 percent of the years. As spring progresses the probability for periods of at least five days duration with temperatures above 30°F. increases rapidly, and by late March runs of days of this length are virtually a certainty in all parts of the region. In autumn the probability of five or more consecutive days with 30°F. remains high through October, but by late November such a period will begin during a given week 60 percent of the years in the Dakotas, Minnesota and Wisconsin.

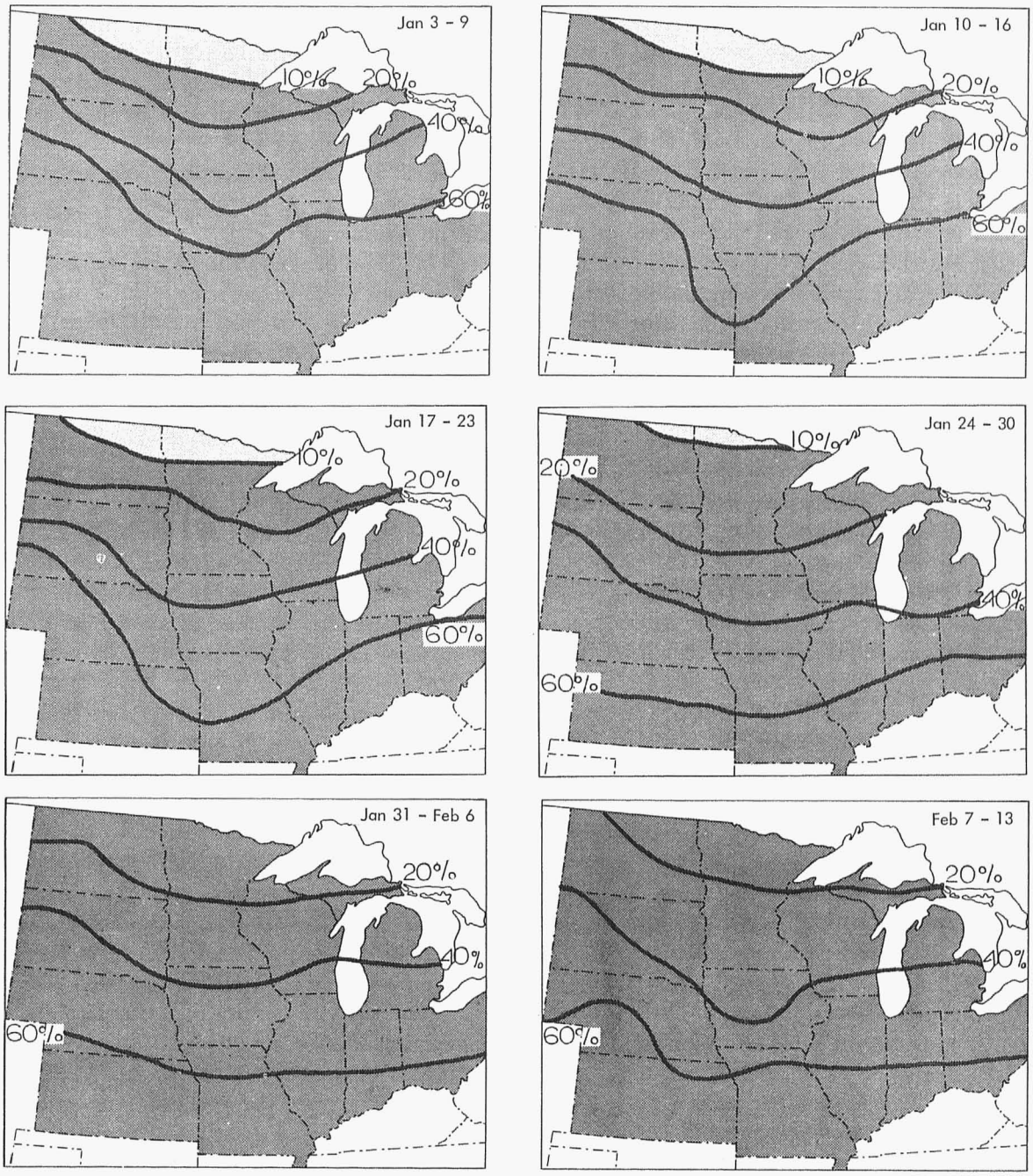
Maps on pages 11 and 12 show the geographic distribution of the probabilities of 15 or more consecutive days with maximum temperatures higher than 30°F. In winter, this event will begin during any week about 40 percent of the years in the southern one-fifth of the region. However, across the northern half of the North Central Region, 15-day periods will occur with the frequency of only 10 percent. By late March the occurrence of 15-day periods with temperatures above 30°F. is nearly a certainty throughout the southern half of the region and the frequency of 15-day periods is in excess of 50 percent in the northern portion of the region. The probability of sustaining such periods with temperatures above 30°F. decreases sharply in the autumn and by late November the patterns closely resemble those of the winter.

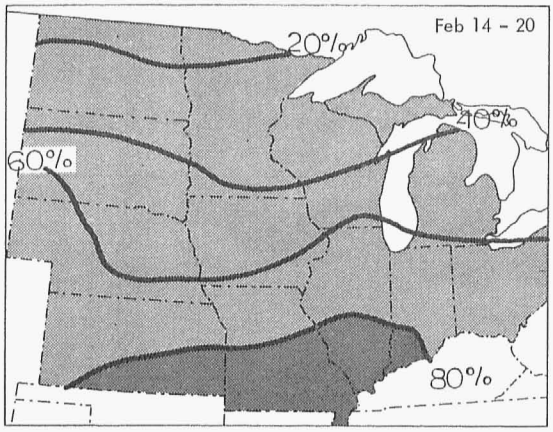
Maps on pages 13 and 14 show that, during winter, periods of 25 or more days with maximum temperatures above 30°F. are extremely rare in the northern two-thirds of the region, but these periods are expected two out of 10 years in most southern portions of the North Central Region. Even during the middle week of March, periods of 25 days or more with temperatures above 30°F. begin less than 40 percent of the years in North Dakota and northern Minnesota. In autumn the probability of periods of 25 days with 30°F. temperatures decreases throughout the North Central Region, and by early November the northern portion of the region experiences these extended runs of days only 20 percent of the years.

Long spells of mild weather in winter occasionally occur, but the maps on page 15 show that only rarely will the maximum temperatures rise above 30°F. on at least 35 consecutive days. In late January this event occurs 20 percent of the years in the extreme southern portions of the North Central Region. It is not until the last week in March that five-week periods with maximum temperatures above 30°F. become virtually a certainty in the southern portion of the area. In March, periods of five weeks duration with maximum temperatures above 30°F. occur only four years out of 10 in the northern extremities of the region. In autumn there is a rapid movement toward the predominant winter pattern with the associated decrease in probability of these long periods of mild weather.

PERIODS OF VARIOUS LENGTHS WITH MAXIMUM TEMPERATURES ABOVE 30°F.

Runs of 5 or More Days with Maximum Above 30°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

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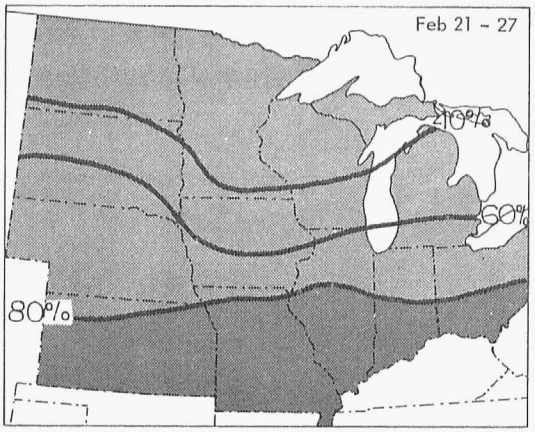
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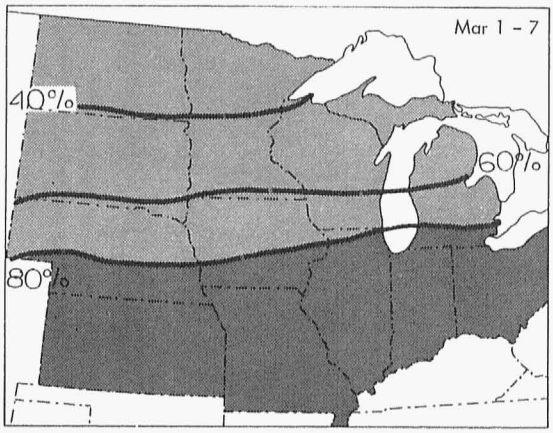
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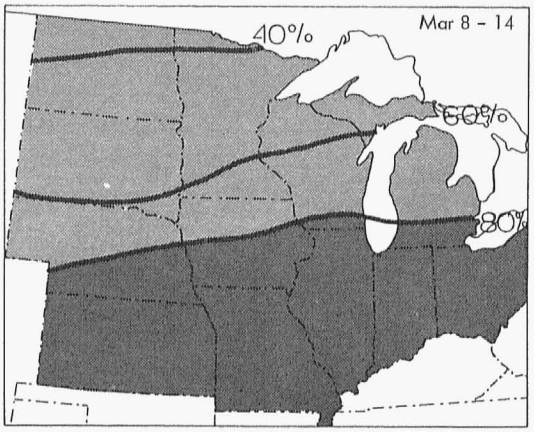
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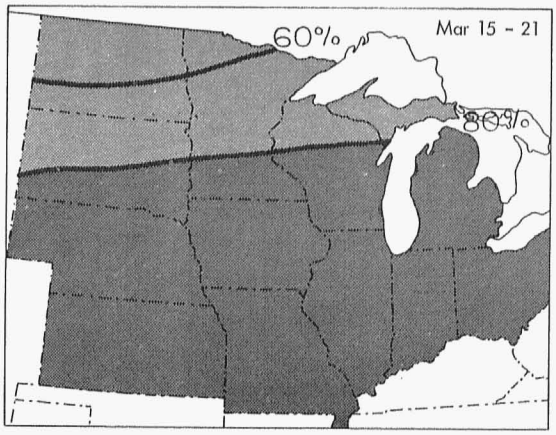
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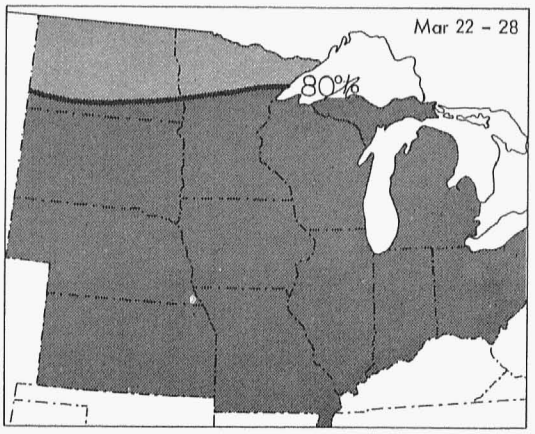
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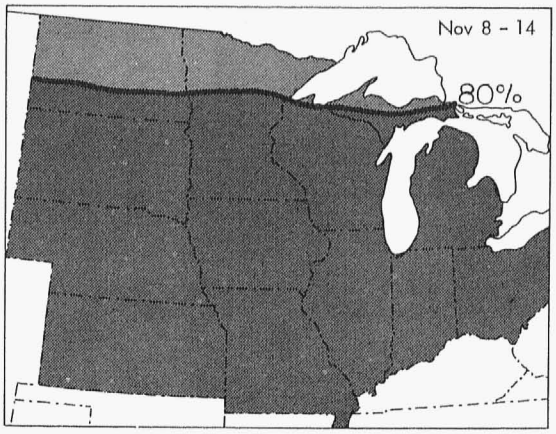
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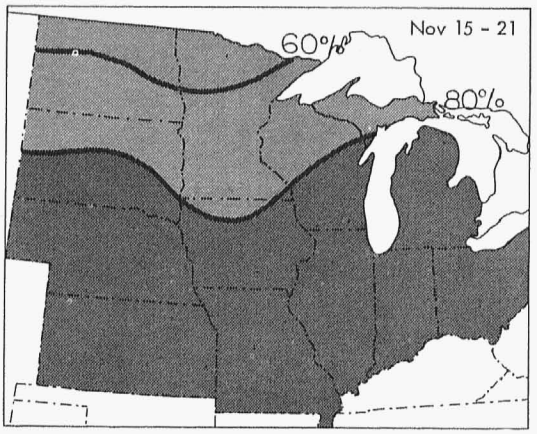
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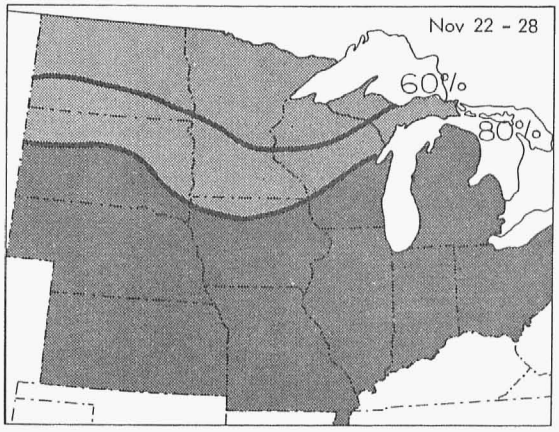
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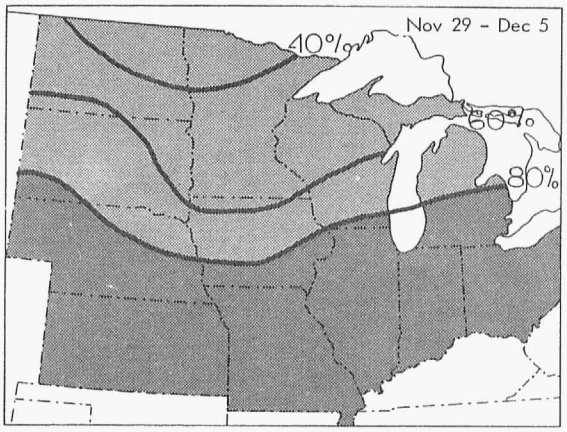
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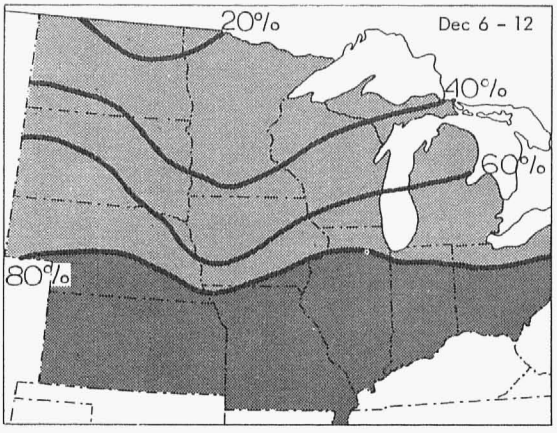
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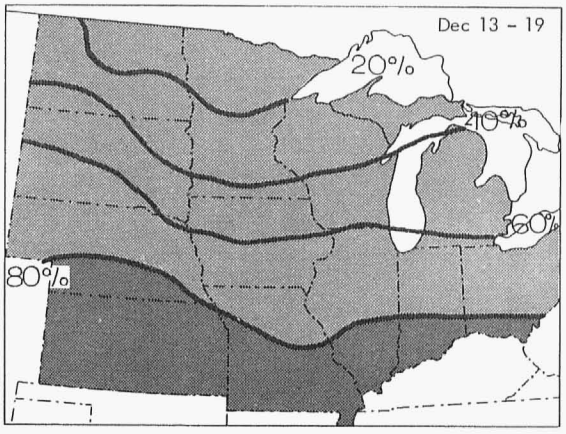
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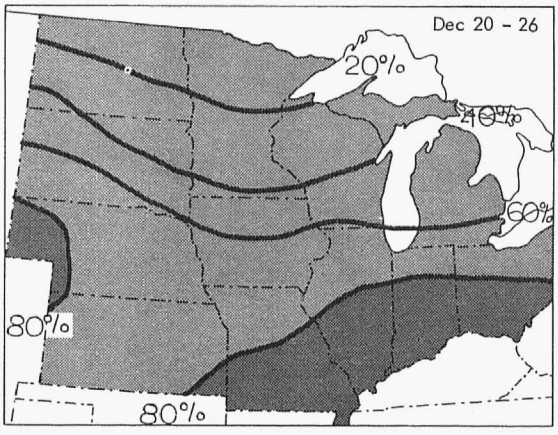
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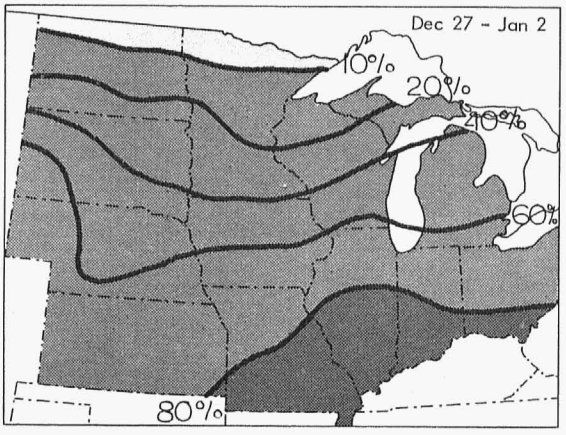
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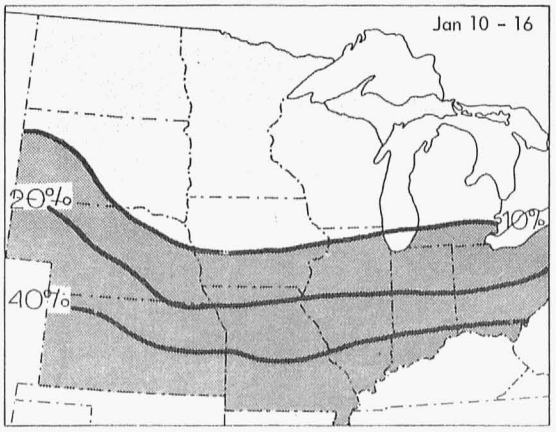
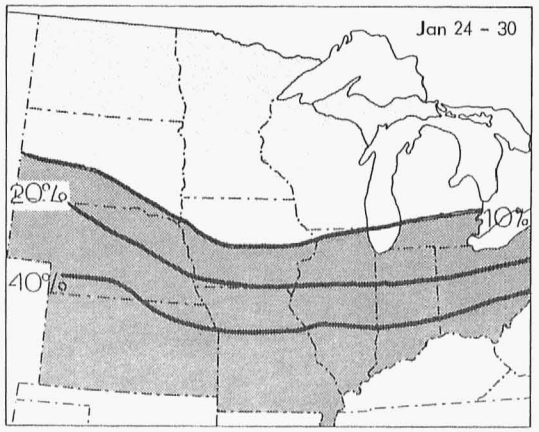
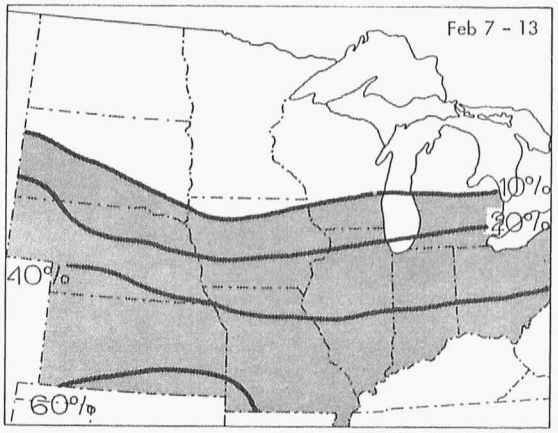
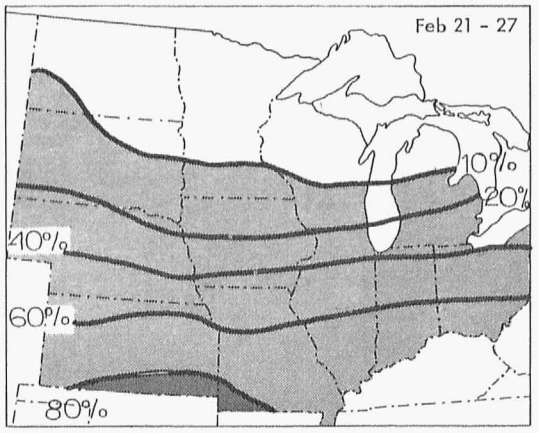
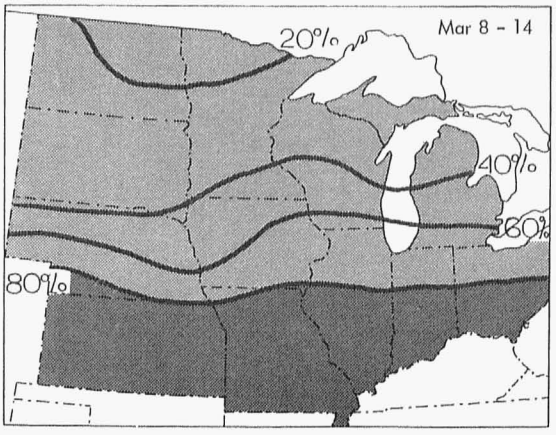
Runs of 15 or more Days with Maximum Above 30°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

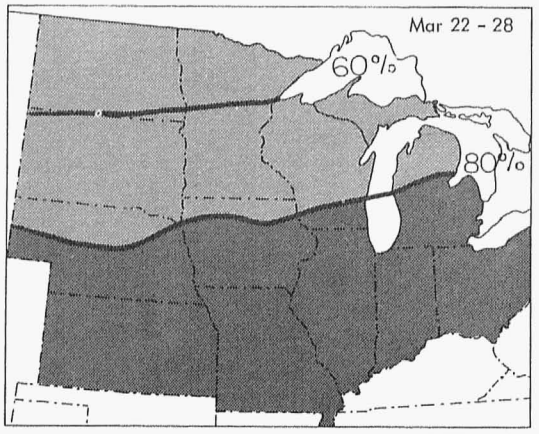


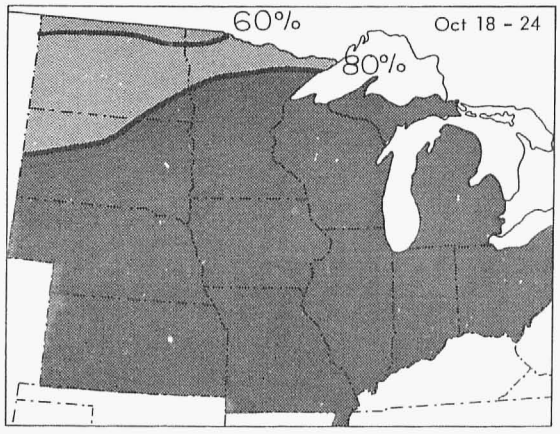








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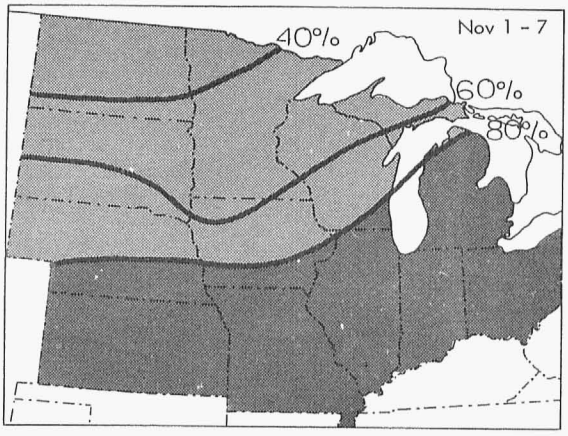
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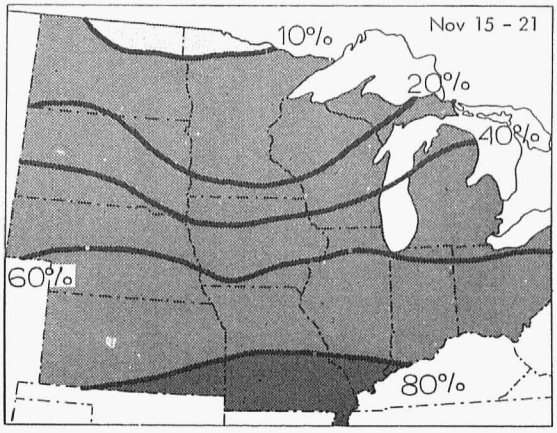
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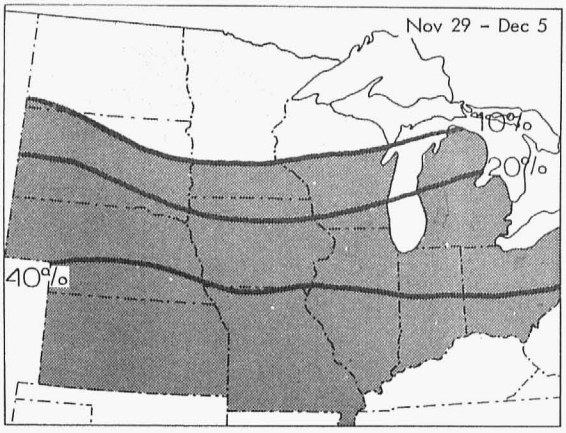
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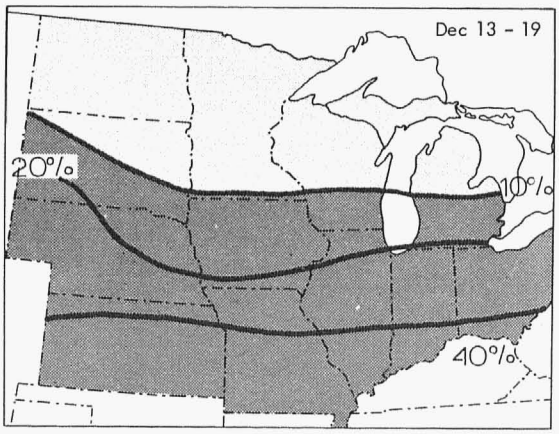
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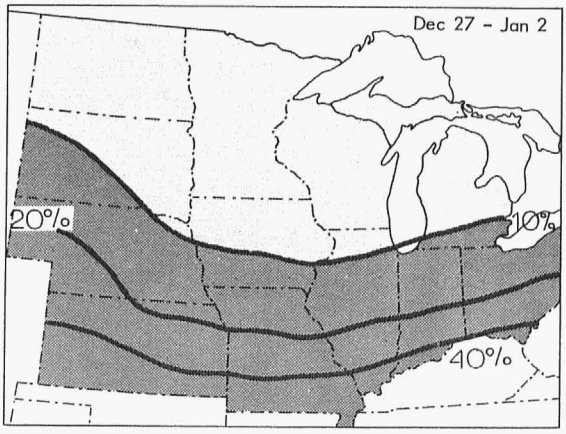
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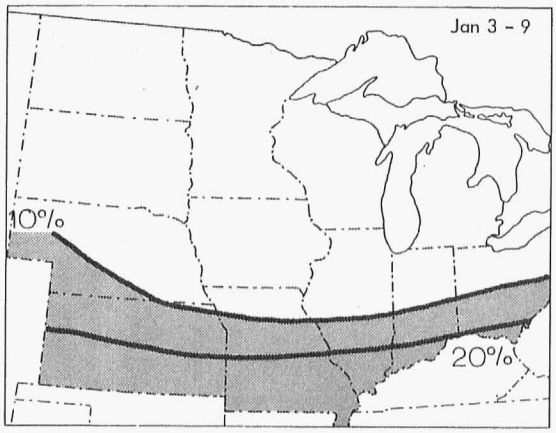
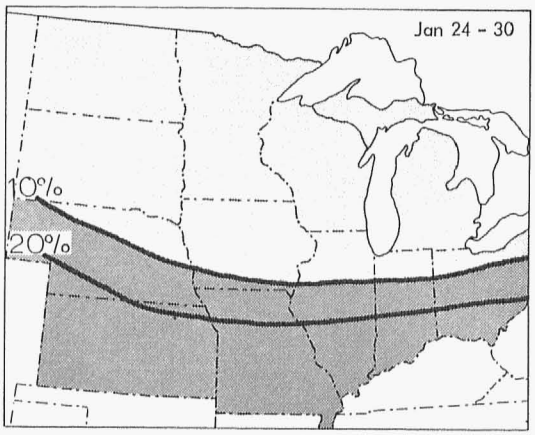
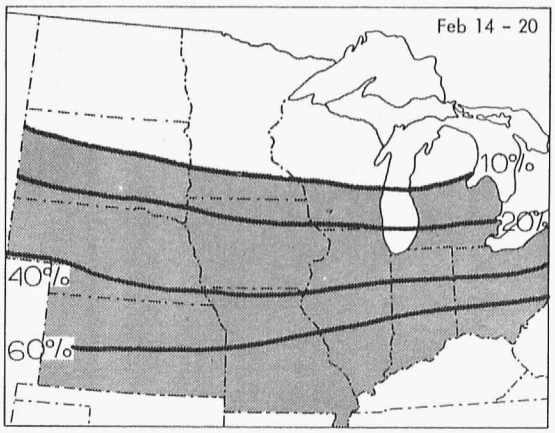
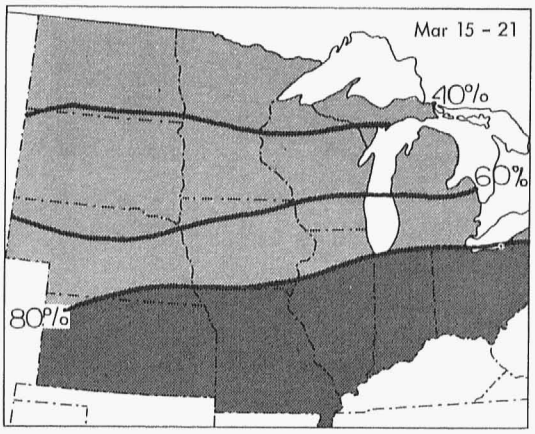
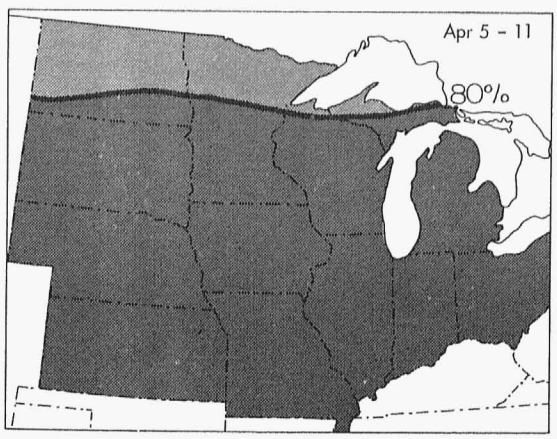
Runs of 25 or More Days with Maximum Above 30°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

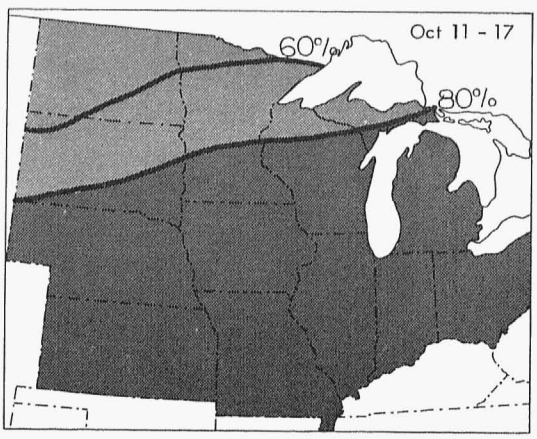


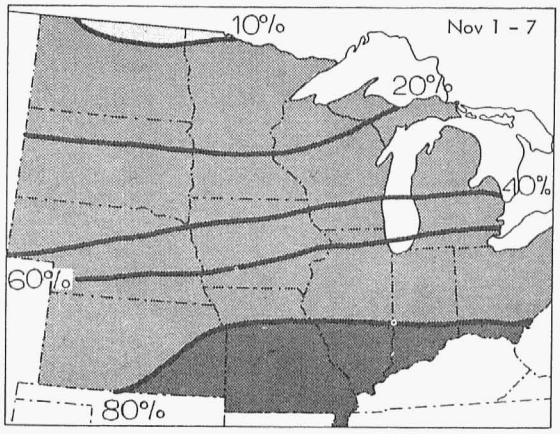


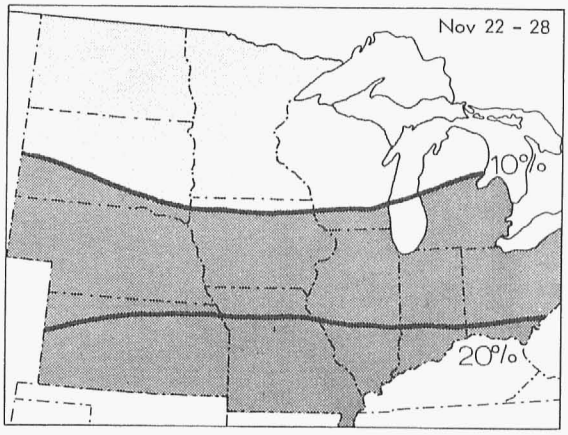


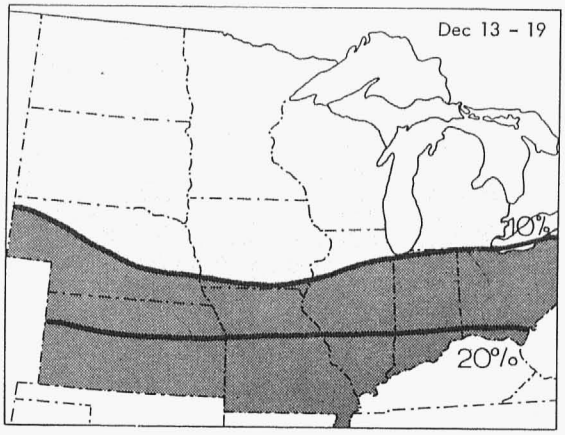




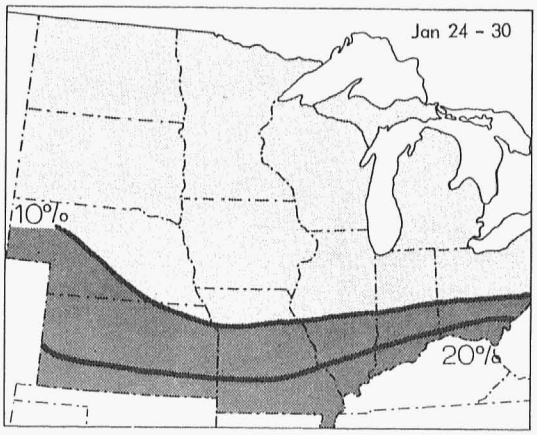


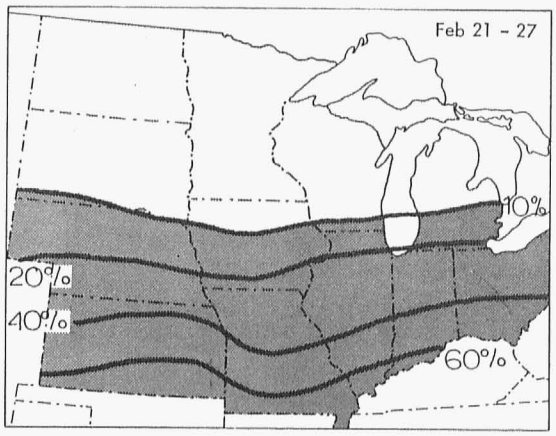

Nov 1 - 7
10%
20%
10%
60%
80%

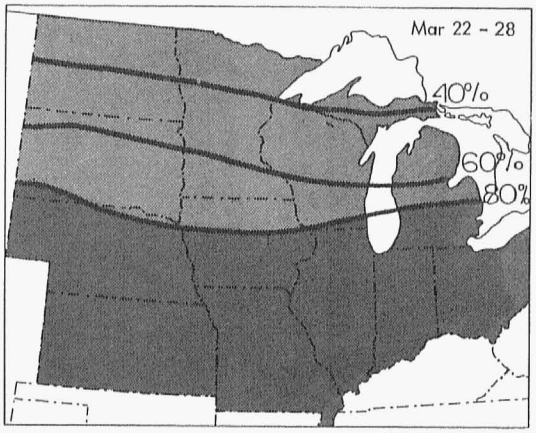

Nov 22 - 28
10%
20%

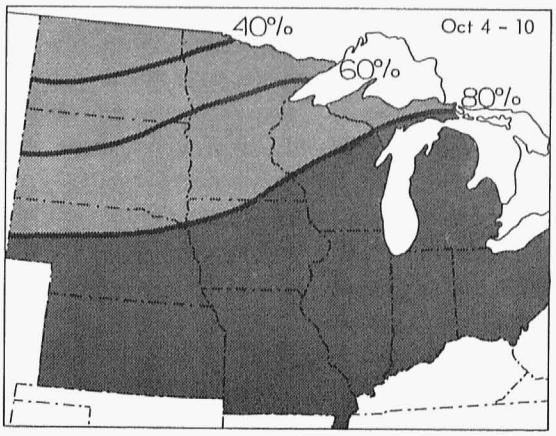

Dec 13 - 19
10%
20%

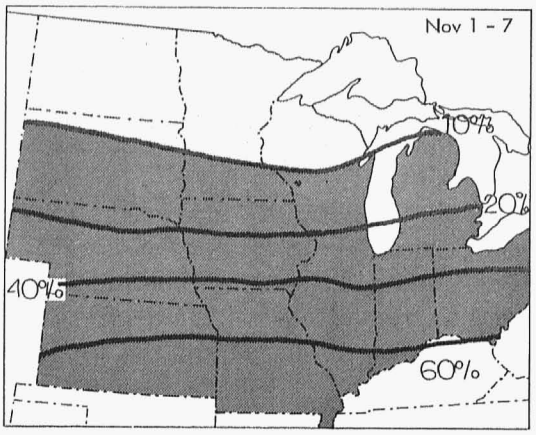
Runs of 35 or More Days with Maximum Above 30°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

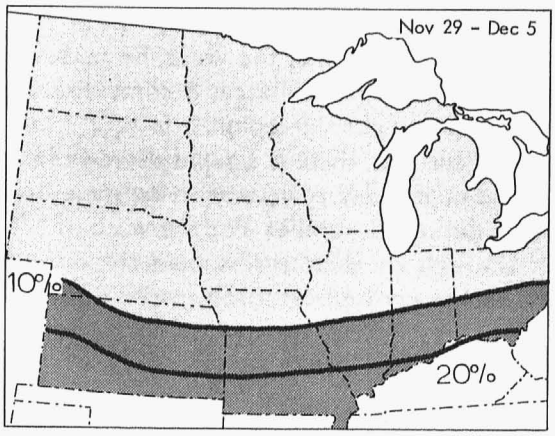


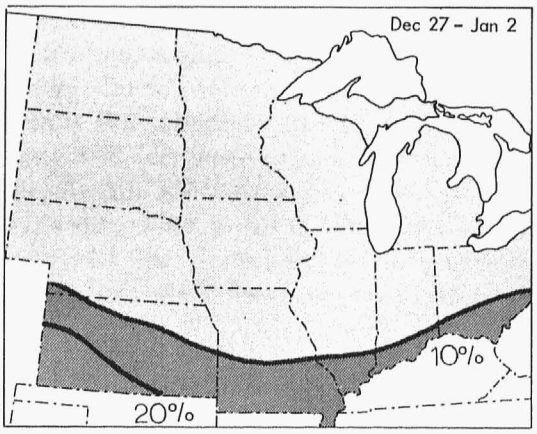












RUNS OF DAYS WITH MAXIMUM TEMPERATURES ABOVE THRESHOLD VALUES FOR GROWTH IN SPRING AND FALL

Plant development and growth does not occur until the threshold temperature for a particular plant has been reached. This temperature is often called the minimum temperature for a given species of plant. The rate of growth or development of a plant increases as the temperature rises above this minimum level. Plants adapted to cool climates or those which begin their development during the early spring are generally believed to have threshold temperatures near 40°F. When several consecutive days with maximum temperatures above 40°F. occur, growth and development for these plants will generally begin. Examples of plants falling in this category are most of the cereals and many of the forage crops. For crops grown under warmer conditions or those which begin growth later in the summer, the threshold temperature appears to be near 50°F. This category would include such crops as corn, sorghum, and soybeans.

On days when winter and spring temperatures are above 40° and autumn temperatures, above 50°F., outdoor farm and construction work may be undertaken. In winter, these are days when temperatures rise above the freezing mark during the daylight hours. In fall and spring, they represent the cool periods when outdoor activities may be accomplished without heavy clothing.

When the temperature within the instrument shelter is above 40° or 50°F., the temperature within the plant canopy will depend upon the energy received at the surface on a particular day. For sunny days, temperature close to the ground may be several degrees warmer than that within the instrument shelter during the afternoon hours. On cloudy days the temperature within the canopy will likely be nearly the same as that measured in the instrument shelter. It is hazardous to generalize concerning the night-time temperatures associated with days when the temperatures rise to levels slightly above 40° to 50°F. On clear days one would expect the night-time temperatures to dip below or near freezing in nearly every case. However, when the weather is cloudy the night-time temperature may be only a few degrees less than that occurring during the day.

Runs of Days with Temperatures Above 40°F. (4.4°C.)

The geographic distribution of the probabilities of runs of days with temperatures above 40°F., is shown on following pages. Maps on pages 18, 19, 20, and 21 present the probabilities of periods of five days or longer with maximum temperatures above 40°F. For any winter week over the northern third of the region only 10 percent of the years have five-day periods with this temperature. In the extreme southern portion of the region, periods of five days or more with these temperatures occur during winter over 50 percent of the years. In March there is a rapid increase in the probabilities for periods with temperatures above 40°F. By early April a week will produce a run of five days or longer with temperatures above 40°F. eight out of 10 years in the southern two-thirds of the region. In the extreme northern portion of the region a run of this length will occur in over half the years. By mid-April, runs of five days length or longer become virtually a certainty throughout the region.

In autumn, there is a rapid decrease in the likelihood of five-day periods with temperatures above 40°F. during November. For the week of November 22 through 28, there is less than 10 percent chance for such a period beginning in the north, while in

the south such a period would be expected about eight out of 10 years.

In the southern portion of the North Central Region during winter there is only 10 to 20 percent chance of a 15-day period with temperatures above 40°F. beginning a particular week. As seen in the maps on pages 22, 23 and 24 from Mid-March to mid-April there is a rapid increase in the likelihood of 15-day periods with maximum temperatures above 40°F. By late April almost all of the region has a certainty of periods of more than two weeks duration with maximum temperatures above 40°F. Shorter periods generally begin to occur again in about October. There is a rapid decrease in the probability of 15-day periods during late October, and by mid-November nearly half of the region experiences a period of this length less than one year in ten.

Pages 25 and 26 show the likelihood of runs of 25 days' length with maximum temperatures above 40°F. It is extremely rare in winter for periods of this duration to occur, and even in extreme southern Kansas such a period will begin on a given week about one out of every 10 years. By early May periods of this length with temperatures above 40°F. become a virtual certainty. In September, the northern portion of the region begins to experience shorter periods with temperatures above 40°F. and by late November nearly all of the region experiences runs of shorter duration than 25 days every year.

The maps on page 27 indicate that five-week periods with temperatures above 40°F are unknown during the fall and winter in the North Central Region. But in late February periods of this length originate in the southern portion of the region one out of 10 years. In autumn, periods of shorter duration than five weeks with temperatures above 40°F. begin to occur by mid-September and in early October five-week periods with this temperature are experienced less than one year out of 10 in most of North Dakota and northern Minnesota.

Runs of Days with Temperatures Above 50°F. (10°C)

The chances for periods of varying length with maximum temperatures above 50°F. are shown on the maps beginning on page 28. The likelihood for five or more consecutive days with temperatures above 50°F. is shown by weekly periods on the first four pages of this series (pages 28 through 31). In winter, only the southern one-fifth of the North Central Region experiences periods of this length. Even in this area the probability that such an occurrence will begin is less than one in ten. By the mid-week of February the ten percent probability for these periods is confined to the northern half of the region with a 40 percent chance occurring in the extreme south. There is a rapid change toward higher probability in late March and by mid-May periods of five days with maximum temperatures above 50°F. are almost certain to begin during every week throughout the region. In autumn, there is a rapid decrease in the probability of five-day periods with temperatures above 50°F. during the month of November. By the last week of November there is only a sixty percent chance for such an occurrence in southern Kansas, with a 10 percent chance in the northern half of the region.

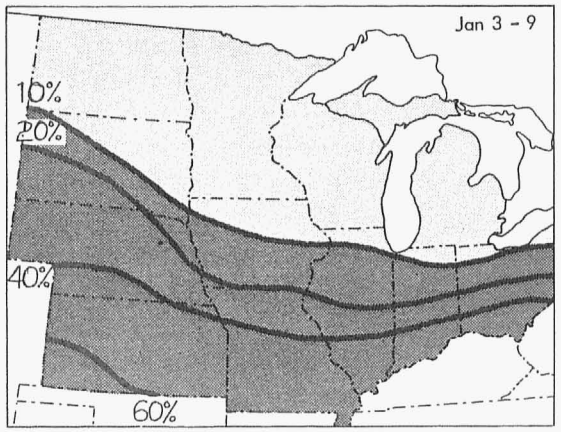
The frequency for periods of 15 days or longer with maximum temperatures above 50°F. is shown on pages 32 and 33. These maps indicate that the probability of periods with this duration is very low throughout most of the region until early April. After this time, the probability increases very rapidly and by the first week in May a 15-day period with such temperatures will occur more than 50 percent of the years in North Dakota, northern Minnesota, Wisconsin, and Michigan. In early autumn, 15-day periods with 50°F. maximum temperatures occur with decreasing likelihood throughout the region and by the last week in September the northern portion of the region experiences periods of this length about four out of 10 years.

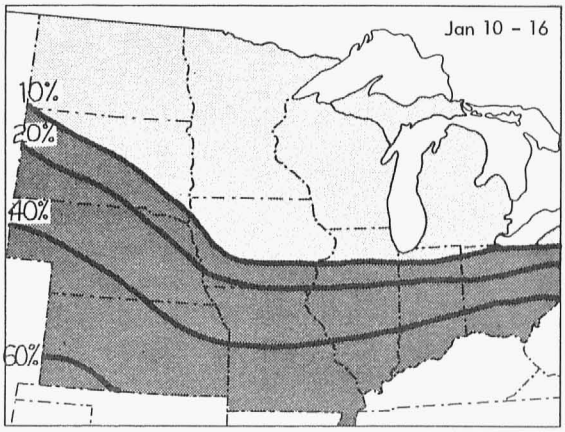
Pages 34 and 35 show the pattern for periods of 25 days length with maximum temperatures of 50°F. or higher. Periods of this length have a very low probability during the late autumn, winter, and early spring. The pattern becomes quite pronounced during the last week in April, with an 80 percent chance for such a period in southern Kansas. There is only a 20 percent probability for this event in extreme northern Minnesota and across the upper peninsula of Michigan. At the end of the summer season there is a corresponding rapid decrease in the likelihood of these extended periods with temperatures above 50°F. during September.

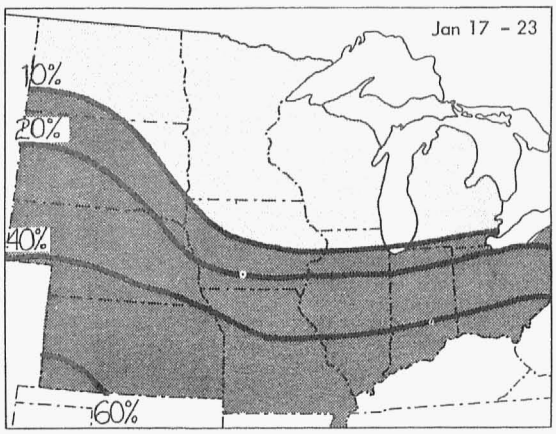
The patterns for 35-day periods with temperatures above 50°F. are shown on page 36. These maps indicate that during winter five-week periods are essentially unknown throughout the region. On the other hand, from May until early August, five-week periods begin during every week in all sections.

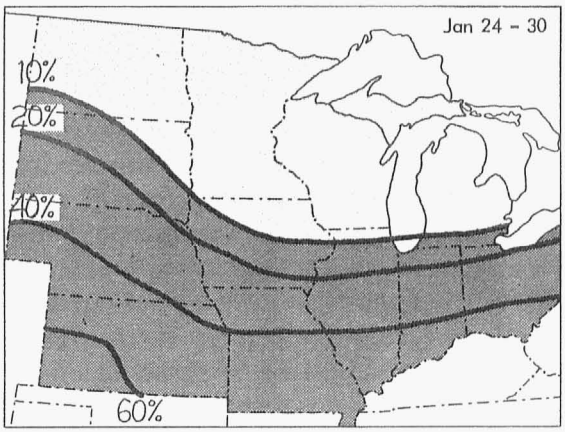
PERIODS OF VARIOUS LENGTH WITH MAXIMUM TEMPERATURES ABOVE 40°F.

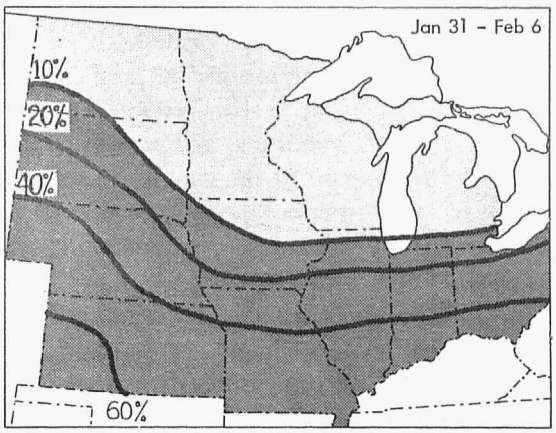
Runs of 5 or More Days with Maximum Above 40°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

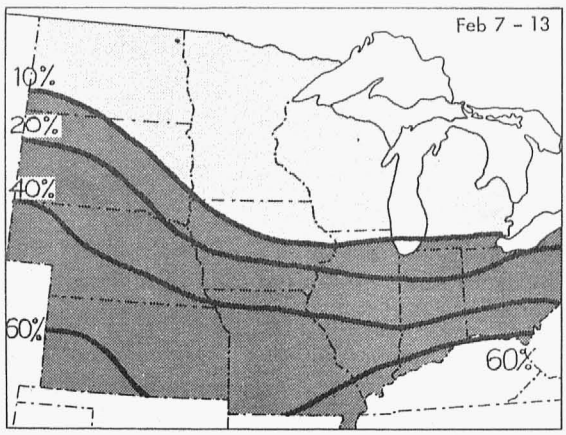


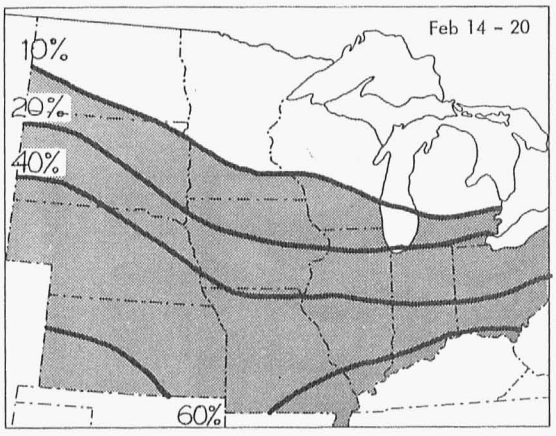


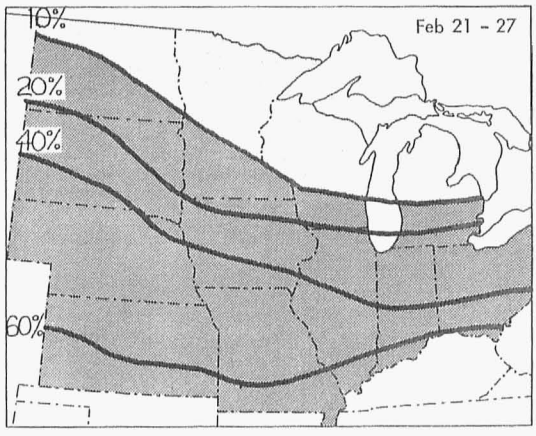









Feb 14 - 20
10%
20%
40%
60%


Feb 21 - 27
10%
20%
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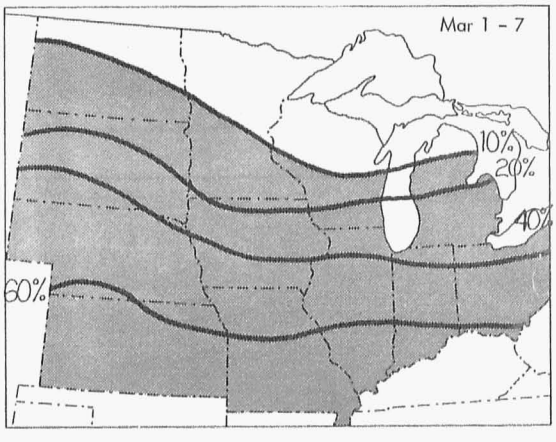
60%


Mar 1 - 7
10%
20%
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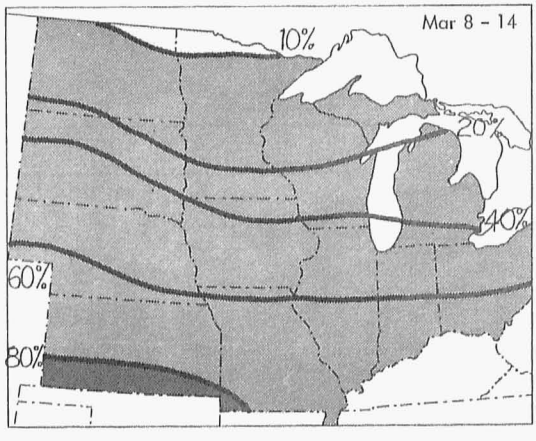
Mar 8 - 14
10%
20%
40%
60%
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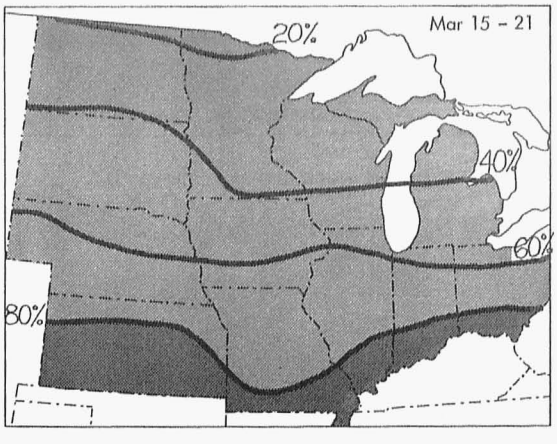
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20%
40%
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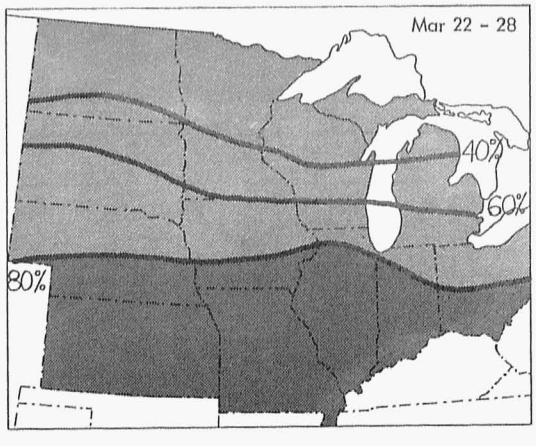
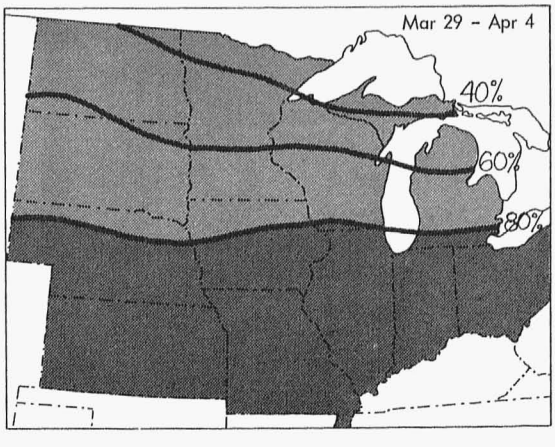

Mar 22 - 28
40%
60%
80%


Mar 29 - Apr 4
40%
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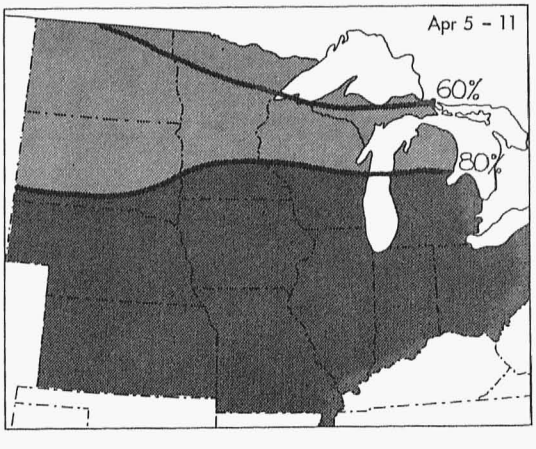
80%


Apr 5 - 11
60%
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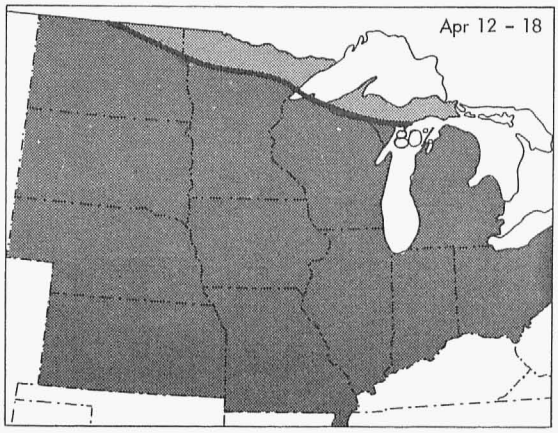
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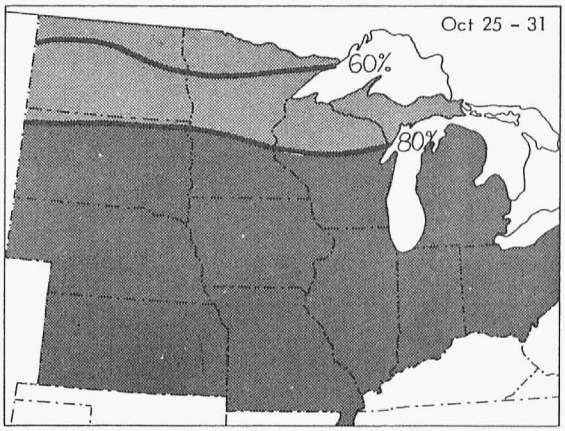
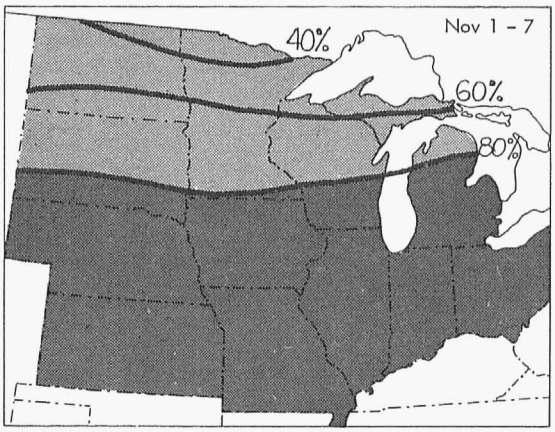

Oct 25 - 31
60%
80%


Nov 1 - 7
40%
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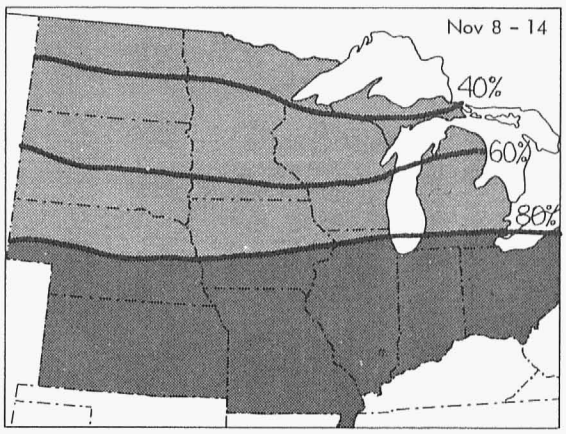
Nov 8 - 14
40%
60%
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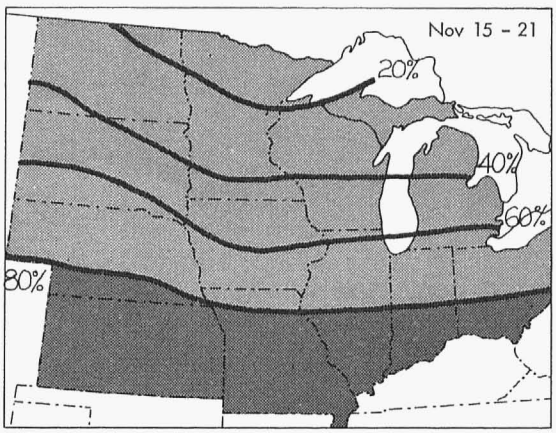
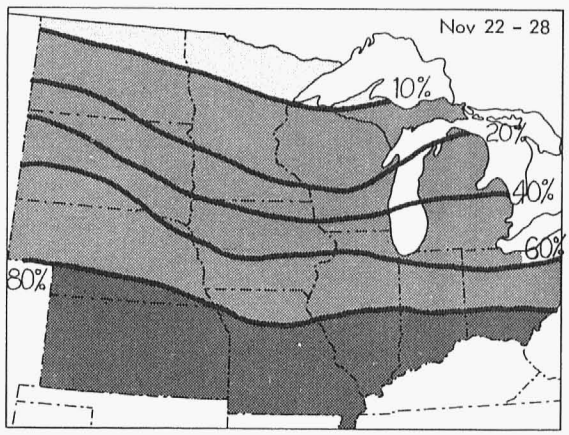

Nov 15 - 21
20%
40%
60%
80%


Nov 22 - 28
10%
20%
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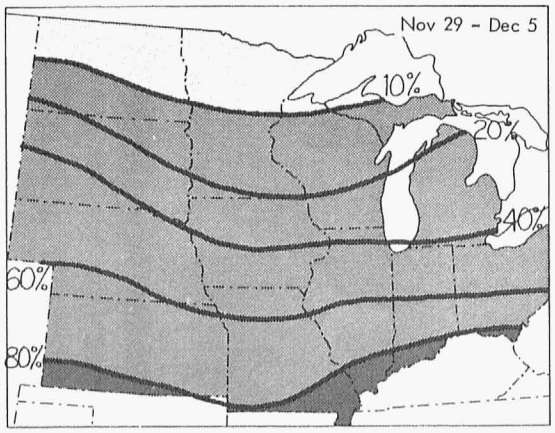
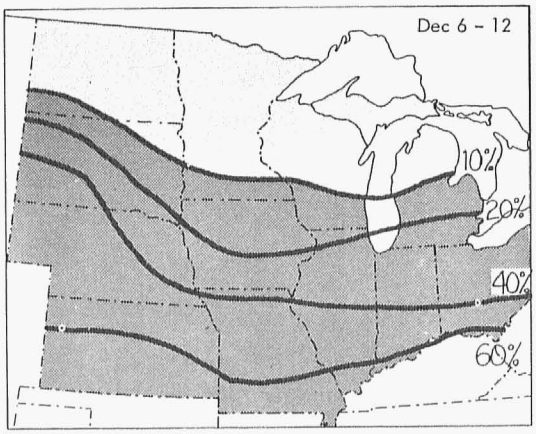
60%
80%


Nov 29 - Dec 5
10%
20%
40%
60%
80%


Dec 6 - 12
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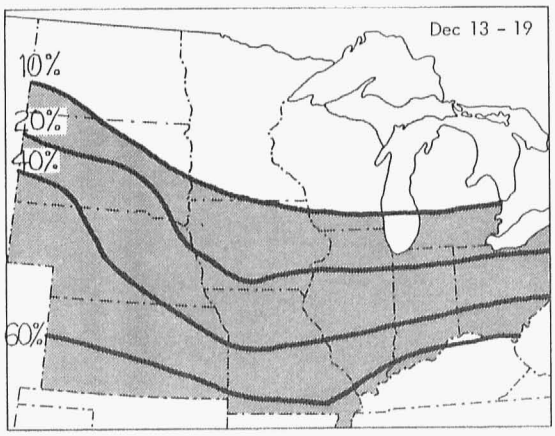
Dec 13 - 19
10%
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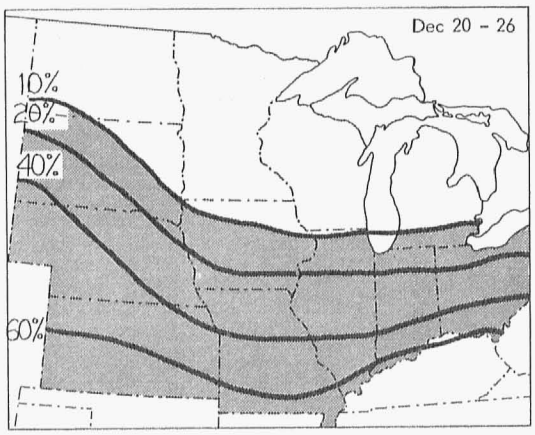
Dec 20 - 26
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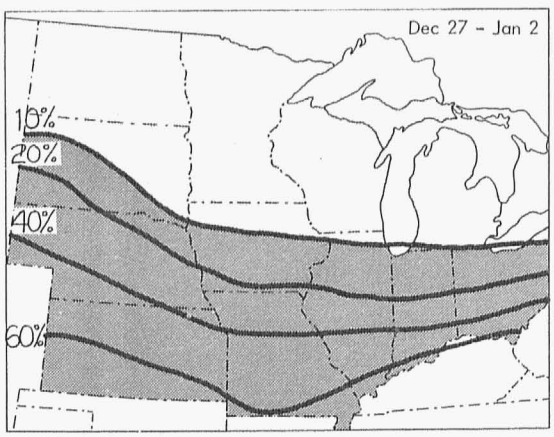
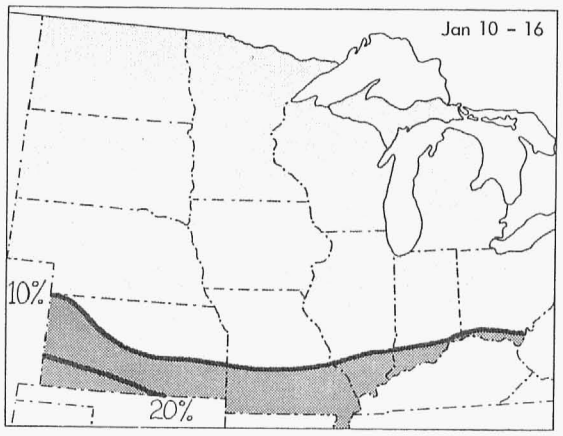
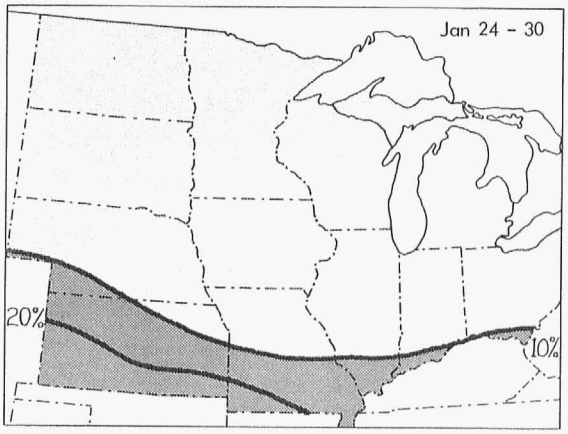
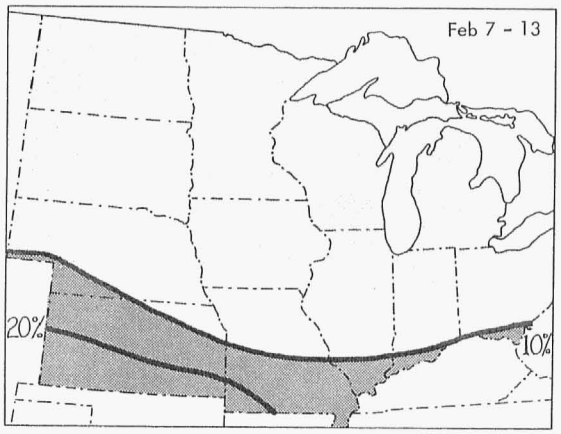
20%
40%
60%

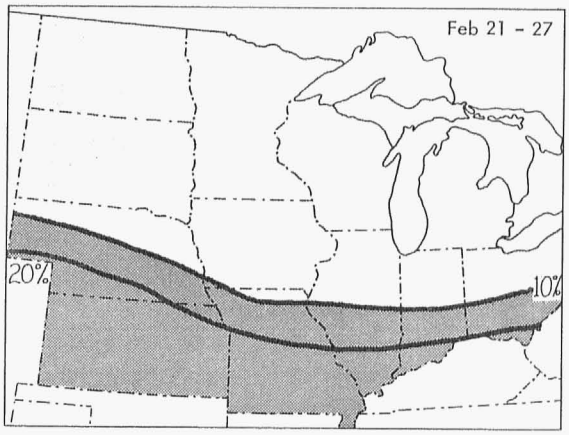

Dec 27 - Jan 2
10%
20%
40%
60%

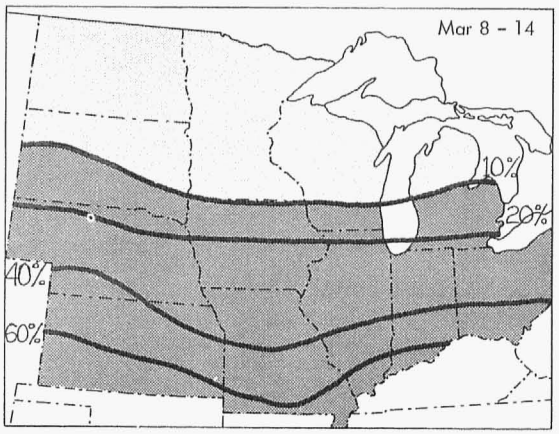
Runs of 15 or More Days with Maximum Above 40°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

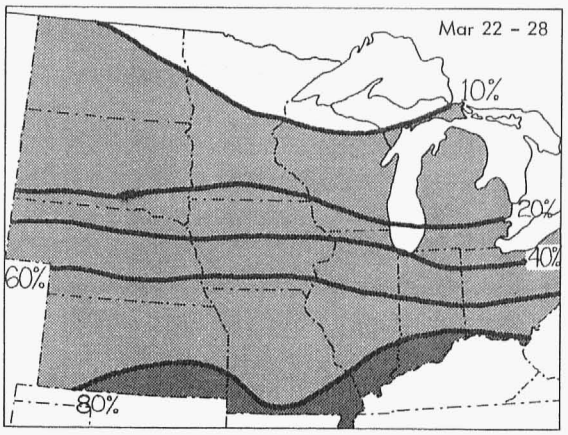


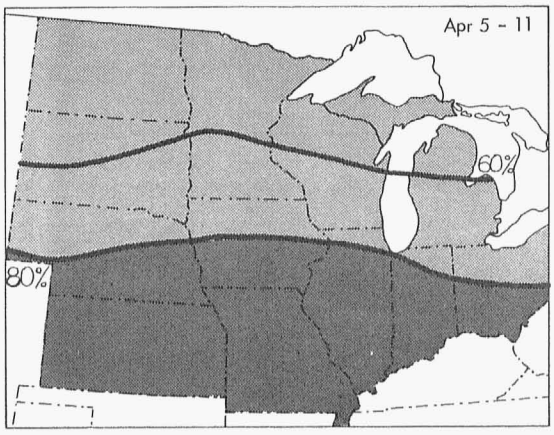


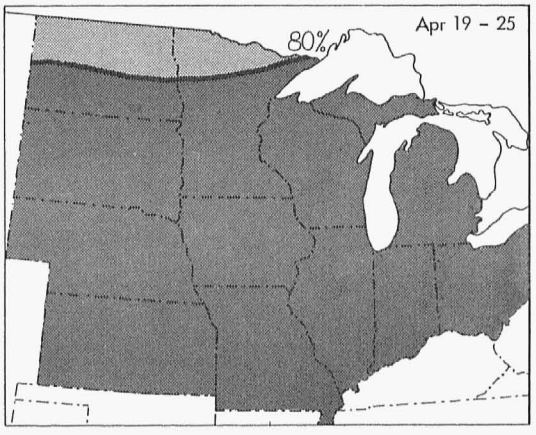


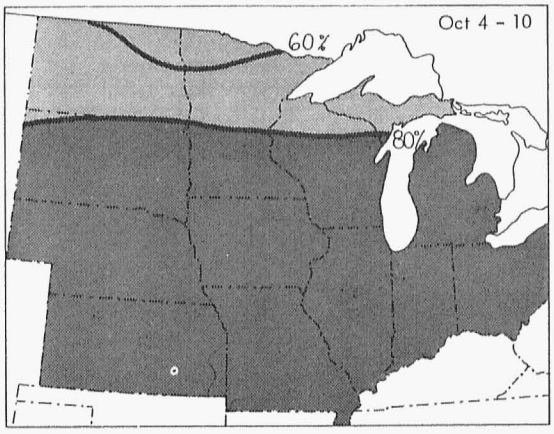


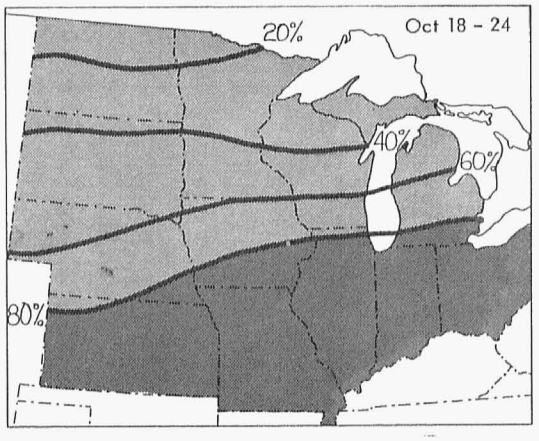


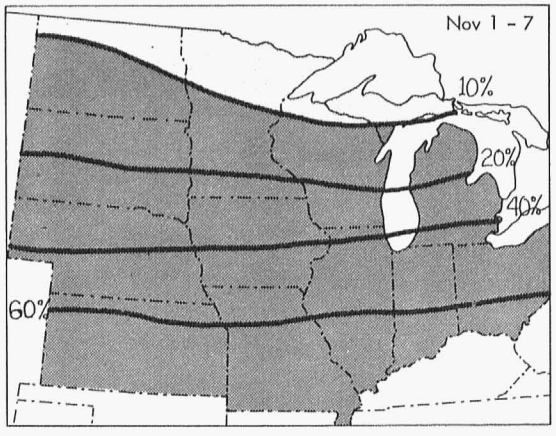


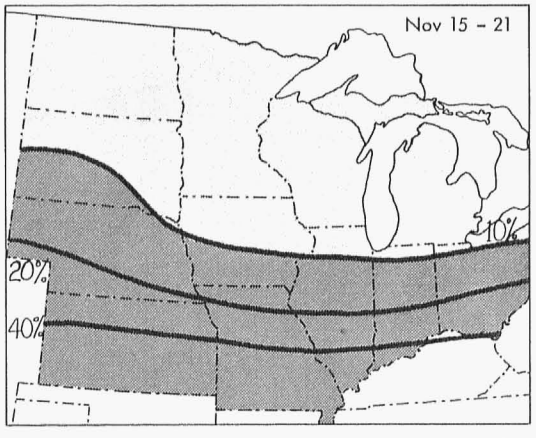

Apr 5 - 11
60%
80%

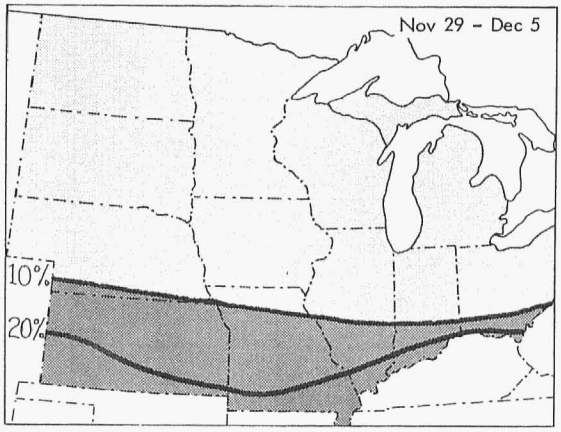

Apr 19 - 25
80%

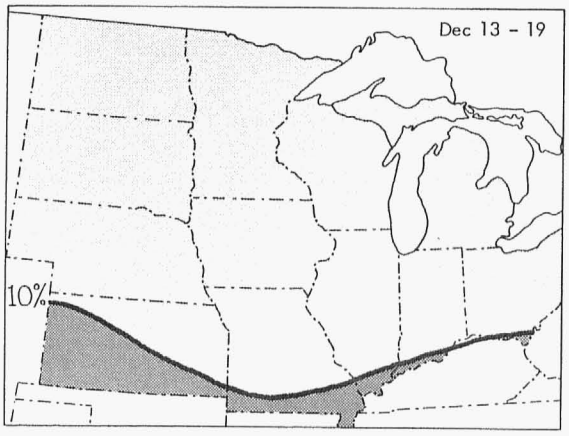

Oct 4 - 10
60%
80%

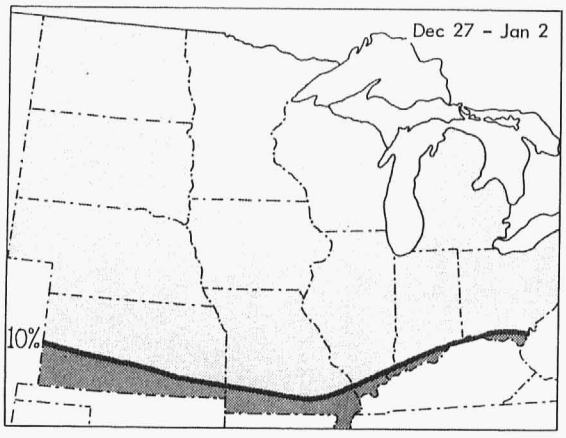

Oct 18 - 24
20%
40%
60%
80%


Nov 1 - 7
10%
20%
40%
60%

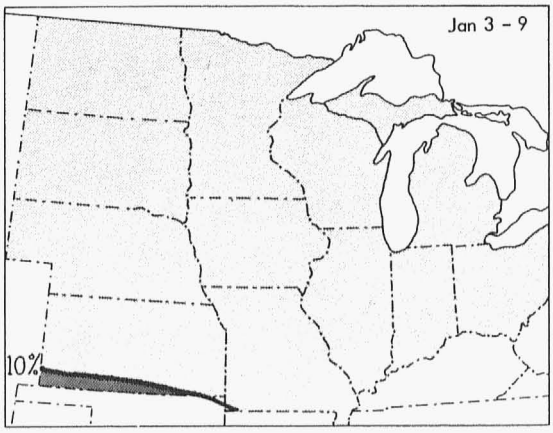

Nov 15 - 21
10%
20%
40%

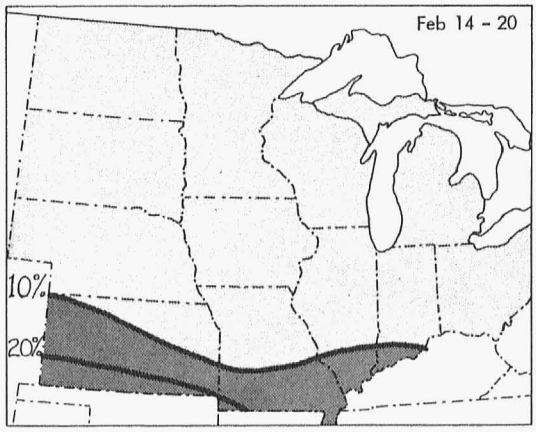

Nov 29 - Dec 5
10%
20%

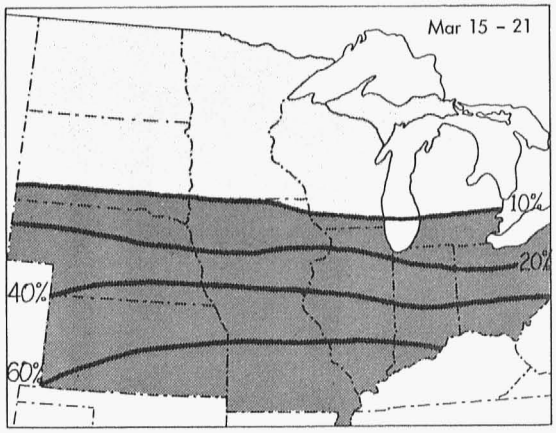

Dec 13 - 19
10%

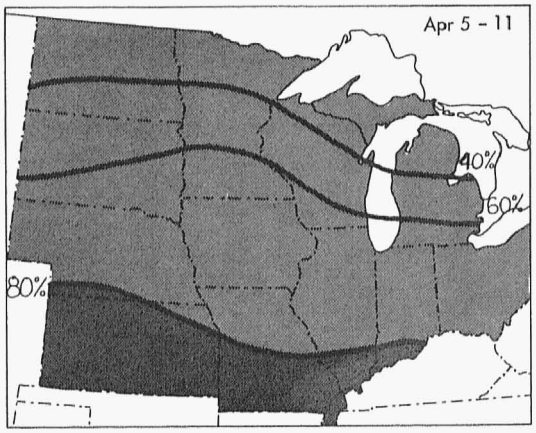

Dec 27 - Jan 2
10%

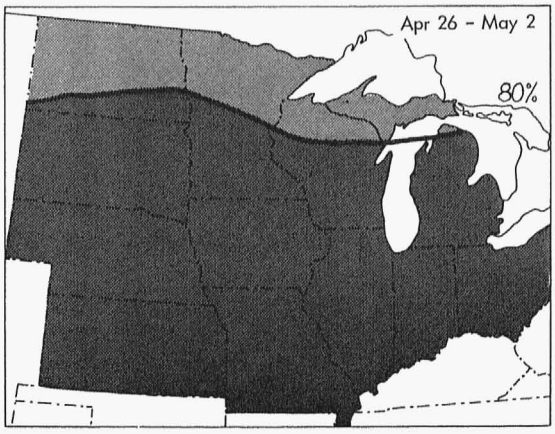
Runs of 25 or More Days with Maximum Above 40°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

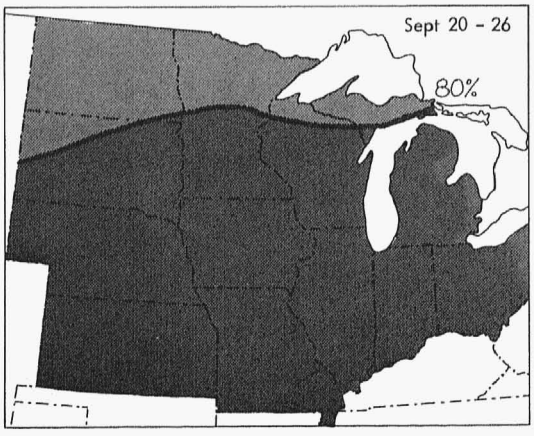


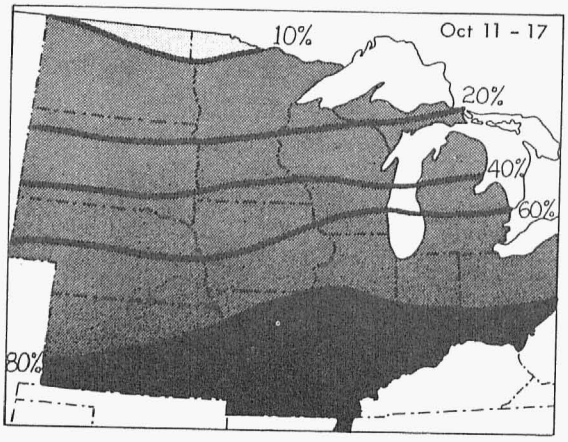


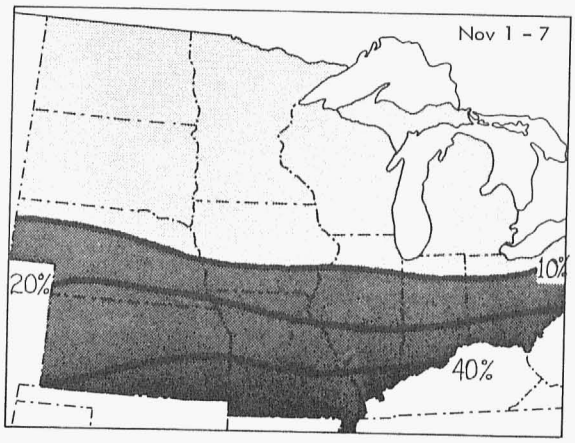


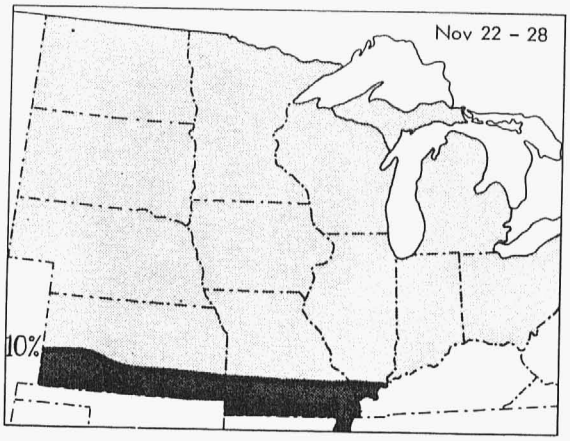




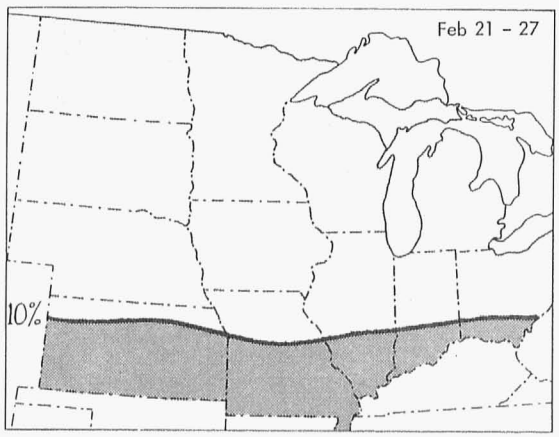


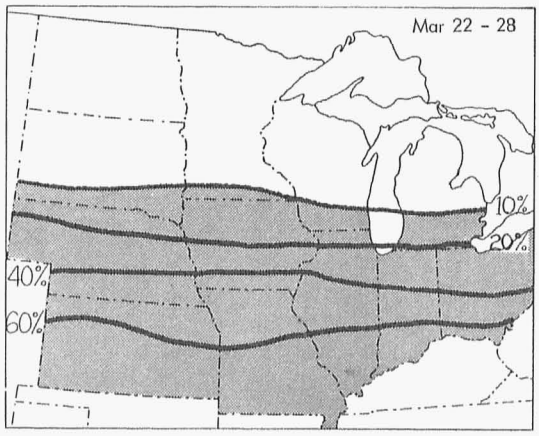

Oct 11 - 17
10%
20%
40%
60%
80%

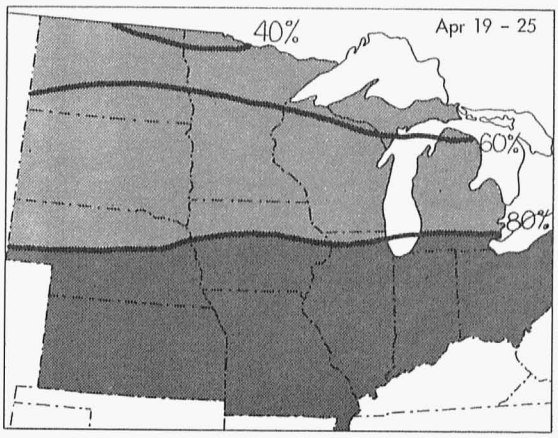

Nov 1 - 7
10%
20%
40%

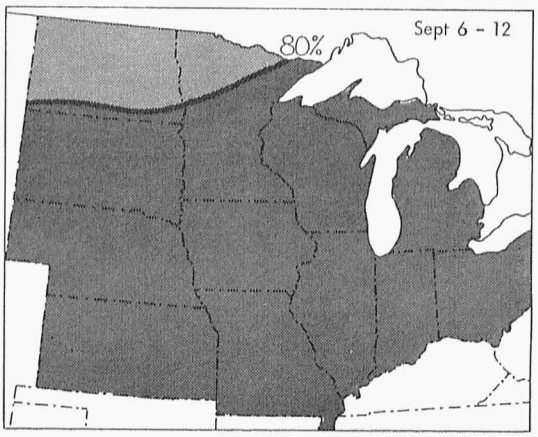

Nov 22 - 28
10%

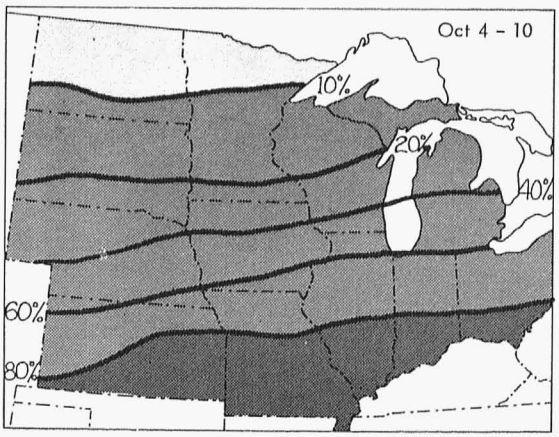
Runs of 35 or More Days with Maximum Above 40°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

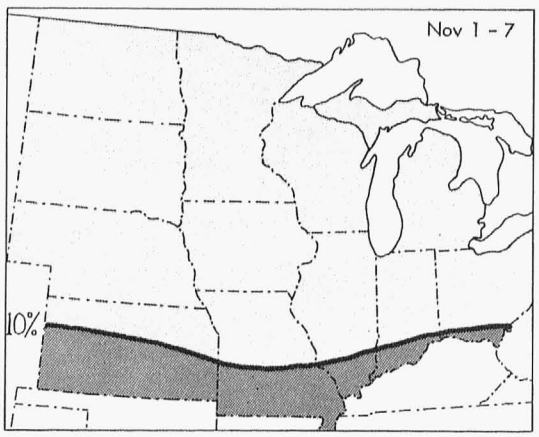






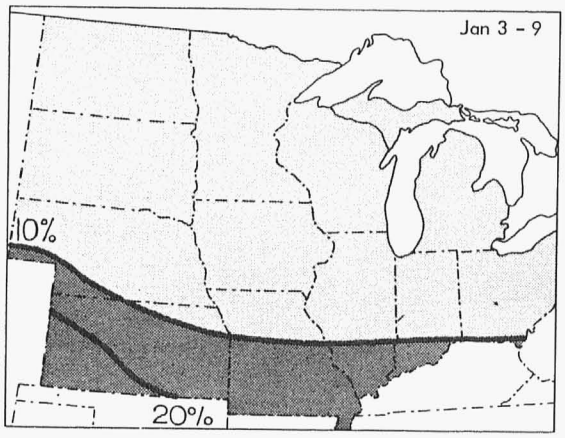


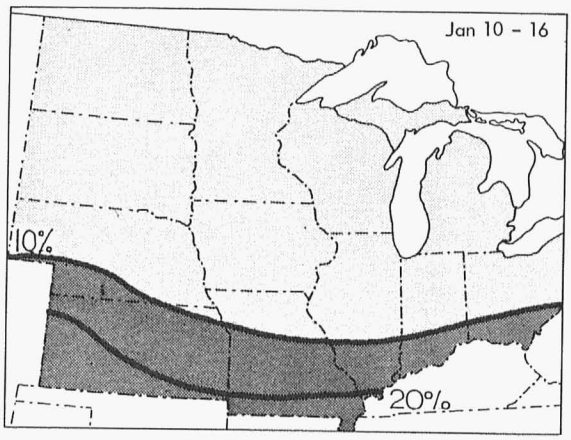


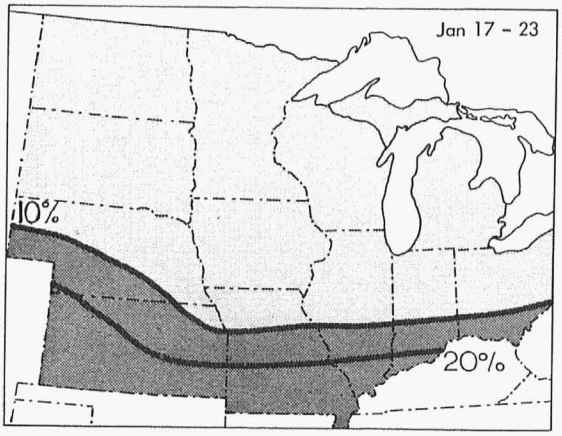


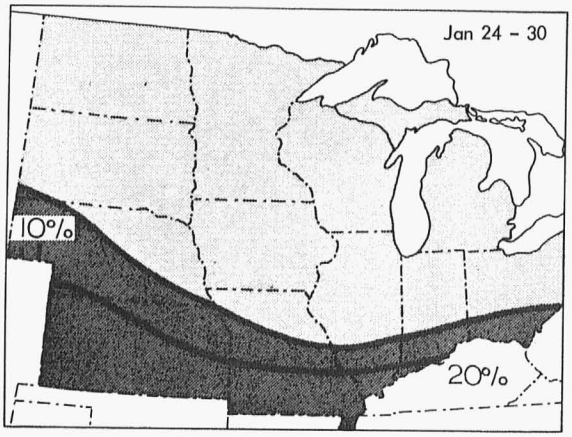
PERIODS OF VARIOUS LENGTHS WITH MAXIMUM TEMPERATURES ABOVE 50°F.

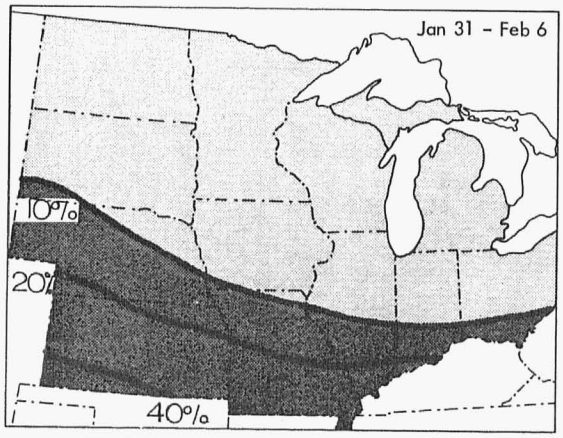
Runs of 5 or More Days with Maximum Above 50°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

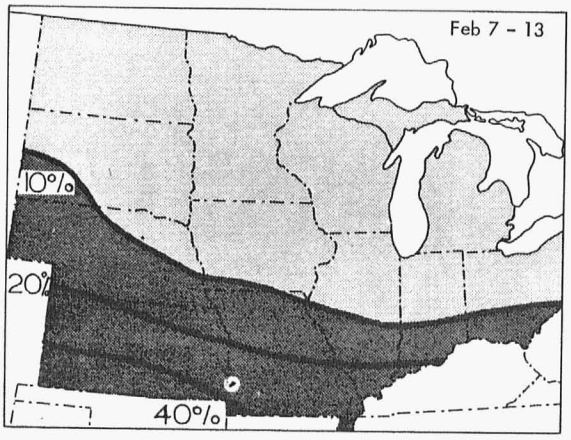


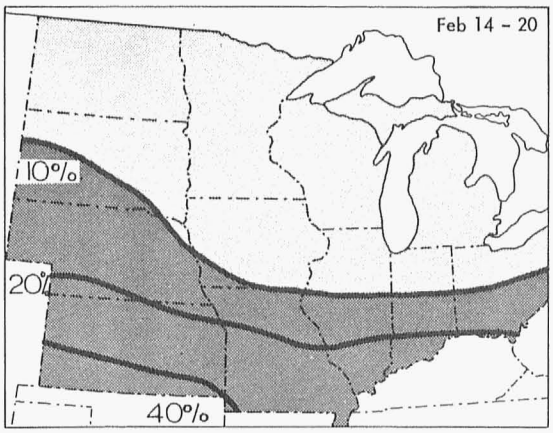


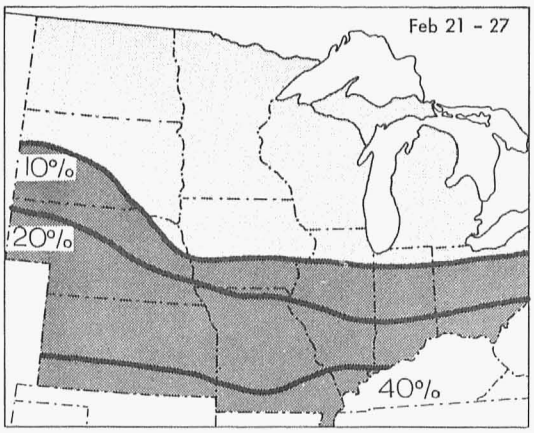


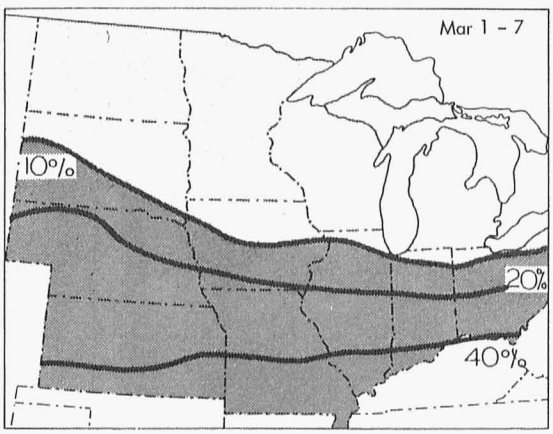


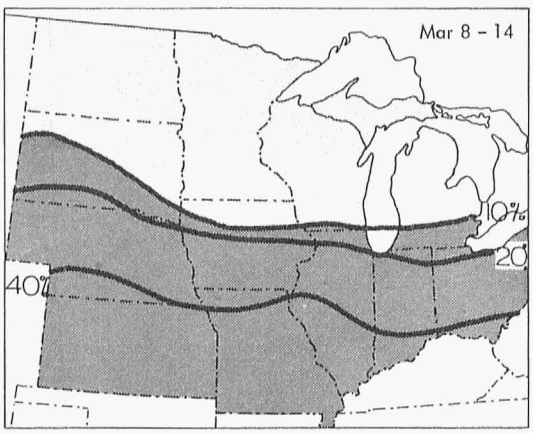


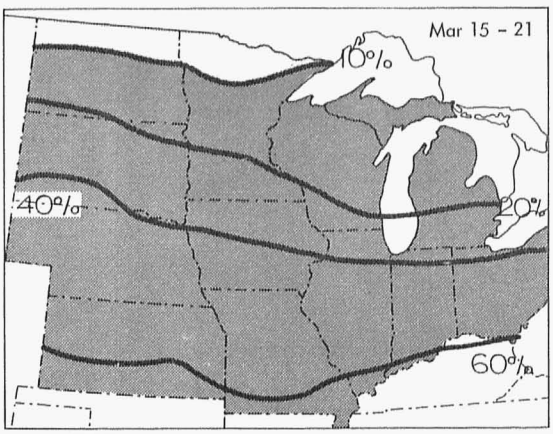


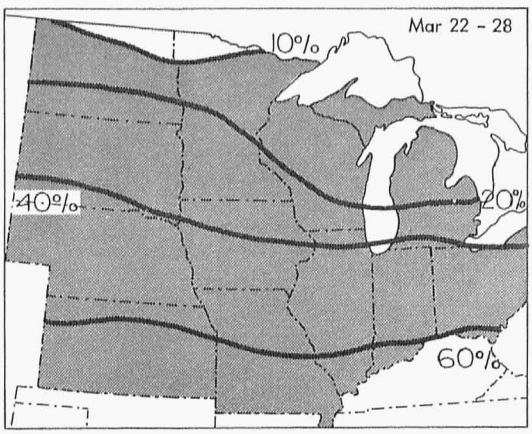

Feb 14 - 20
10%
20%
40%

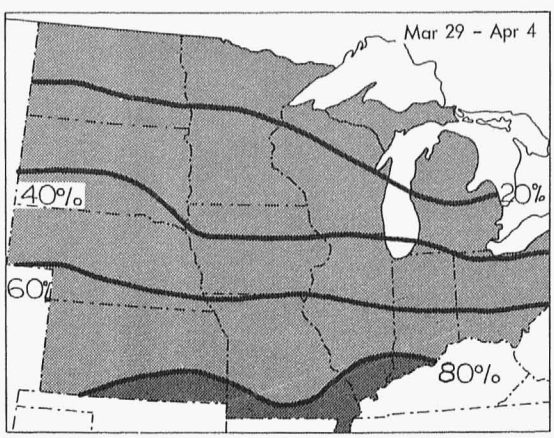

Feb 21 - 27
10%
20%
40%

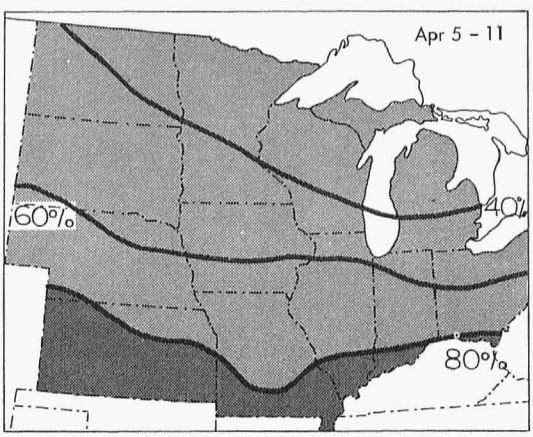

Mar 1 - 7
10%
20%
40%

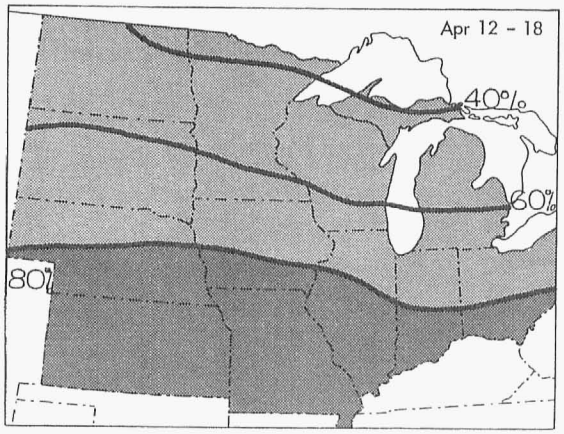

Mar 8 - 14
10%
20%
40%

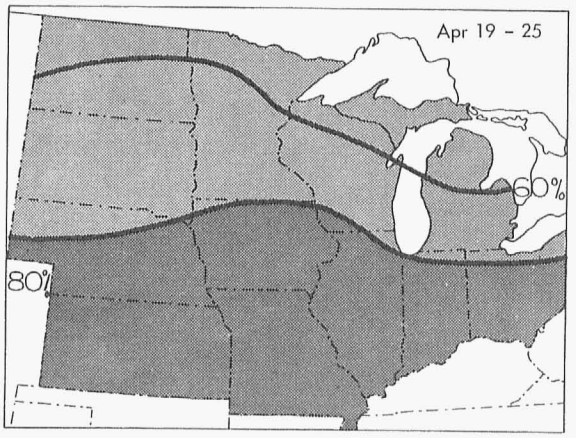

Mar 15 - 21
10%
20%
40%
60%

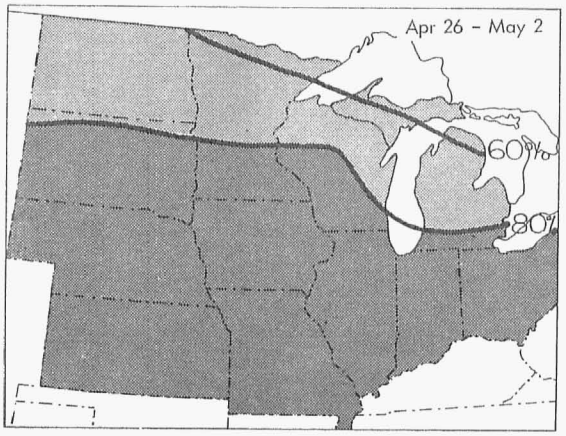

Mar 22 - 28
10%
20%
40%
60%

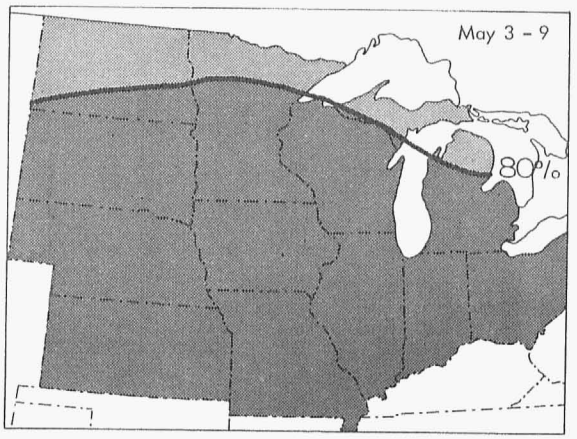

Mar 29 - Apr 4
20%
40%
60%
80%

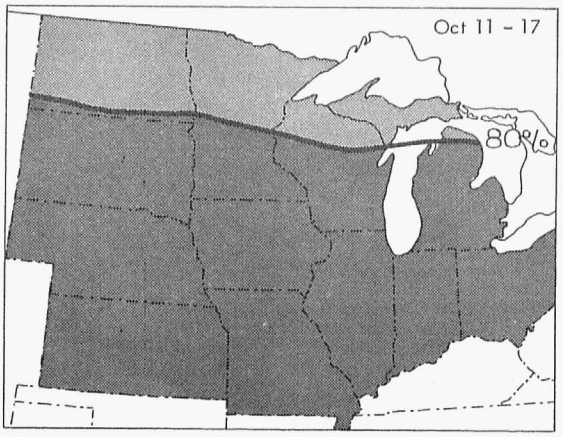

Apr 5 - 11
40%
60%
80%

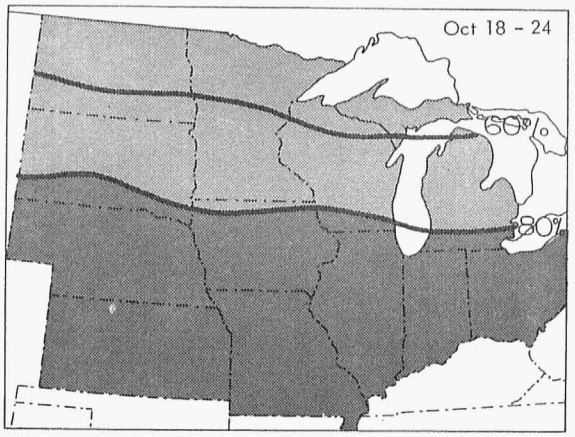

Apr 12 - 18
40%
60%
80%

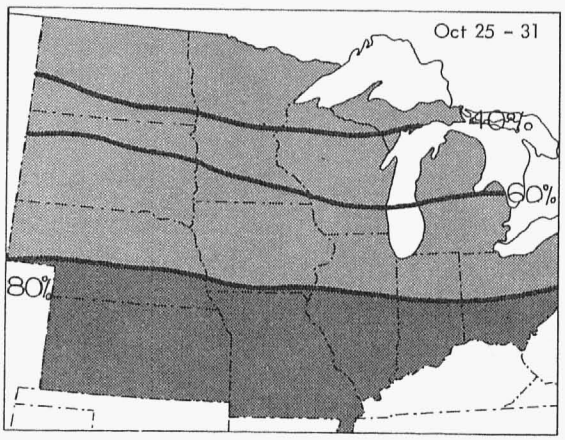

Apr 19 - 25
60%
80%

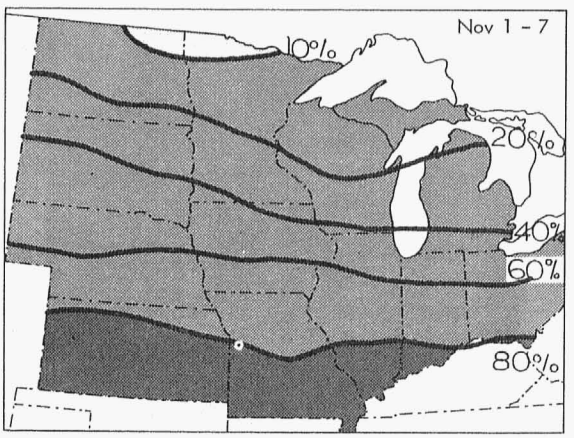

Apr 26 - May 2
60%
80%

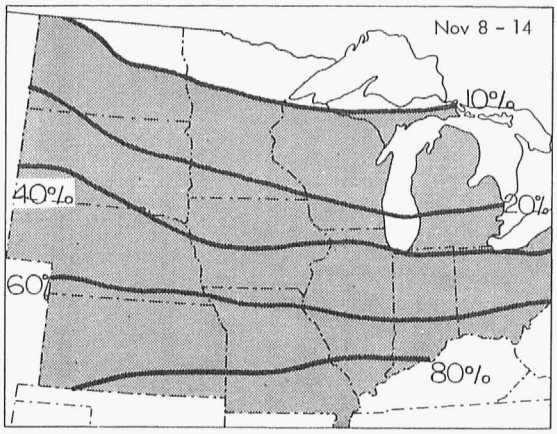

May 3 - 9
80%

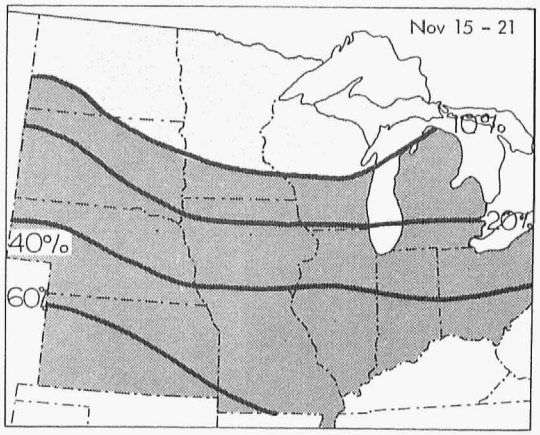

Oct 11 - 17
80%

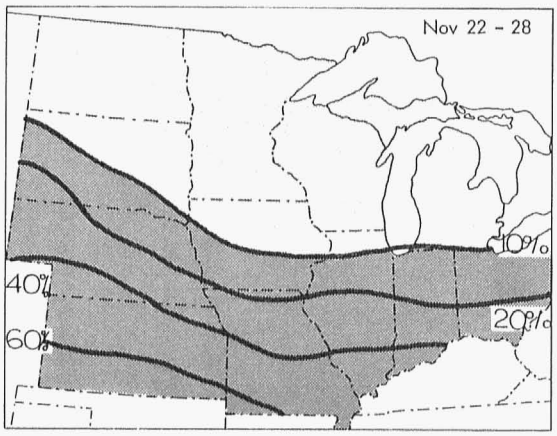

Oct 18 - 24
60%
80%

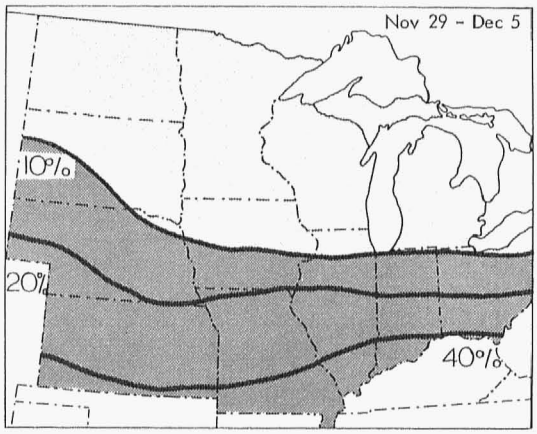

Oct 25 - 31
40%
60%
80%

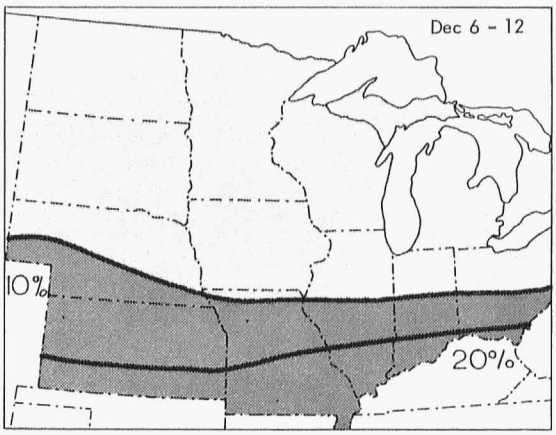

Nov 1 - 7
10%
20%
40%
60%
80%

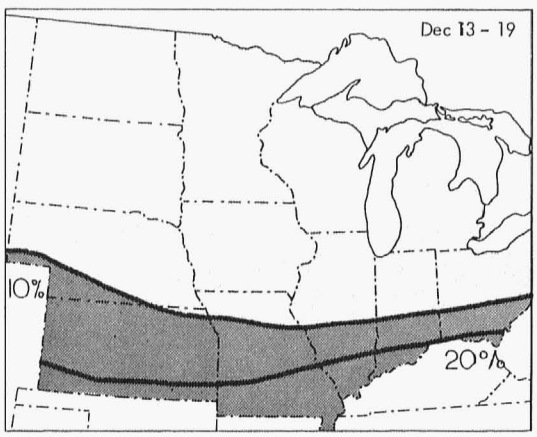

Nov 8 - 14
10%
20%
40%
60%
80%

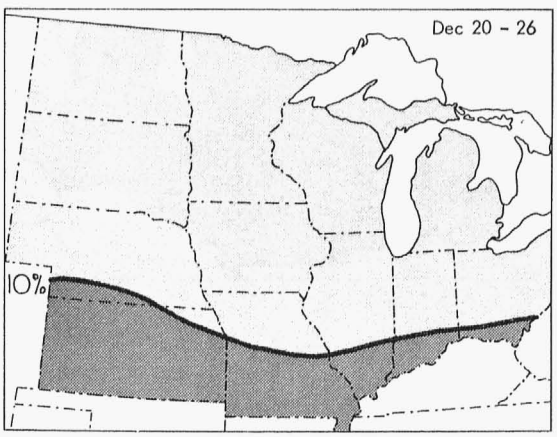

Nov 15 - 21
10%
20%
40%
60%

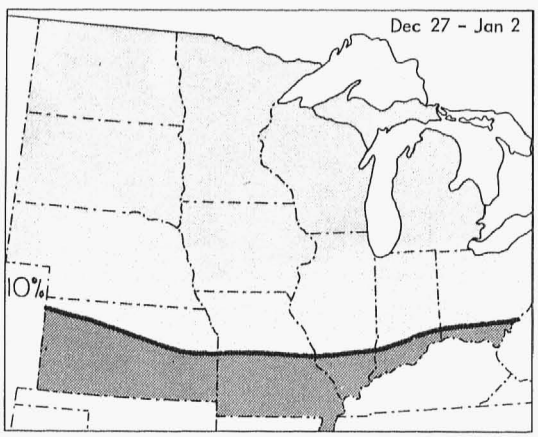

Nov 22 - 28
10%
20%
40%
60%


Nov 29 - Dec 5
10%
20%
40%

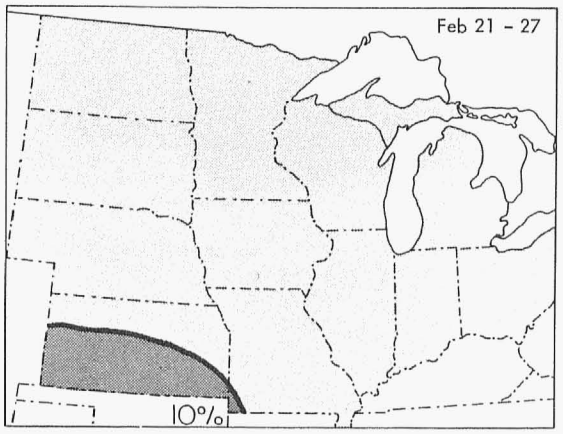

Dec 6 - 12
10%
20%

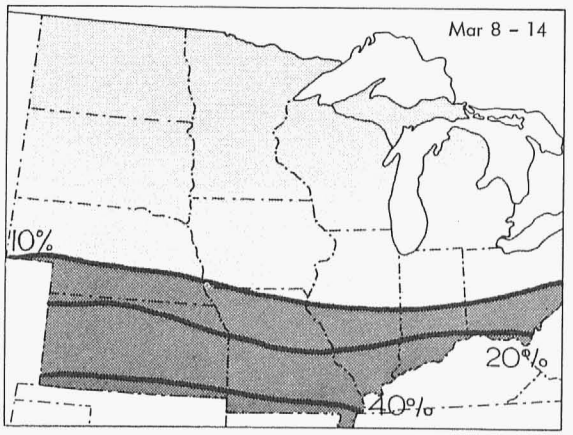

Dec 13 - 19
10%
20%

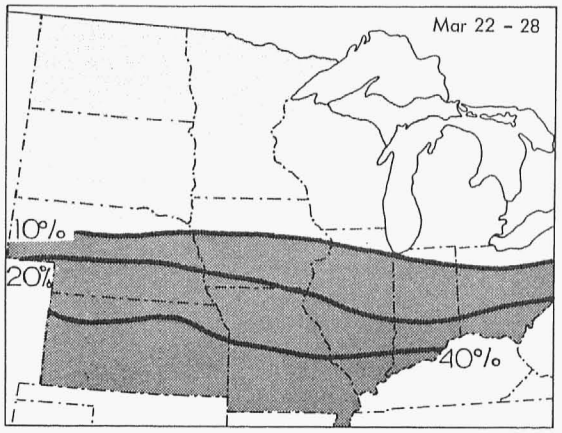

Dec 20 - 26
10%

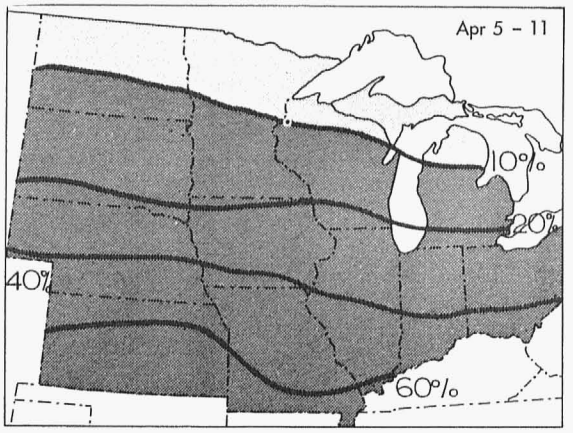

Dec 27 - Jan 2
10%

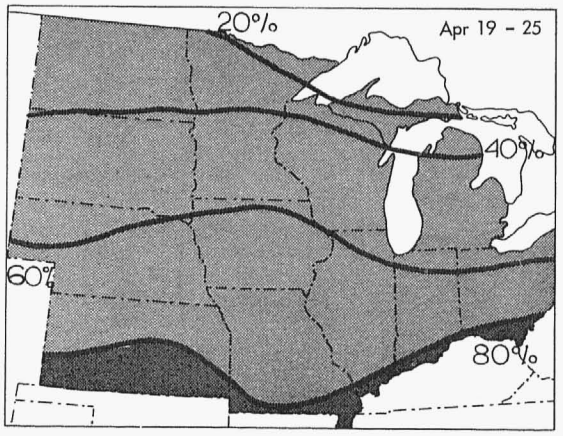
Runs of 15 or More Days with Maximum Above 50°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

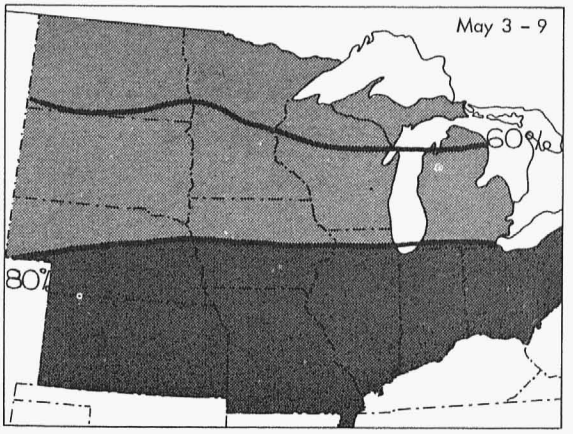


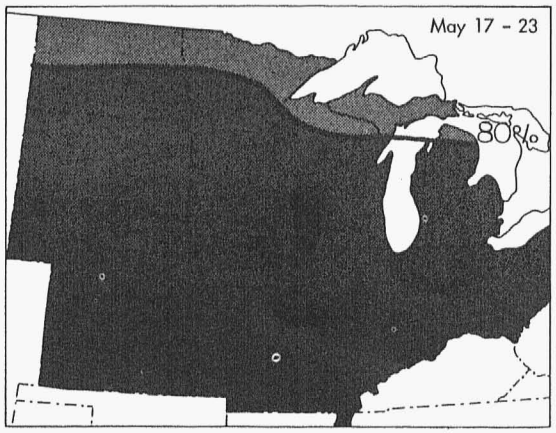


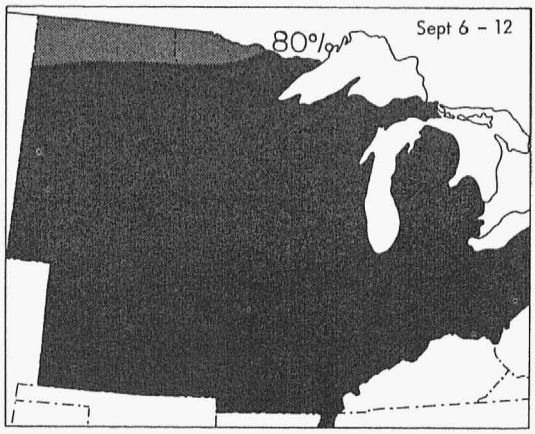


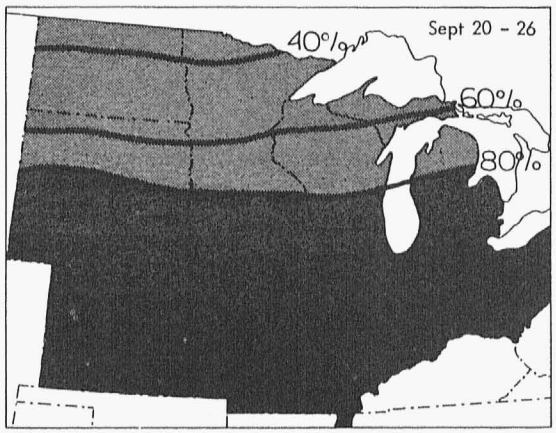


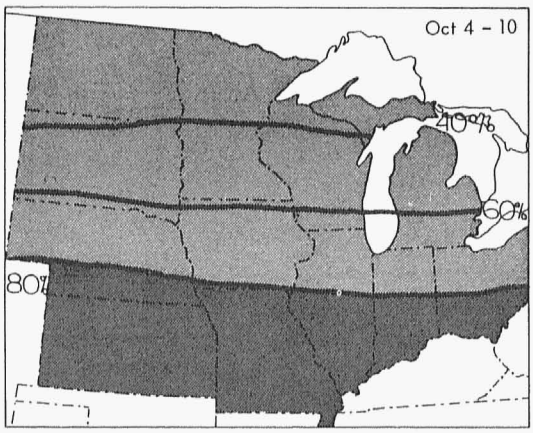


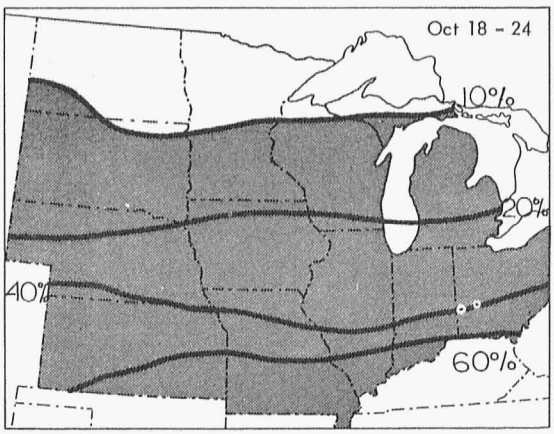


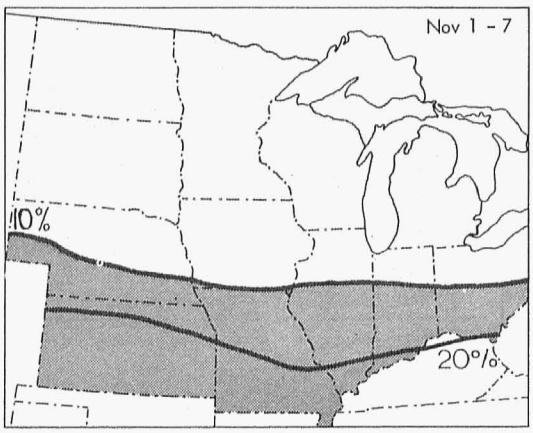

May 17 - 23
80%

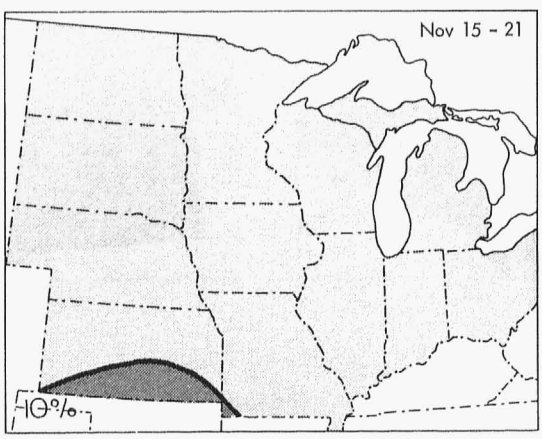

Sept 6 - 12
80%


Sept 20 - 26
40%
60%
80%

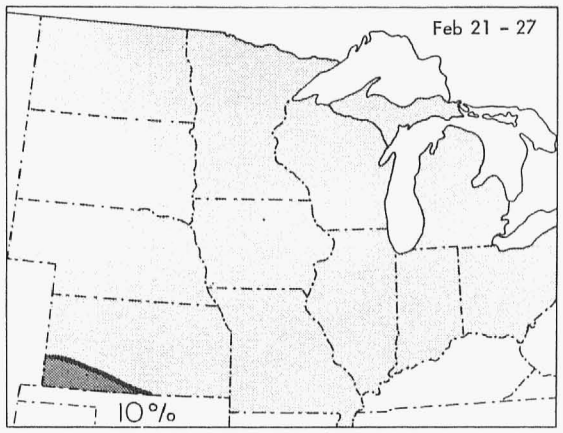

Oct 4 - 10
40%
60%
80%

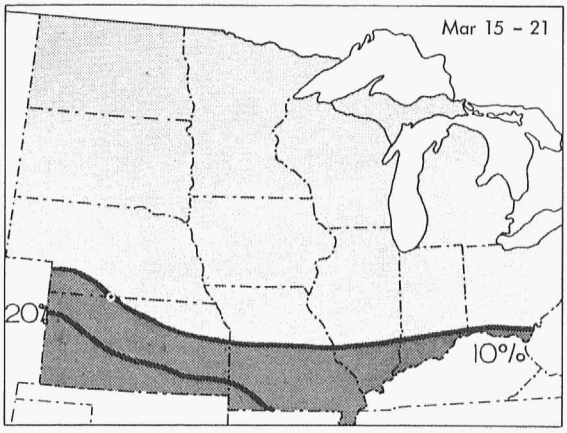

Oct 18 - 24
10%
20%
40%
60%

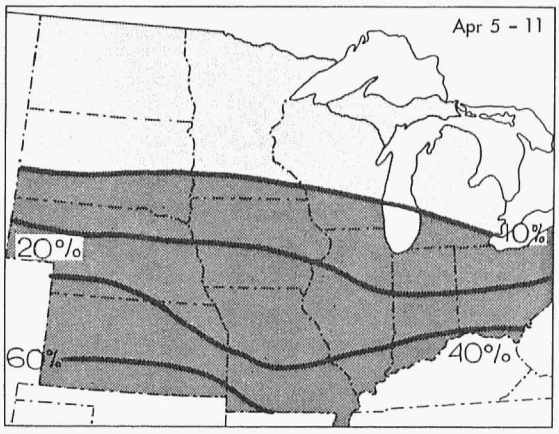

Nov 1 - 7
10%
20%

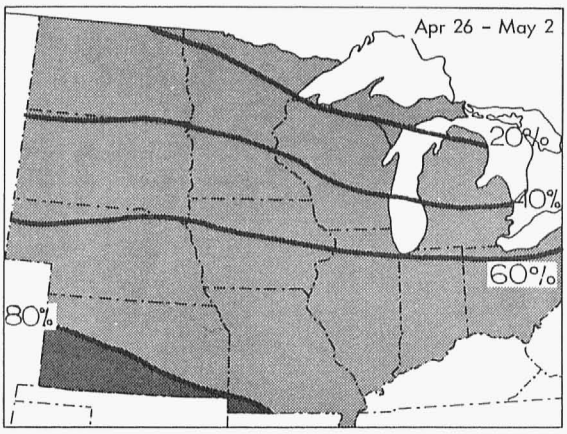

Nov 15 - 21
10%

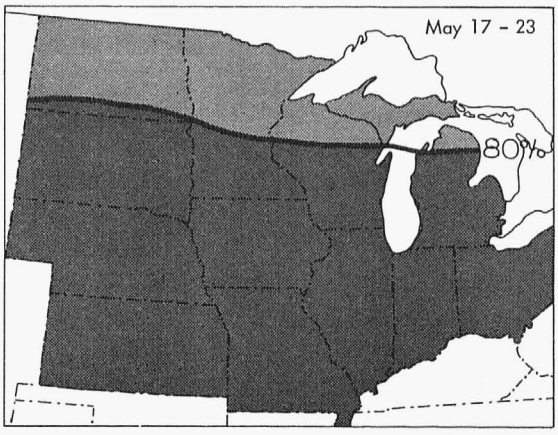
Runs of 25 or More Days with Maximum Above 50°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

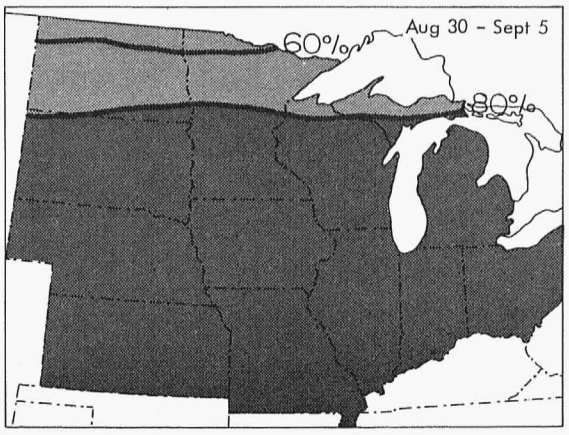


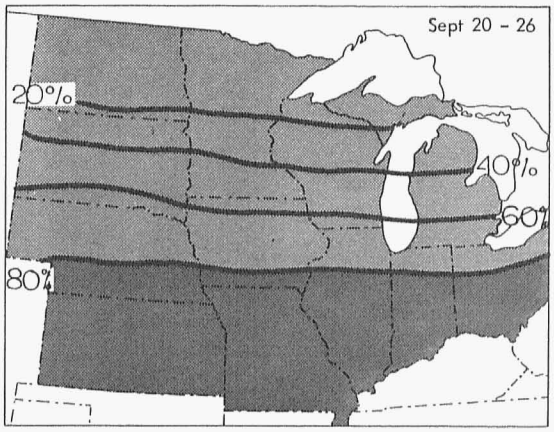


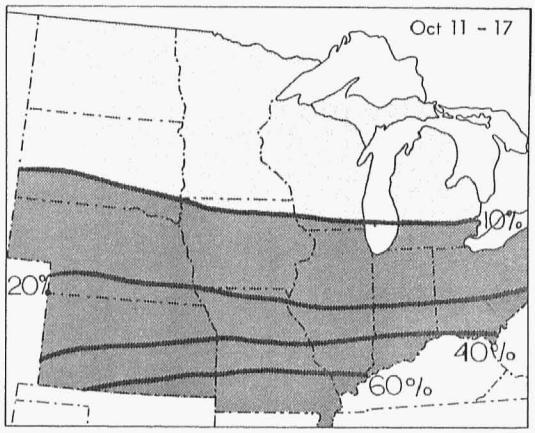


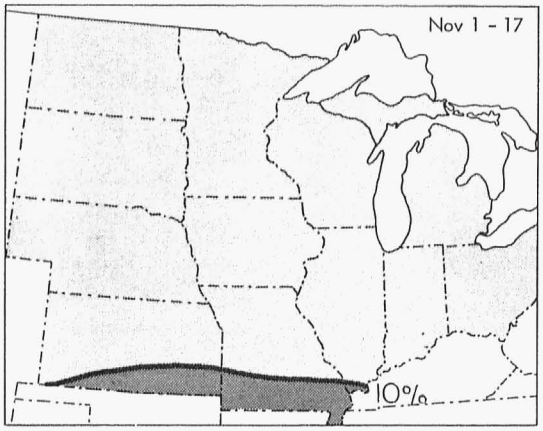




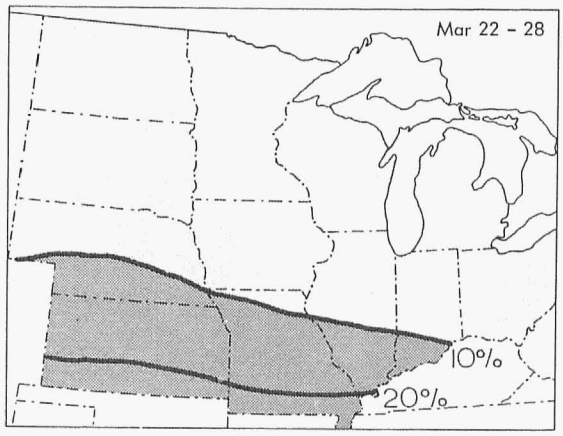


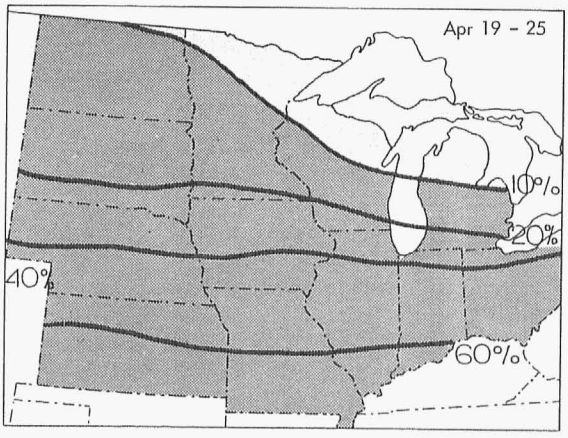

Sept 20 - 26
20%
40%
60%
80%

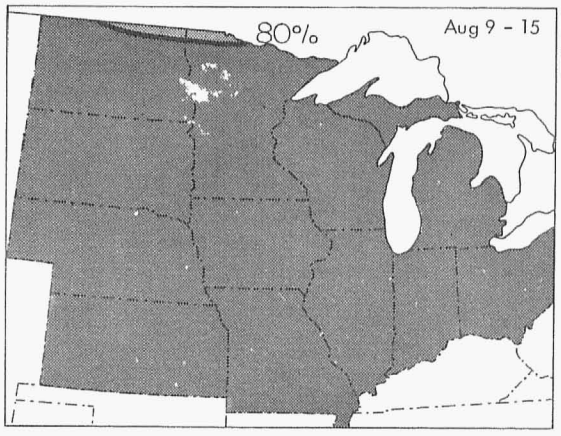

Oct 11 - 17
10%
20%
40%
60%

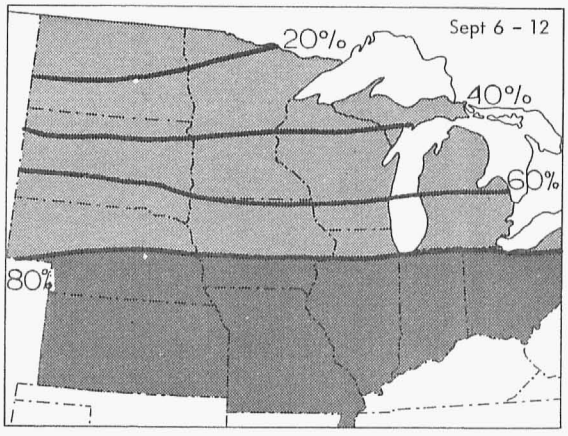

Nov 1 - 17
10%

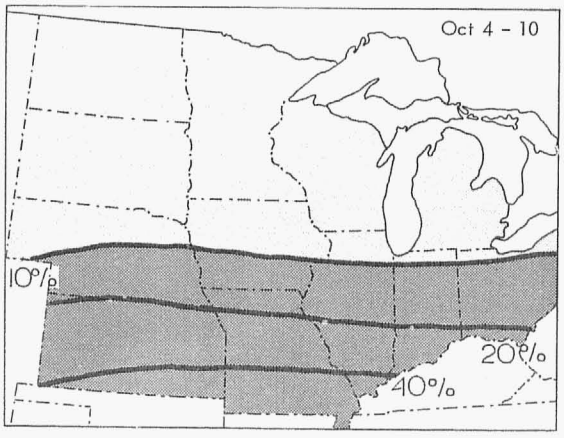
Runs of 35 or More Days with Maximum Above 50°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.











HIGH TEMPERATURES DURING SUMMER

Maps on the following five pages show the geographic distribution of the probability of runs of days with high temperatures during the summer season. These periods have been tabulated, using temperatures of 90°F. and 100°F. as the critical values. Although these temperatures were arbitrarily selected, they represent accepted thresholds for the upper limits of temperature response by many agricultural activities.

One of the primary effects of high temperatures is the associated increase in evaporation from the soil and water surfaces and increased transpiration by plant canopies. The rise in evaporative demands induced by the high solar energy associated with these temperatures often reduces soil water reserves below the needs of growing crops. While a plant may recover from a single day with such a stress the occurrence of several consecutive days with high temperatures often results in injury to the plant and reduction in yields.

For most agricultural plants 100°F. approaches the value which may be considered lethal. Many economically important plants grown in the North Central Region will sustain permanent injury at temperatures of about 110°F. (43°C.).

Livestock production is also extremely sensitive to temperature. Research has shown that dairy production declines rapidly as temperatures rise above 85°F. The rate of gain for beef and other meat producers also falls at these high temperatures. Most livestock species do not have adequate means of dissipating heat through perspiration. They sometimes attempt to adjust their energy level by reduction in food intake. When the occurrence of high temperatures continues for many days the associated production loss may become extremely serious. The maps shown should provide a guide to areas where summer shelters for shading will be required in animal production.

Distribution of Runs of Days of 90°F. (32.2°C.)

In summer, runs of five or more consecutive days with maximum temperatures above 90°F. occur throughout the North Central Region. Consulting the maps on pages 38, 39, and 40 will reveal that by late May such periods begin each week more than one out of 10 years in the extreme southern portions of the region. From late June through mid-August, the likelihood of five consecutive days with temperatures above 90°F. is about 60 percent across southern Kansas and Missouri. The chance for these periods is less than one year out of 10 in northern North Dakota, Minnesota, and Wisconsin, and in virtually all of Michigan. By early October the frequency of five consecutive days with temperatures above 90°F. approaches zero over nearly all of the region.

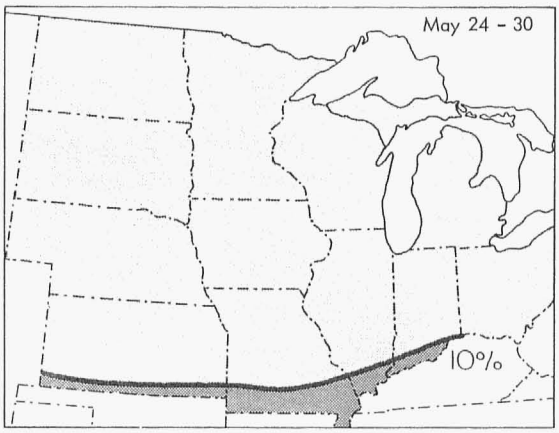
It is indeed rare when periods as long as two weeks occur with temperatures above 90°F. every day. Page 41 shows that in Kansas and southern Missouri periods of 15 consecutive days with temperatures above 90°F. begin during each summer week one or two times every ten years. In the remaining portions of the region periods of this duration occur with less than a 10 percent frequency.

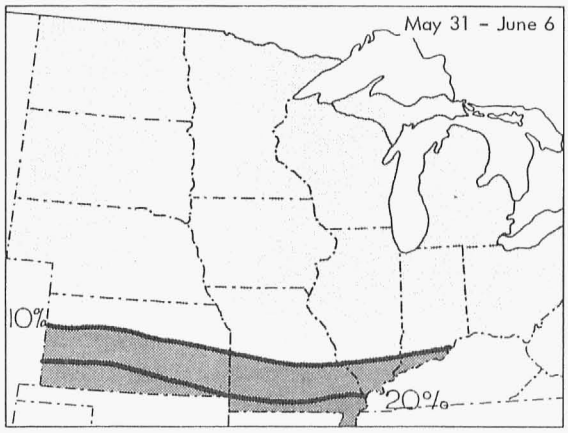
The Distribution of Runs of Days With Maximum Temperatures Above 100°F. (37.8°C.)

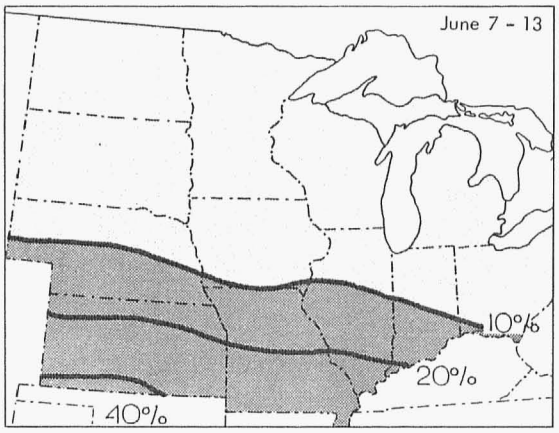
Temperatures rise above 100°F sometime during the summer in the southern portion of the North Central Region; but, the occurrence of such a temperature is really not a very likely event. Maps on page 42 indicate that in all parts of the region the probability of five consecutive days with temperatures above 100°F. is less than 10 percent of the years. During the mid-summer months of July and August, a small area in the southwestern portion of the region will experience such periods for any week just over one out of ten years.

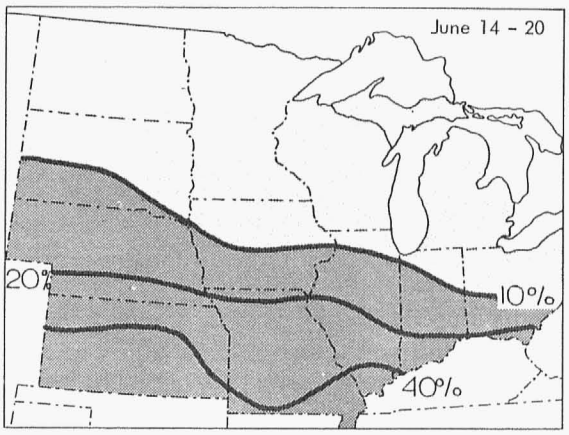
PERIODS OF VARIOUS LENGTHS WITH MAXIMUM TEMPERATURES ABOVE 90°F.

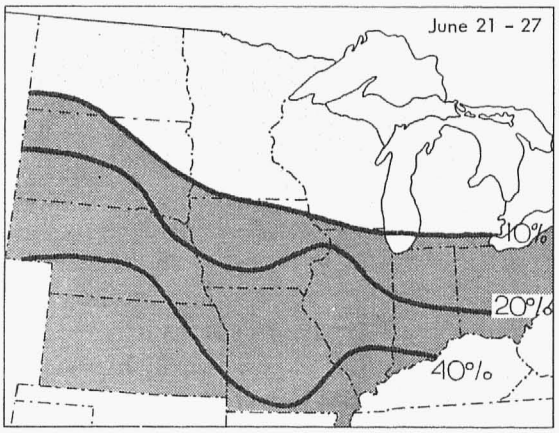
Runs of 5 or More Days with Maximum Above 90°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

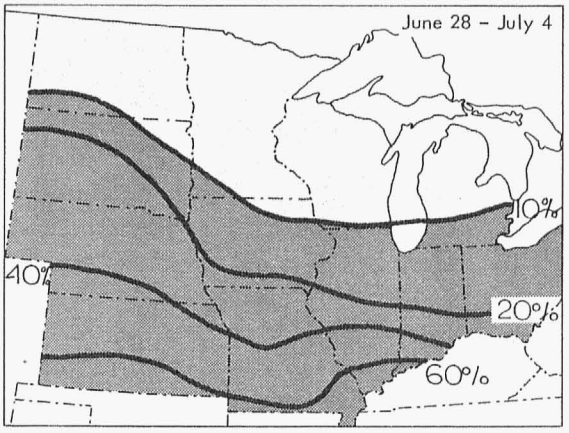


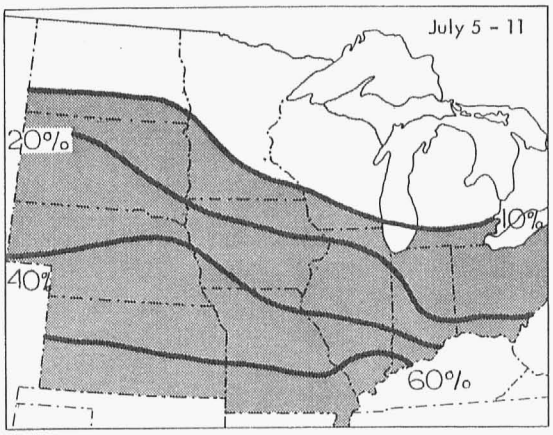


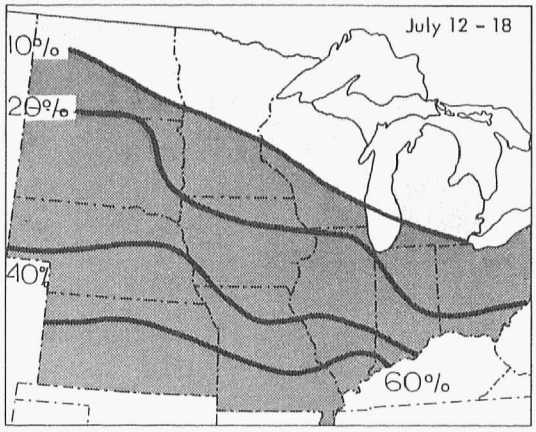


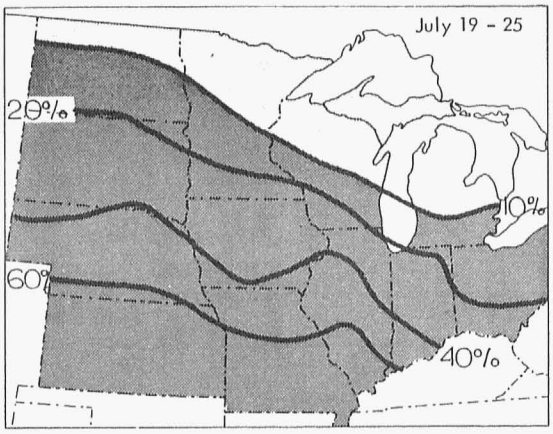


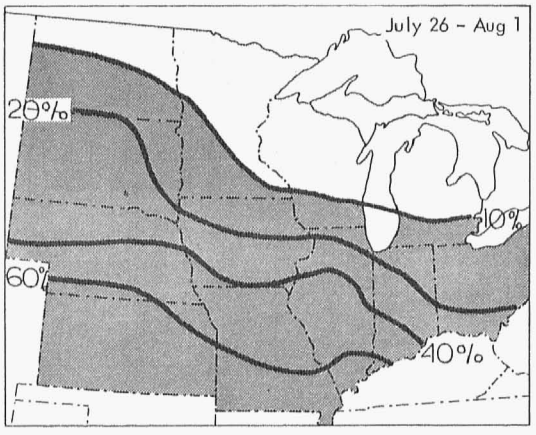


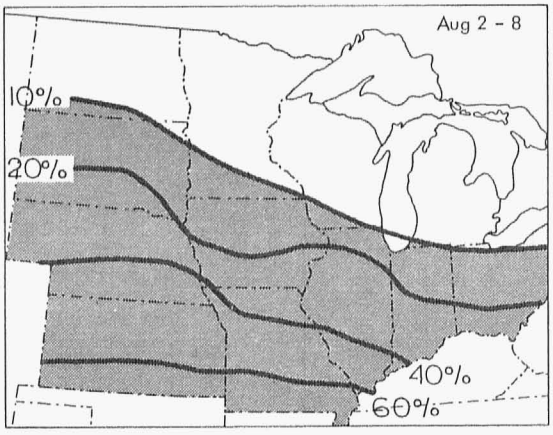


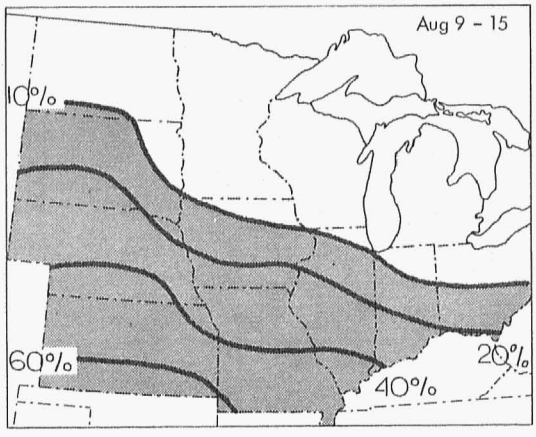

July 5 - 11
20%
10%
40%
60%

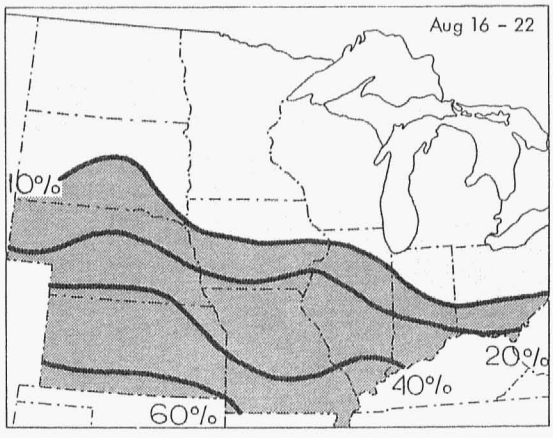

July 12 - 18
10%
20%
40%
60%

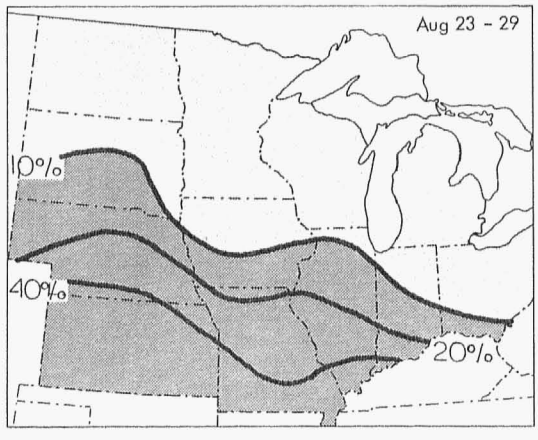

July 19 - 25
20%
10%
60%
40%

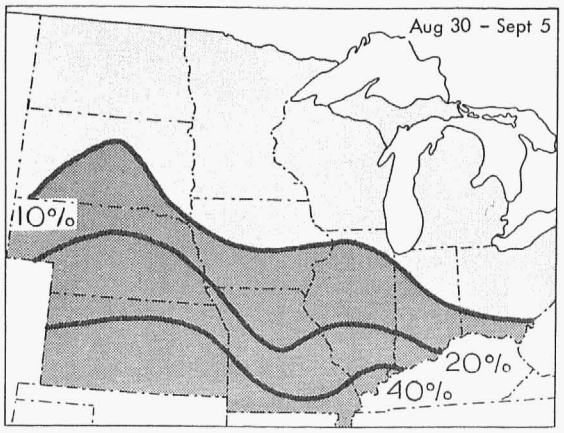

July 26 - Aug 1
20%
10%
60%
40%

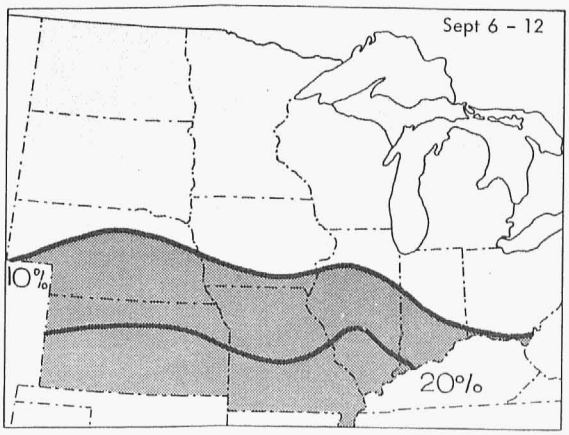

Aug 2 - 8
10%
20%
40%
60%

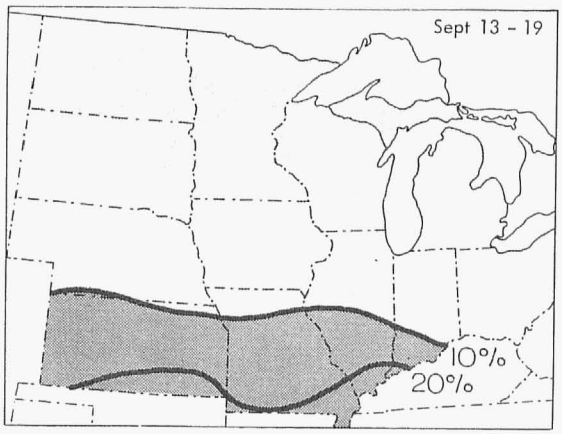

Aug 9 - 15
10%
60%
20%
40%

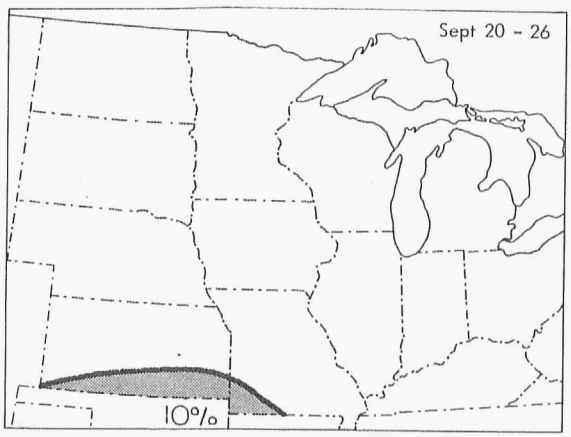

Aug 16 - 22
10%
20%
40%
60%

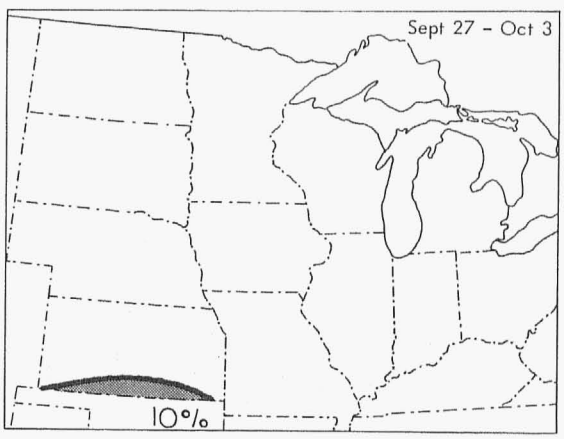

Aug 23 - 29
10%
40%
20%


Aug 30 - Sept 5
10%
20%
40%

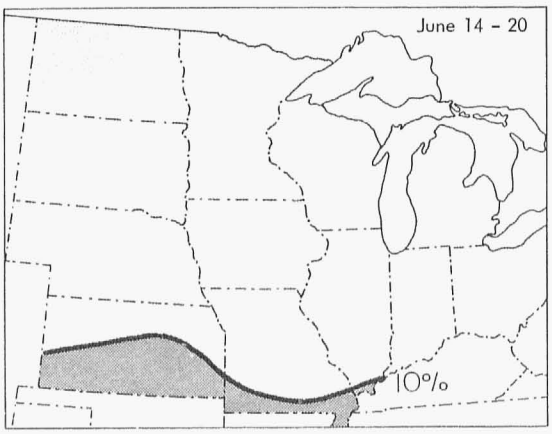

Sept 6 - 12
10%
20%

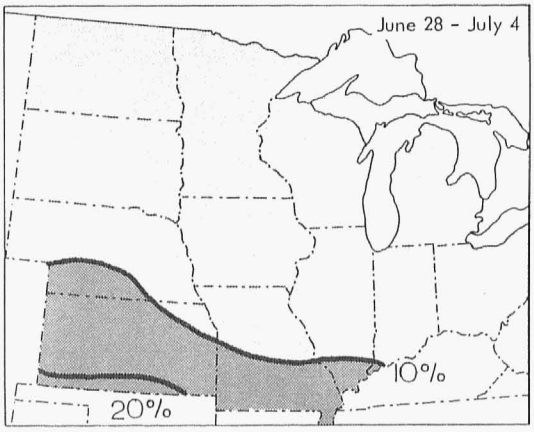

Sept 13 - 19
10%
20%

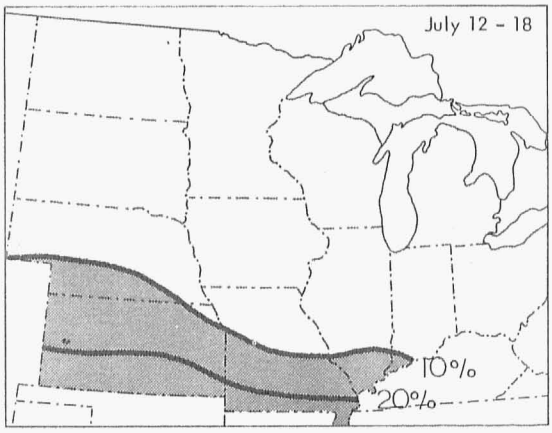

Sept 20 - 26
10%

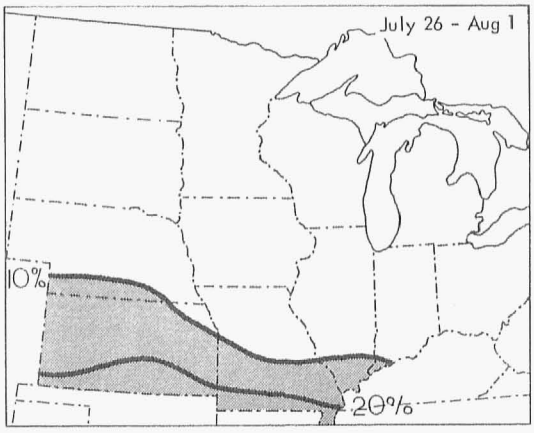

Sept 27 - Oct 3
10%

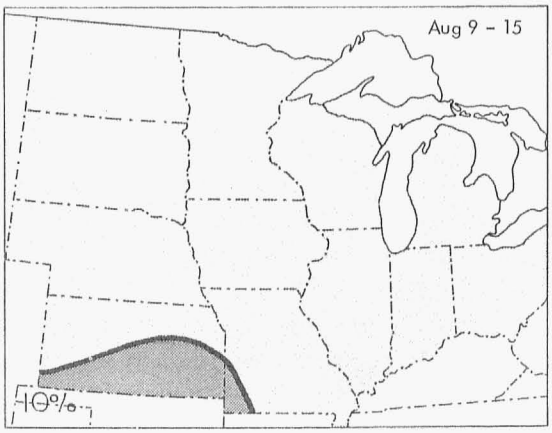
Runs of 15 or More Days with Maximum Above 90°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

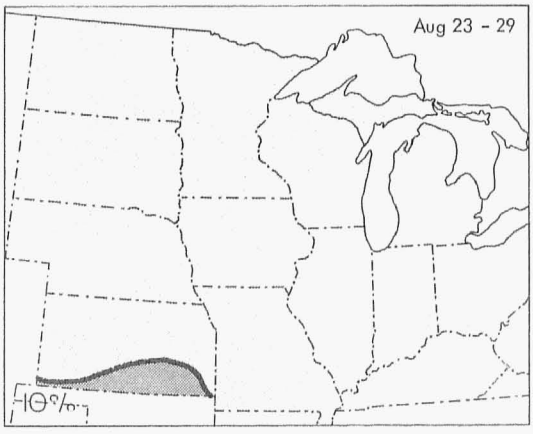






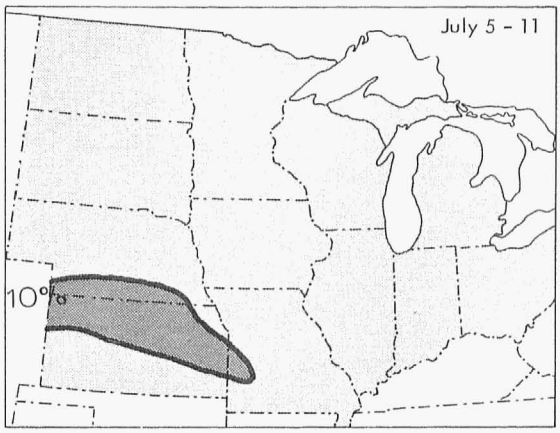


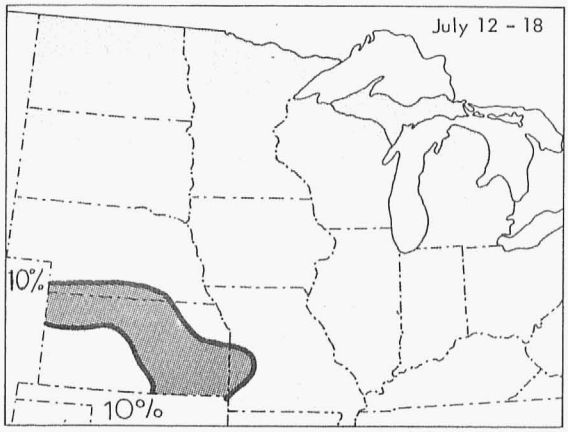


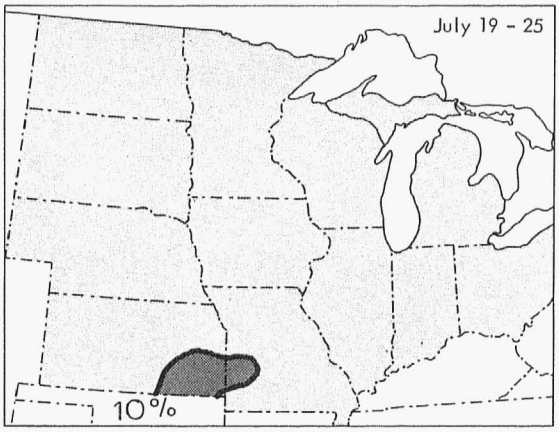


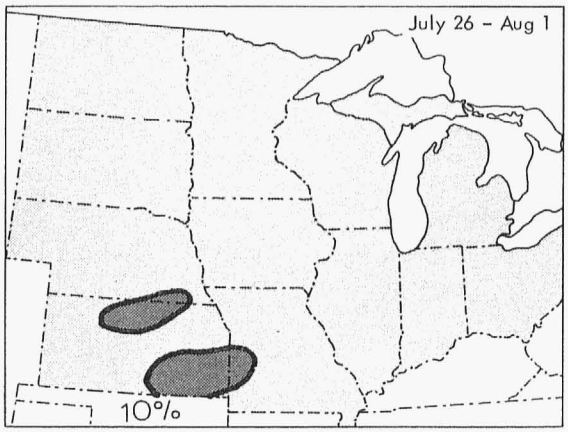
PERIODS WITH MAXIMUM TEMPERATURES ABOVE 100°F.

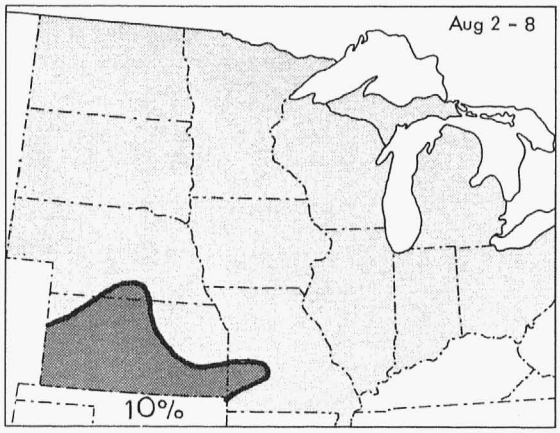
Runs of 5 or More Days with Maximum Above 100°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

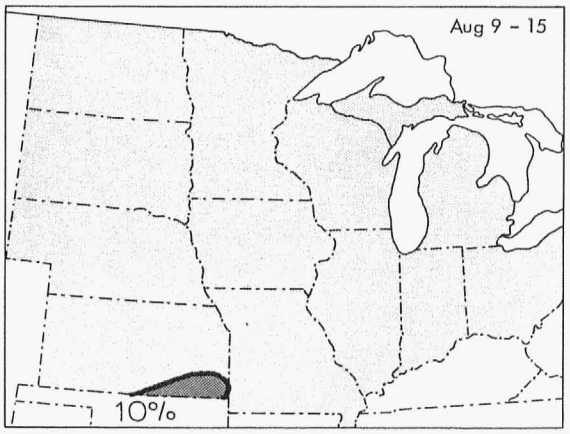












OCCURRENCE OF PERIODS WITH LETHAL COLD TEMPERATURES

Runs of Days With Minimum Temperatures Below 0°F. (-17.8°C.)

Very cold temperatures in winter are experienced in all areas of the North Central Region. During prolonged periods of cold weather water surfaces are frozen and frost penetrates to considerable depths in the soil. Outdoor activity is curtailed or made difficult by these low winter temperatures. The occurrence of temperatures below 0°F. is an indicator of the extreme cold. However, the establishment of this temperature as a critical limit has more convenience than real significance, so far as the physiological response to cold is concerned. When these temperatures occur during period with high winds, livestock must receive special protection and man's activity is curtailed.

The probability for periods of days with temperatures below zero are shown each week on pages 44, 45, and 46. During a week in mid-winter, periods of five-day duration will begin more than half the years in the northern portion of the region. But in the southern half, the probability of such a period for a particular week is less than one in ten. Periods of 15 days with sub-zero temperatures are not very probable in any of the North Central Region.

Runs of Days With Minimum Temperatures Below 30°F. (-1.1°C.)

Occurrence of freezing temperatures at night has special significance to agriculture. This occurrence may seriously damage the tender growth of newly emerging plants in the spring or it may terminate the growth of plants in the fall. As discussed earlier in this bulletin, freezes of different intensities may be defined but for this tabulation a critical temperature of 30°F. was chosen.

The occurrence of freezing temperatures during winter also has a bearing on the type and amount of outdoor work which may be completed by a farmer, construction crew, or engineering activity. Although sub-freezing temperatures occur throughout the North Central Region each winter, there are always some winter days that do not get this cold.

Pages 47 through 50 of this bulletin are maps of the North Central Region showing the probability each week for the beginning of five-day periods with minimum temperatures below 30°F. During winter, for the southeastern portion of the region, such periods occur during any given week only six to eight years out of 10. In the remainder of the region, five-day periods with temperatures as low as 30°F. begin during each week virtually every year. During March and early April the probabilities of five days or more with temperatures below 30°F. decreases rapidly and for the first week in April periods five days or longer will begin only one out of 10 years in the southern third of the region. By mid-May the likelihood of five consecutive days with temperatures below 30°F. is virtually zero throughout the region.

The probability of five-day periods with temperatures below 30°F. increases sharply during the period from mid-October through November. During the middle week of November such periods will begin in south Missouri only two years out of ten, while in North Dakota the chance is greater than 80 percent.

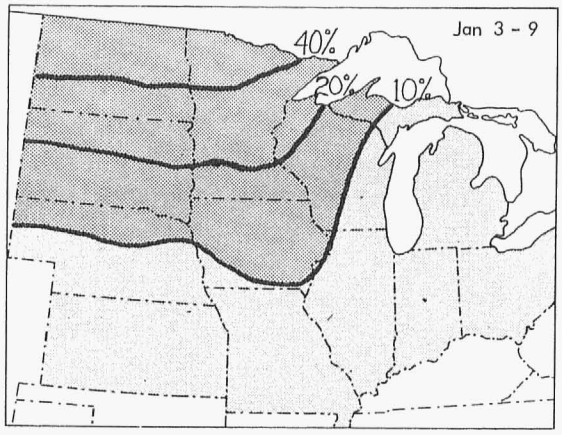
Maps on pages 51 and 52 show the probability of runs of 15 or more days with temperatures below 30°F. In mid-winter, virtually every week will originate such a period, somewhere in the region, but the southern portion experiences these periods with below freezing temperatures only about one out of 10 years. The probability declines during the spring and by mid-April the chance for 15-day periods with temperatures below 30°F. is virtually zero throughout the region. In autumn the probability of 15-day periods increases and by mid-November there is more than a 50 percent chance for such periods in North Dakota, Minnesota, and northern Wisconsin.

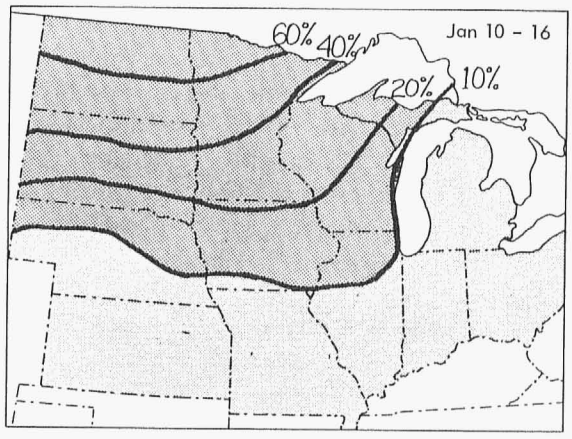
The probability of periods with 25 days or more of temperatures below 30°F. is shown on the maps on page 53. The same pattern prevails here as described in the previous paragraph, except that the likelihood for such long periods is lower in the spring and in the fall.

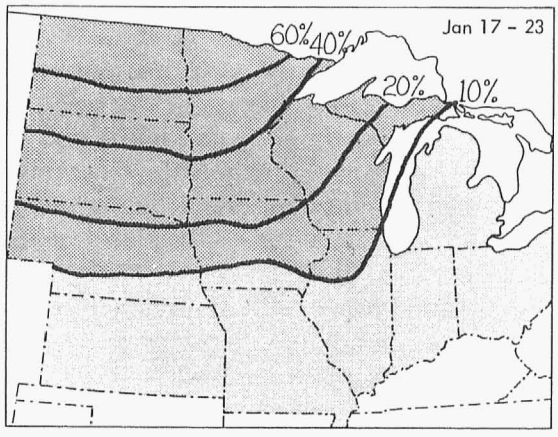
The geographic distribution for the probability of runs of periods of 35 days duration with temperatures below 30°F. is given on page 54. Interestingly, during winter these five-week periods occur more than 80 percent of the years in North Dakota and northern Minnesota. Throughout Kansas, Missouri, Illinois, Indiana, and Ohio, these five-week periods begin during a winter week with a frequency of less than 10 percent.

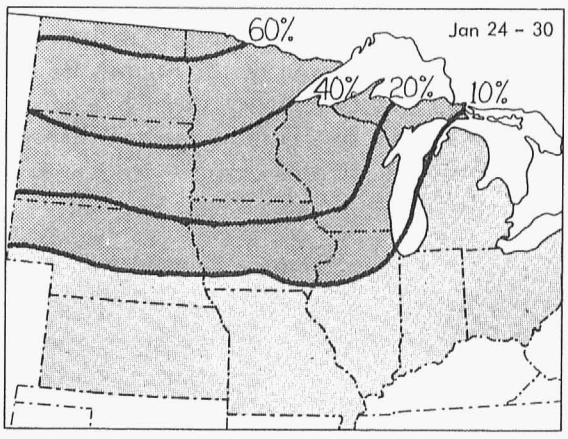
PERIODS OF VARIOUS LENGTHS WITH MINIMUM TEMPERATURES BELOW 0°F.

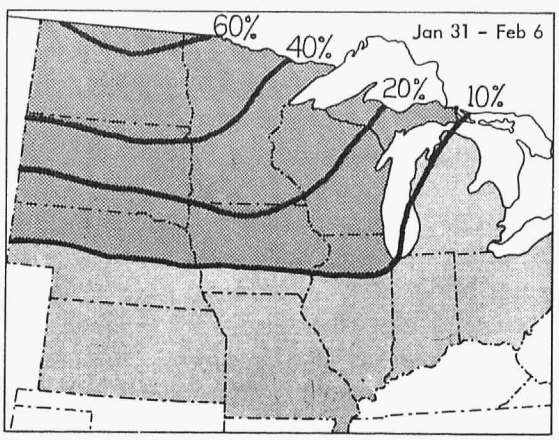
Runs of 5 Days or Longer with Minimum Below 0°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

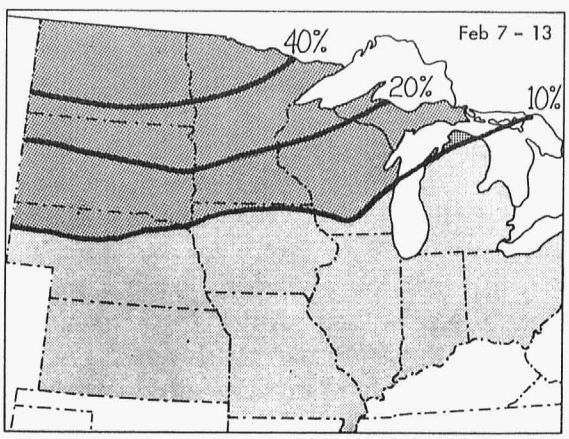


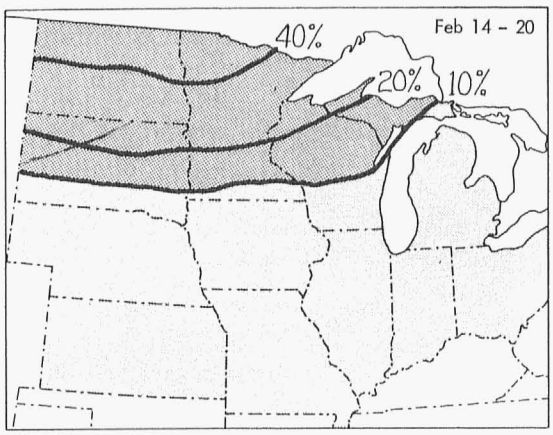











Feb 14 – 20
40%
20%
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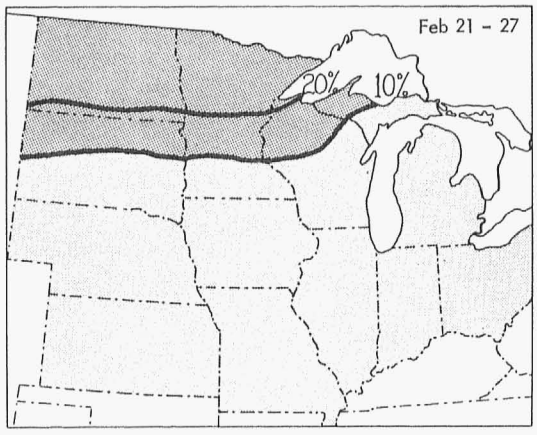
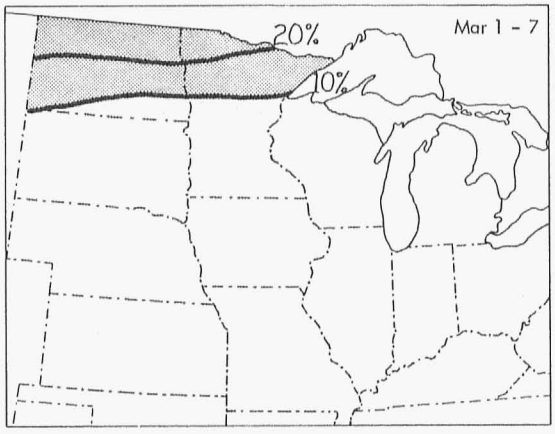
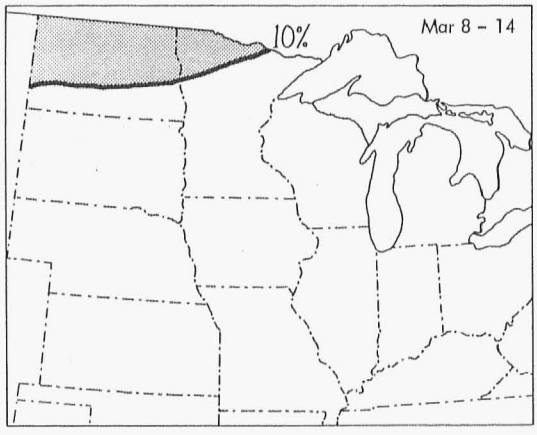
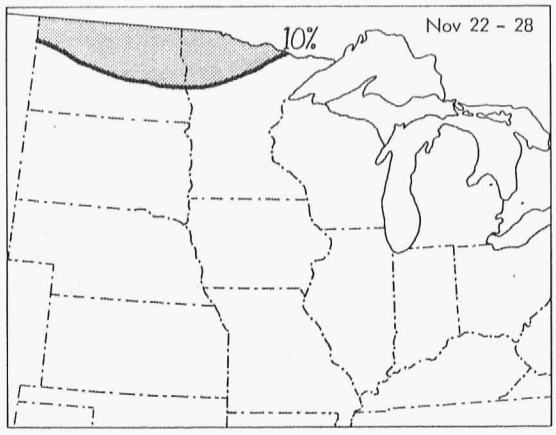
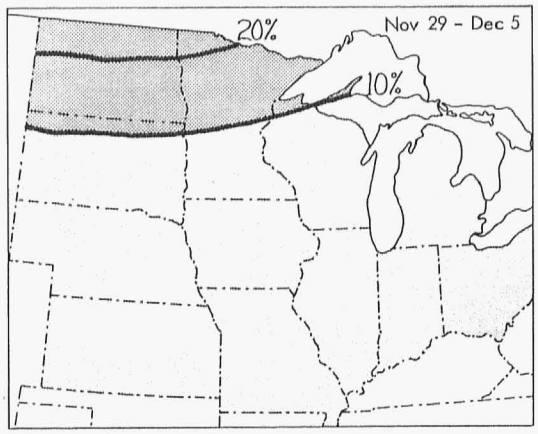
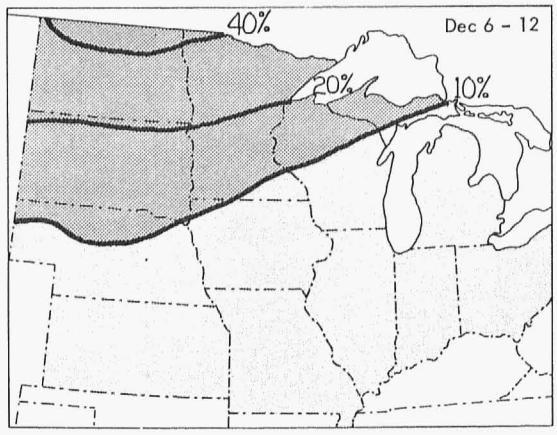

Feb 21 – 27
20%
10%


Mar 1 – 7
20%
10%


Mar 8 – 14
10%


Nov 22 – 28
10%


Nov 29 – Dec 5
20%
10%


Dec 6 – 12
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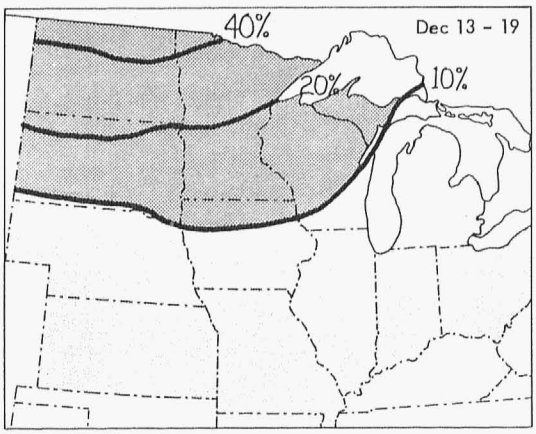
Dec 13 – 19
40%
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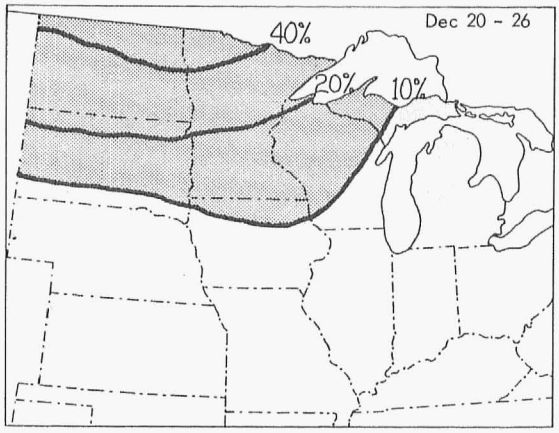
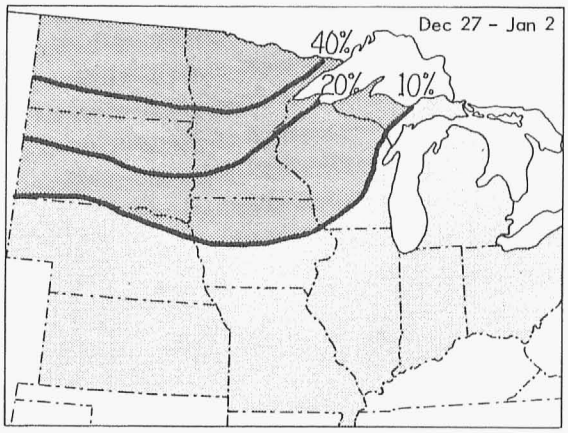
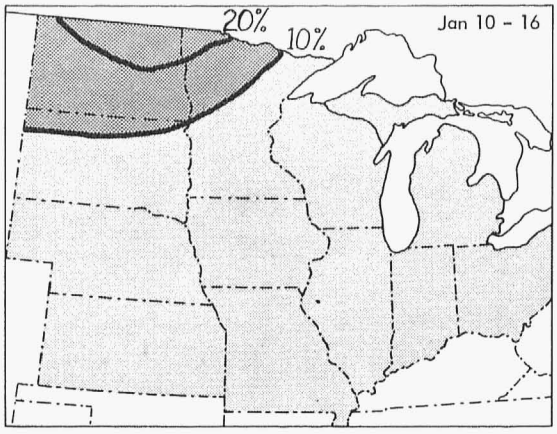
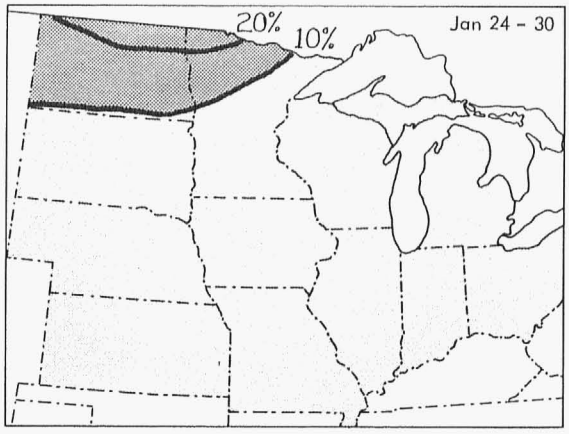
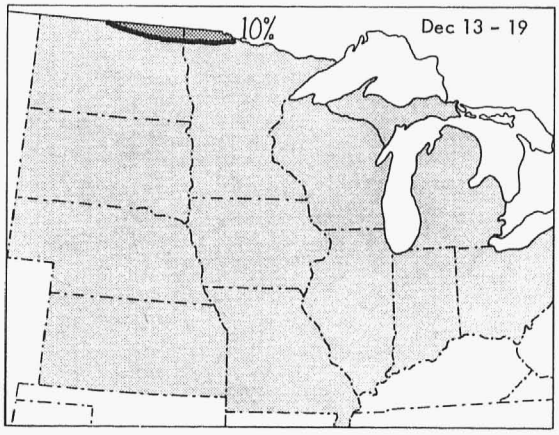


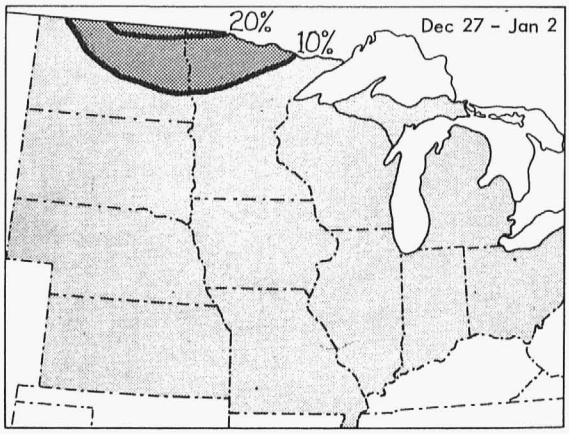


Runs of 15 Days or Longer with Minimum Below 0°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.



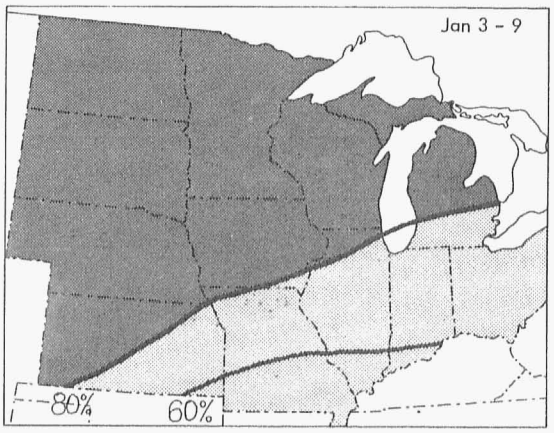


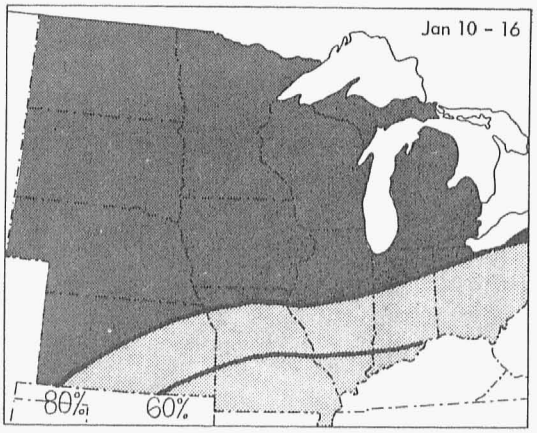


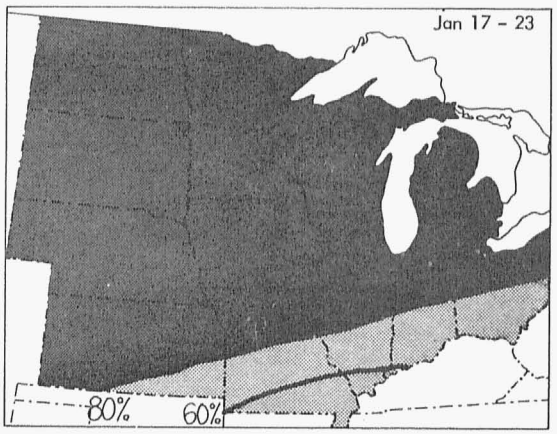


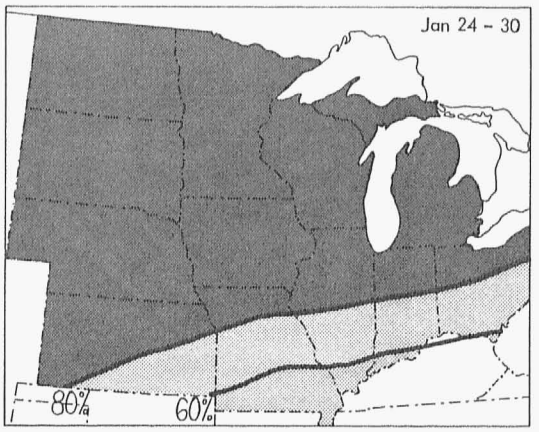
PERIODS OF VARIOUS LENGTHS WITH MINIMUM TEMPERATURES BELOW 30°F.

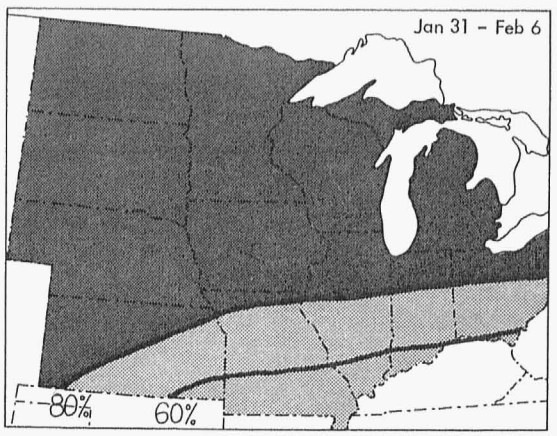
Runs of 5 or More Days with Minimum Below 30°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

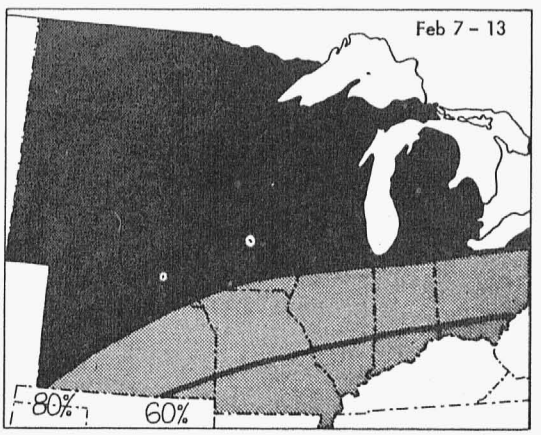


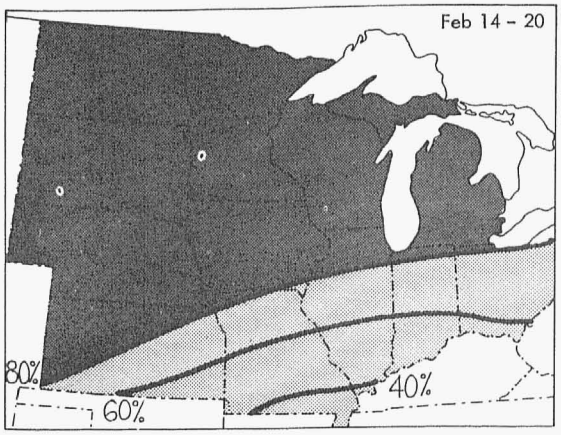











Feb 14 - 20
80%
60%
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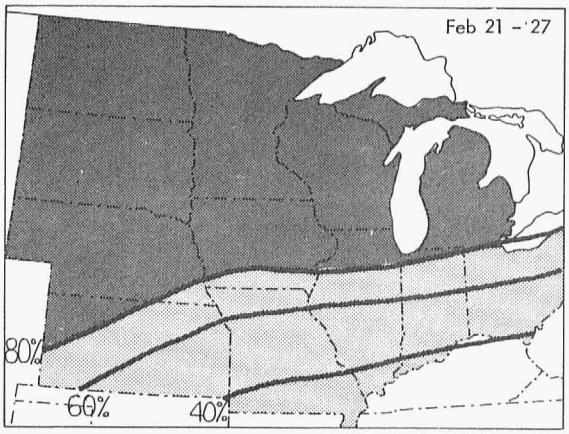
Feb 21 - 27
80%
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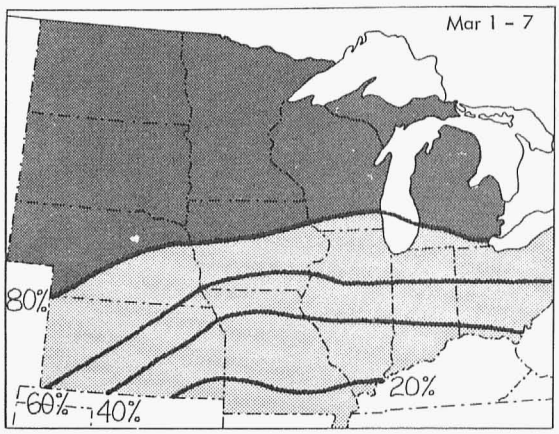
Mar 1 - 7
80%
60%
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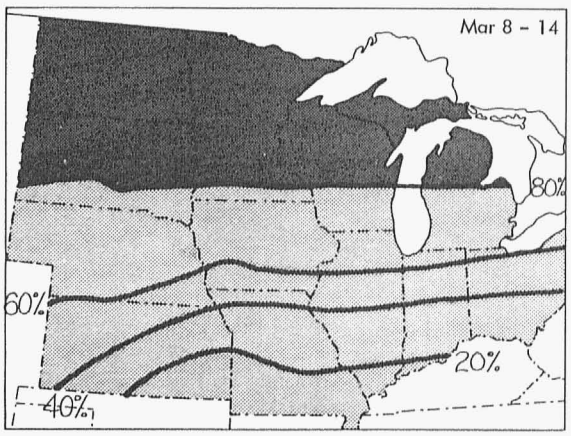
Mar 8 - 14
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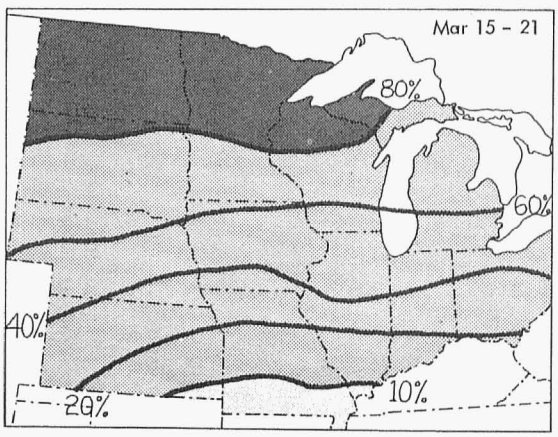
Mar 15 - 21
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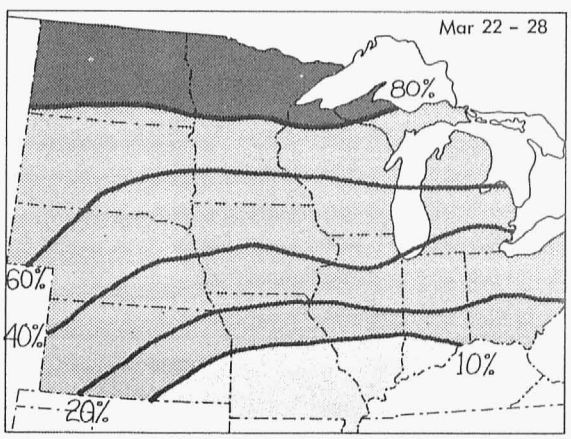
Mar 22 - 28
80%
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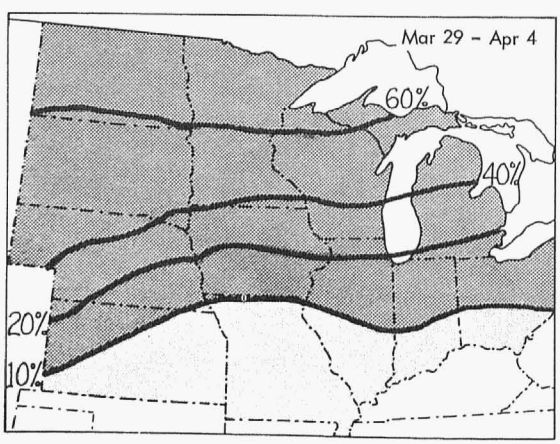
Mar 29 - Apr 4
60%
40%
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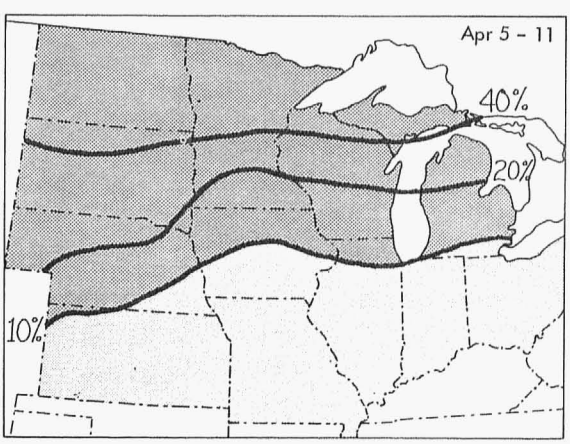
Apr 5 - 11
40%
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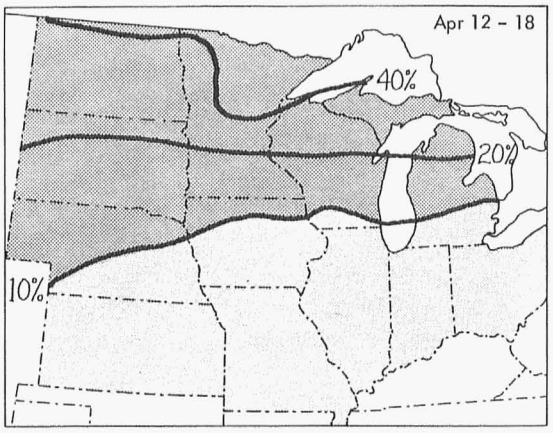
Apr 12 - 18
40%
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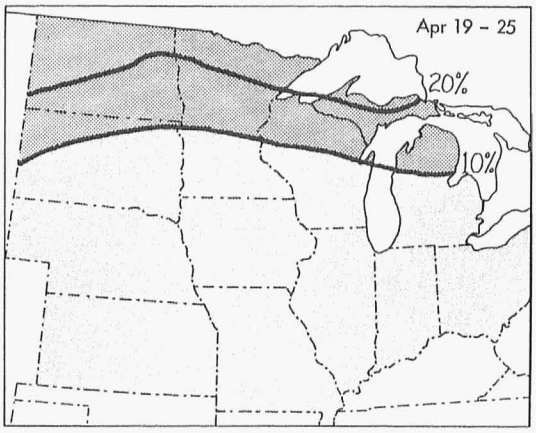
Apr 19 - 25
20%
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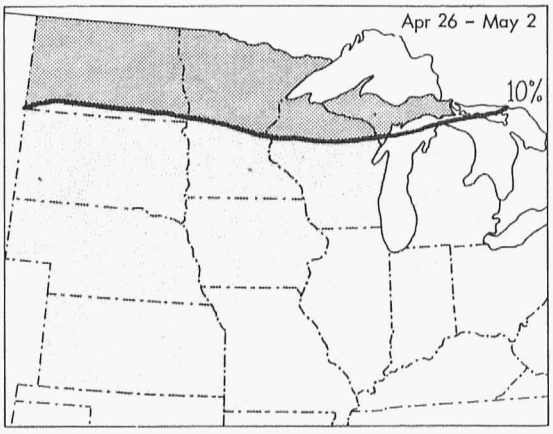
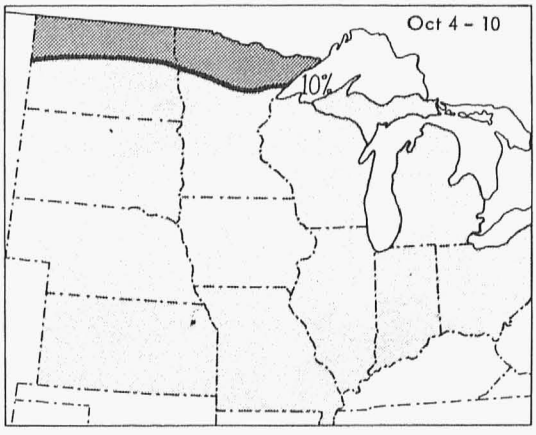
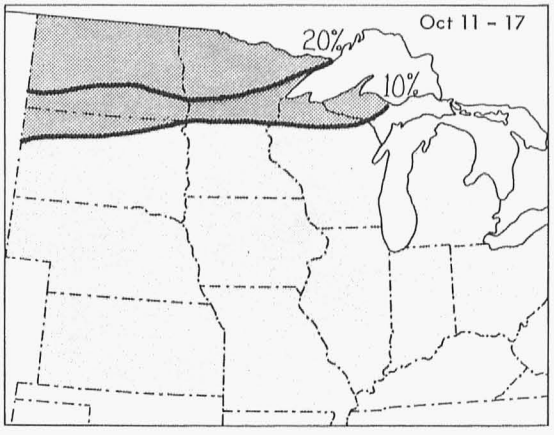
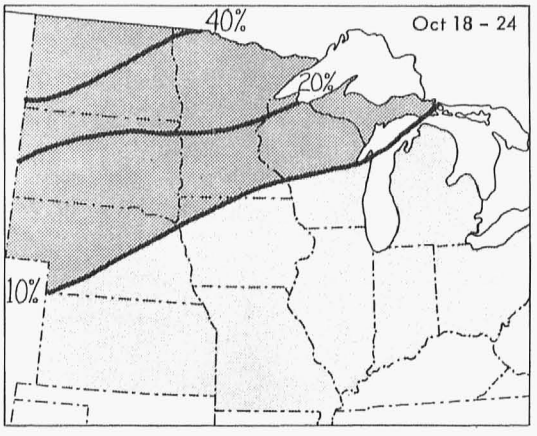

Apr 26 - May 2
10%


Oct 4 - 10
10%


Oct 11 - 17
20%
10%


Oct 18 - 24
40%
20%
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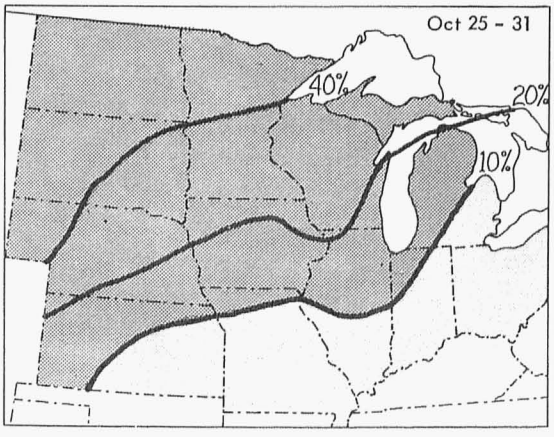
Oct 25 - 31
40%
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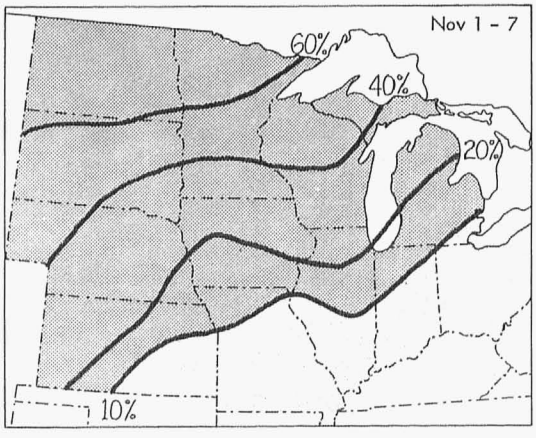
10%


Nov 1 - 7
60%
40%
20%
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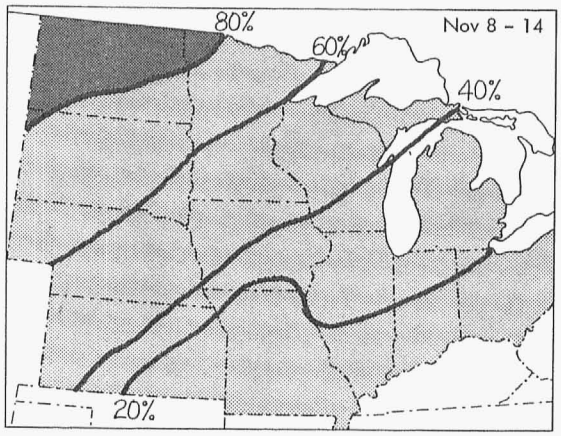
Nov 8 - 14
80%
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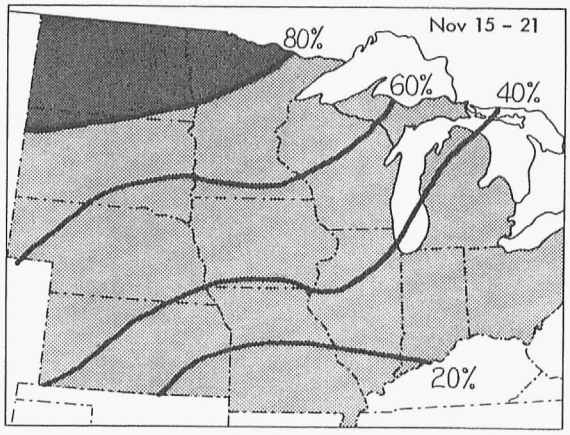
Nov 15 - 21
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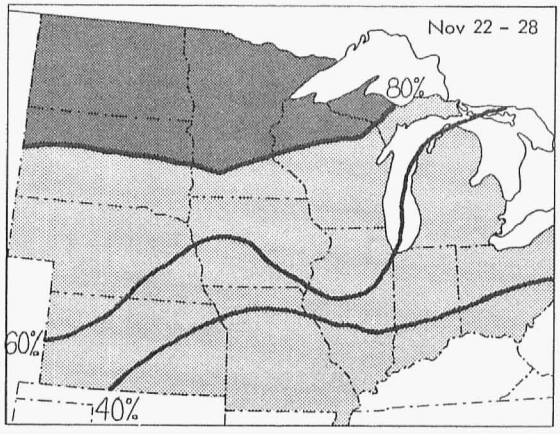
Nov 22 - 28
80%
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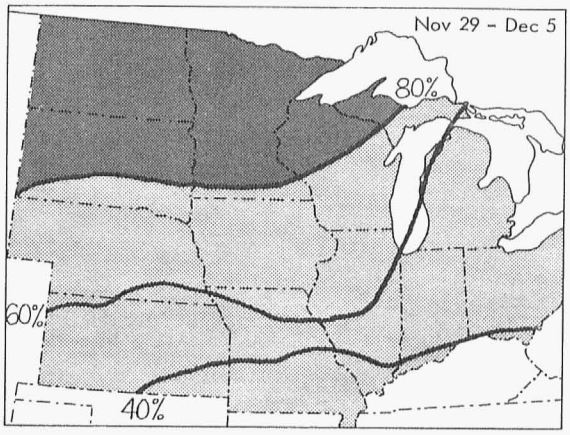
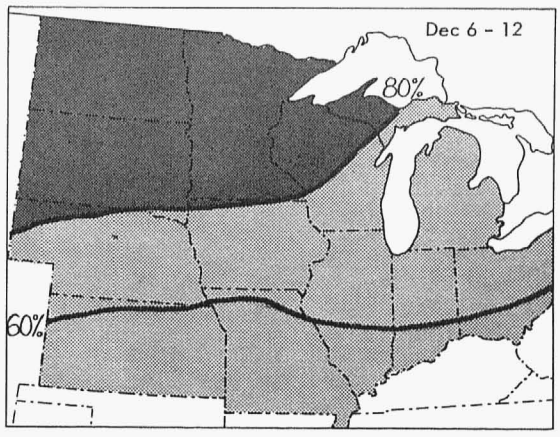
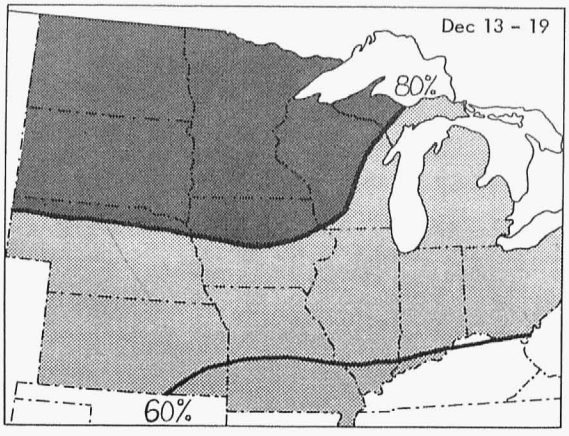
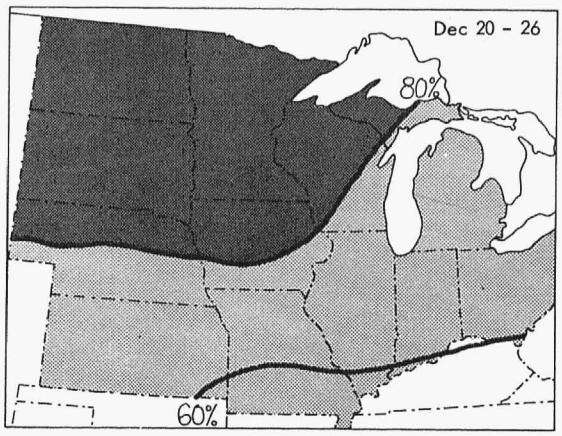
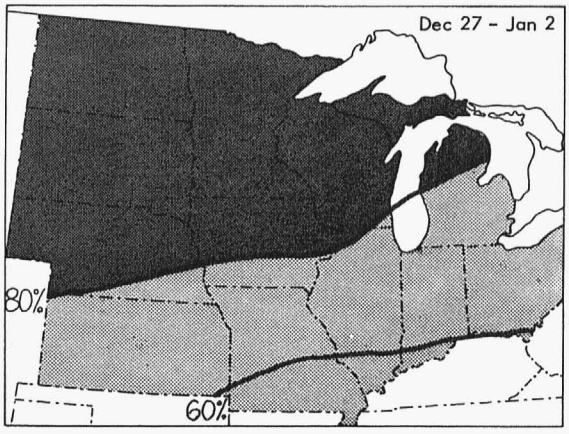

Nov 29 - Dec 5
80%
60%
40%

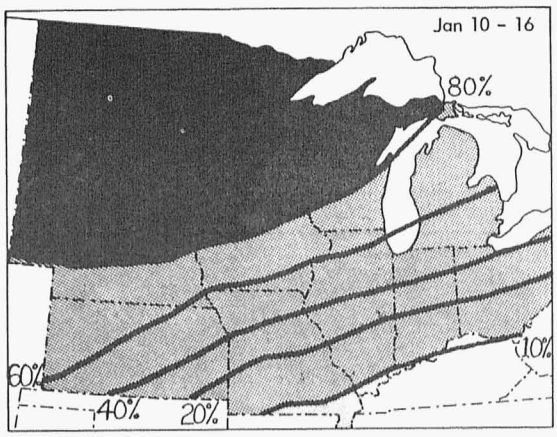

Dec 6 - 12
80%
60%

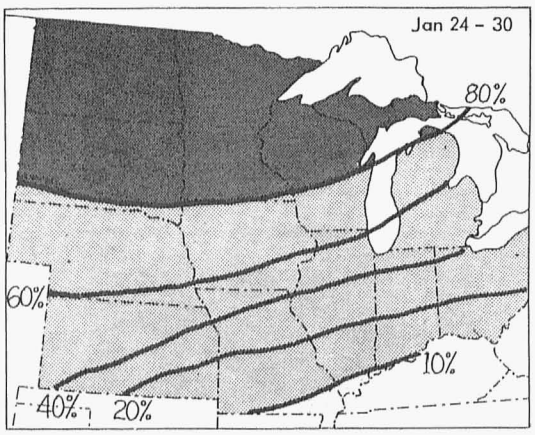

Dec 13 - 19
80%
60%

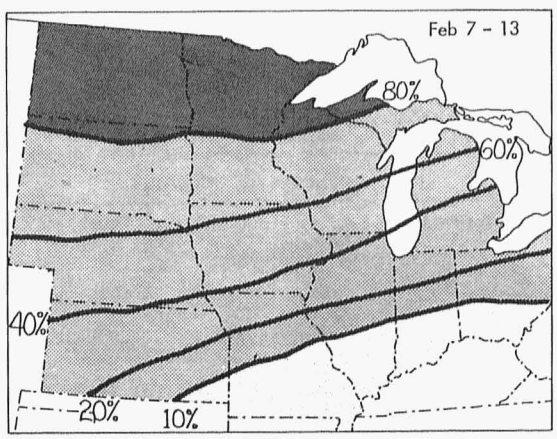

Dec 20 - 26
80%
60%

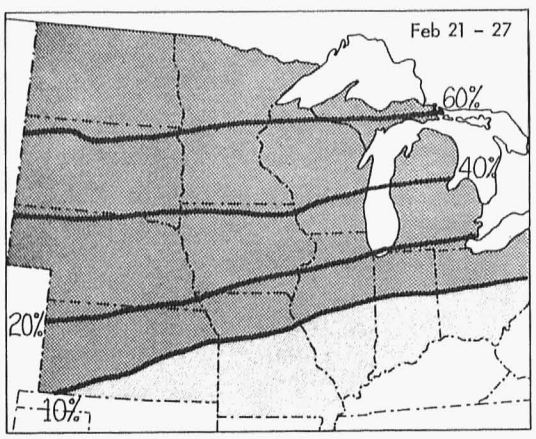

Dec 27 - Jan 2
80%
60%

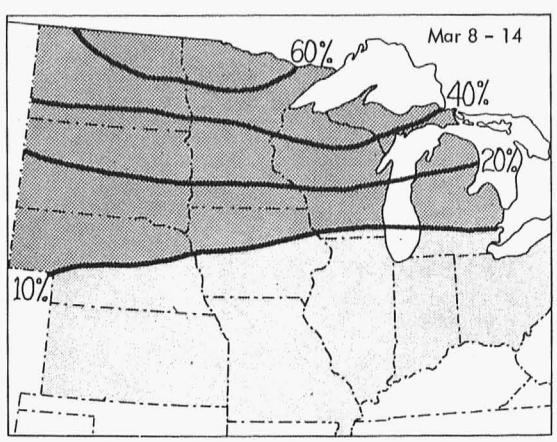
Runs of 15 or More Days with Minimum Below 30°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

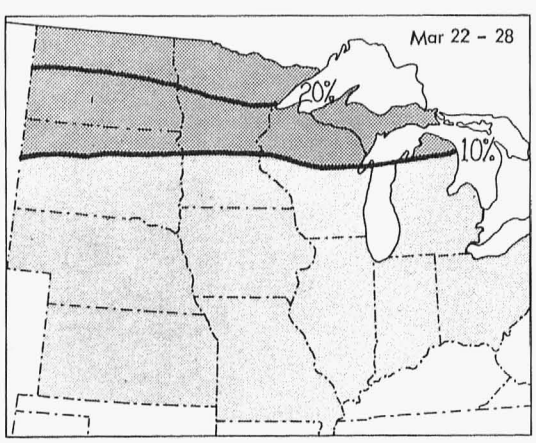


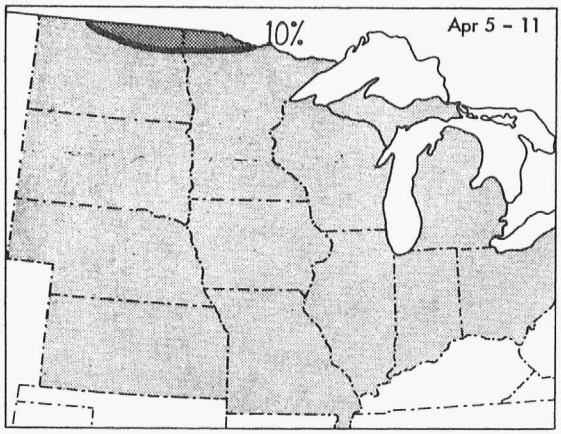


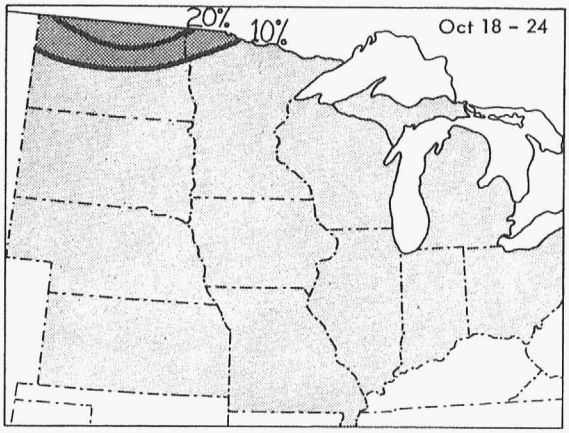


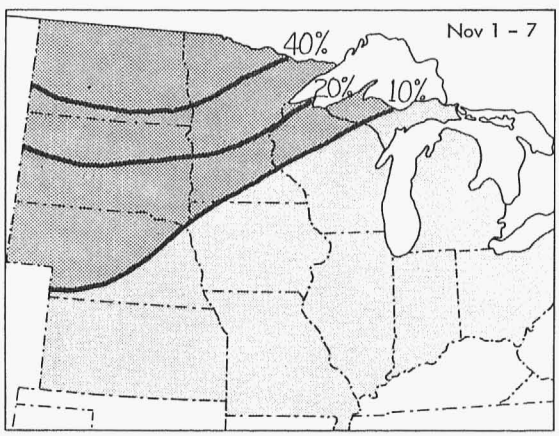


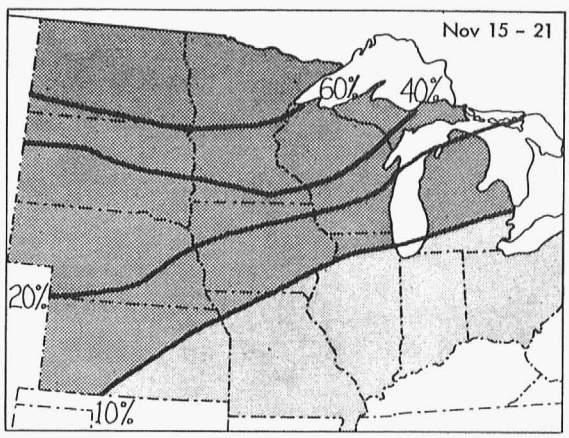


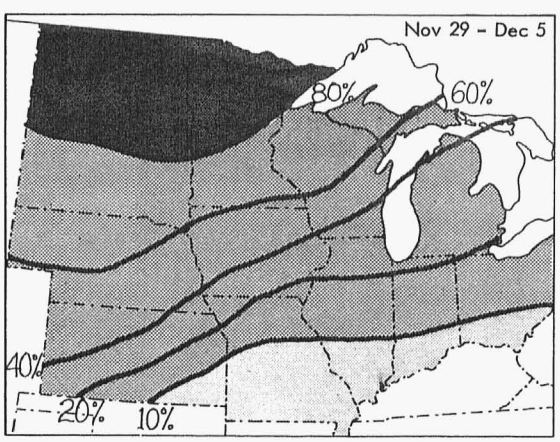


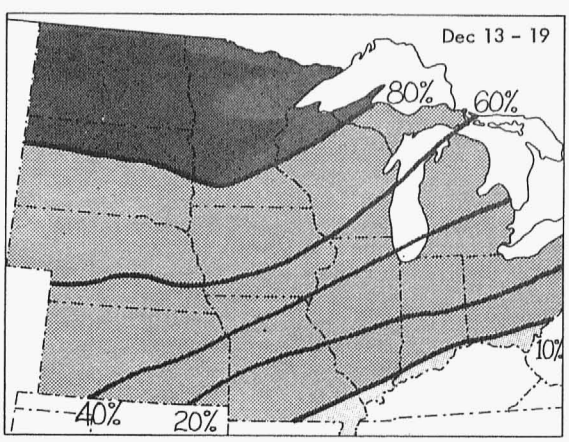

Apr 5 - 11
10%

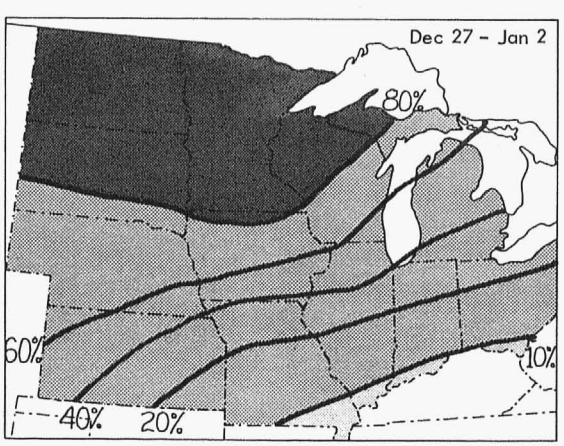

Oct 18 - 24
20%
10%


Nov 1 - 7
40%
20%
10%

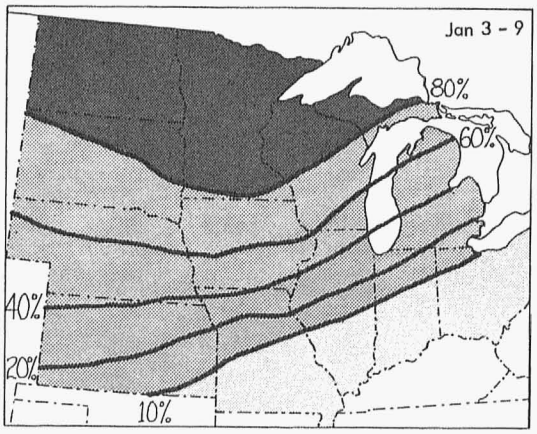

Nov 15 - 21
60%
40%
20%
10%

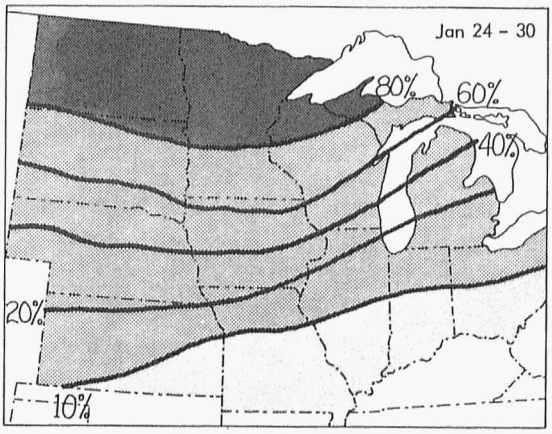

Nov 29 - Dec 5
80%
60%
40%
20%
10%

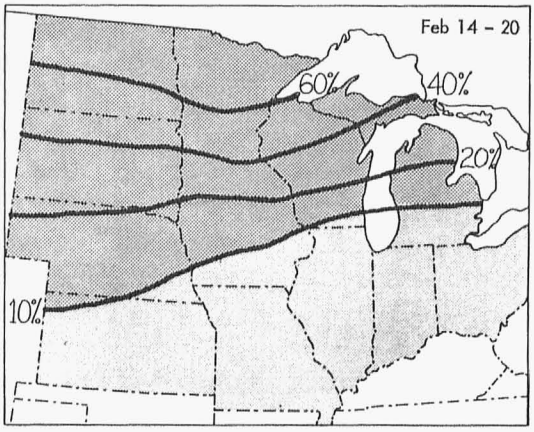

Dec 13 - 19
80%
60%
40%
20%
10%

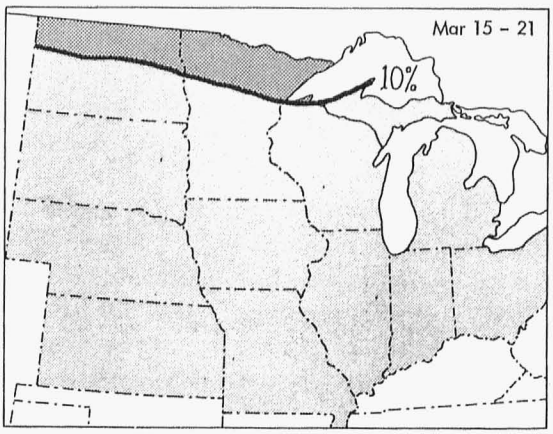

Dec 27 - Jan 2
80%
60%
40%
20%
10%

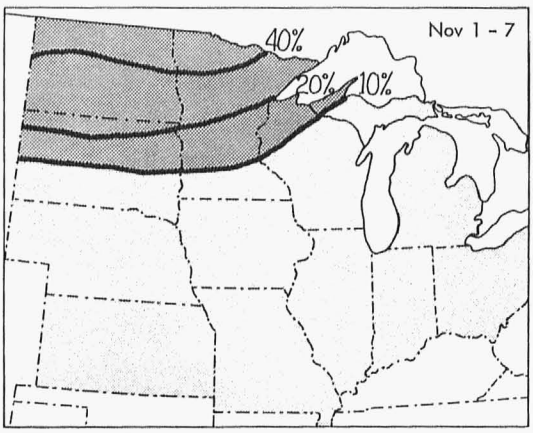
Runs of 25 or More Days with Minimum Below 30°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

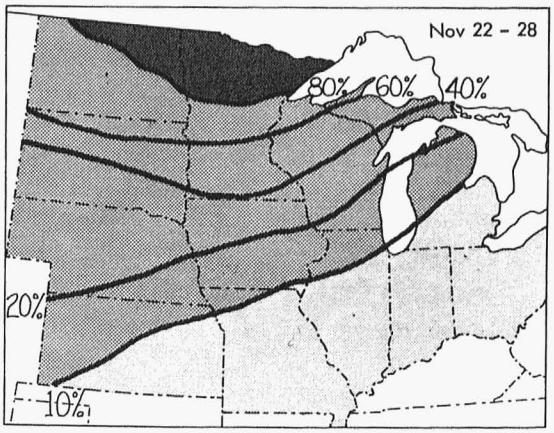


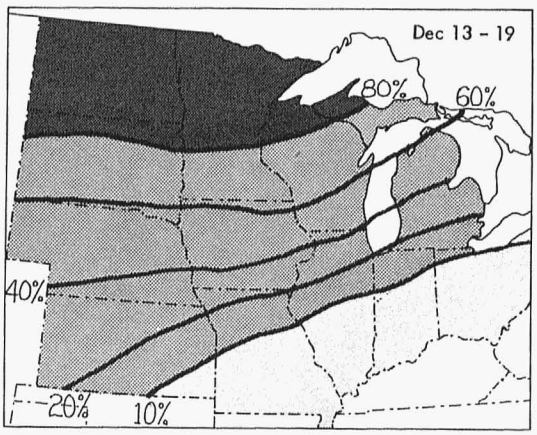




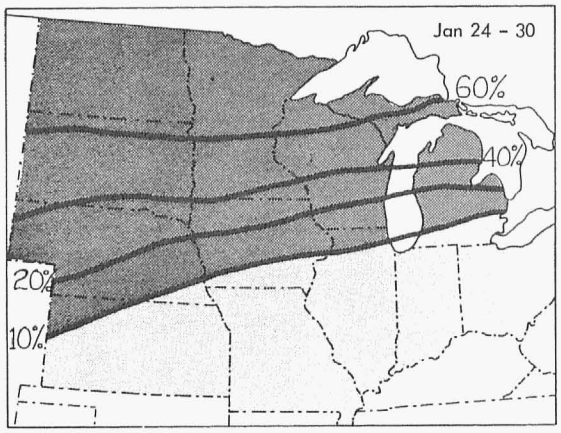


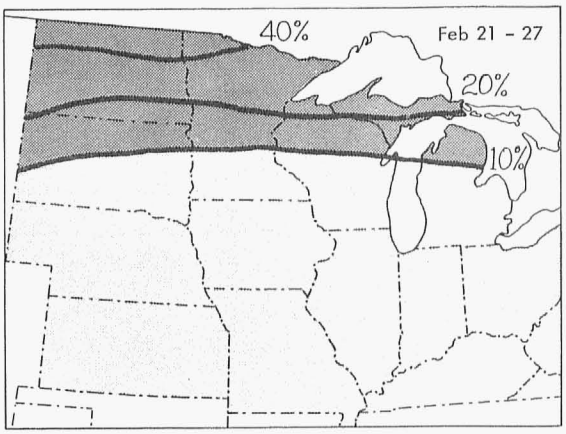


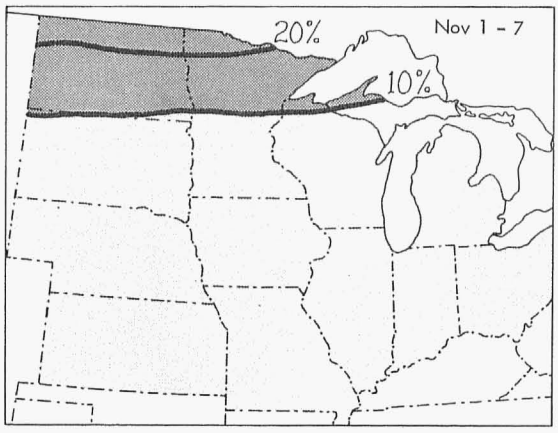


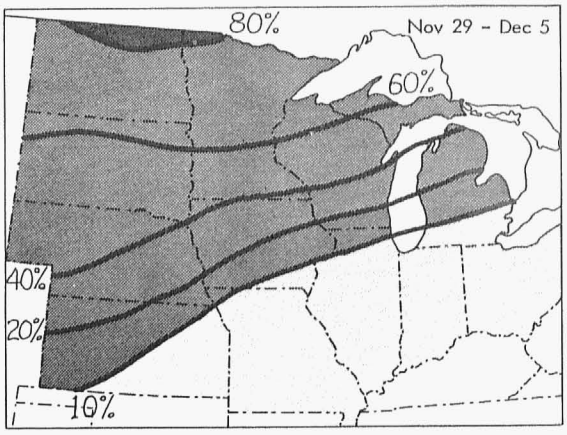


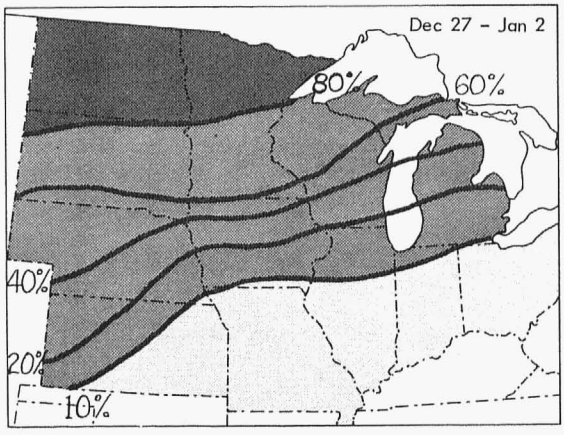
Runs of 35 or More Days with Minimum Below 30°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.











RUNS OF DAYS WITH MINIMUM TEMPERATURES BELOW THRESHOLD VALUES IN SPRING AND FALL

When temperatures fall below the minimum value for a given vegetative type, growth and development of the plant cease. Cool-season plants begin their development when temperatures rise above 40°F., while plants more adapted to the warmer temperatures of summer often have temperatures of 50°F. as their minimum value. Tabulations of the probability for extended periods with temperatures below 40° and 50°F. represent the likelihood for extended periods with unfavorable nighttime temperatures. It should be recognized that the cessation of development may occur only for a short period during the night with favorable conditions prevailing during the hours of daylight.

Runs of Days With Minimum Temperatures Below 40°F. (4.4°C.)

The next four pages of this bulletin depict the likelihood for periods of five days or longer with minimum temperatures below 40°F. Periods of this duration began during nearly every week of the winter season throughout the North Central Region. In early March, the likelihood of five-day periods with this temperature becomes less than 80 percent in the extreme southern portion of the region and this probability decreases during spring throughout the region. By mid-May there remains a small chance in northern portions of the region for periods of five days or longer with temperatures below 40°F. During summer there is little likelihood of periods of this duration below 40° in the North Central Region, but by mid-September the probability begins to increase. In late November periods of this type become a certainty in all areas except the southern portion of the region.

Pages 60, 61 and 62 show the geographic distribution of the likelihood of a run of 15 days or more with minimum temperatures below 40°F. In winter there is a 60 to 80 percent chance for such periods in southeastern Kansas and in southern Missouri, Illinois, Indiana, and Ohio. The remainder of the region will experience periods of this length virtually every year. During late February the probability of 15 consecutive days with temperature below 40°F. decreases rapidly throughout the region and by late April the chance for such an occurrence is virtually zero. Beginning in late September the likelihood of periods of 15 days duration with these temperatures increases across the region and the winter pattern prevails after late November.

The chance for longer periods with minimum temperatures below 40°F. is shown in pages 63, 64 and 65. These patterns show high probabilities during winter and zero probability during summer. There is a more than 80 percent chance for an uninterrupted five-week period below 40°F. during winter throughout the northern two-thirds of the region.

Runs of Days With Minimum Temperature Below 50°F (10°C.)

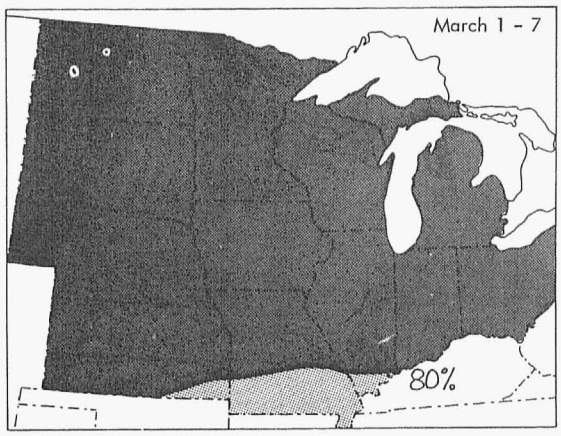
The likelihood of runs of days with minimum temperatures below 50°F. is shown on the maps on pages 66 through 76. These patterns of equal probability follow extremely close to those already discussed for a threshold temperature of 40°F.

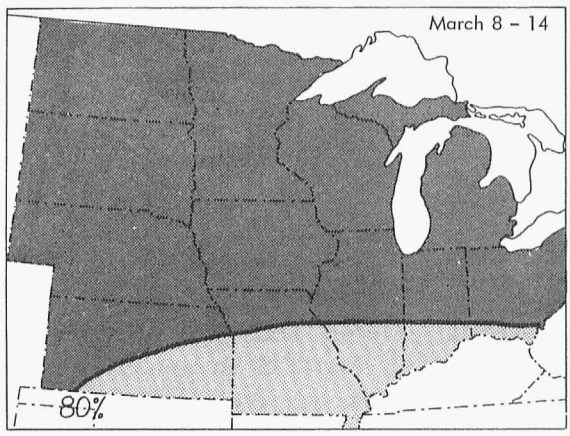
In general, the probability for periods of 5, 15, 25 and 35 days duration with temperatures below 50°F. is high during the winter, early spring, and late autumn. These likelihoods decrease sharply as the spring season progresses and the chance for such periods beginning during any week increases again in the fall.

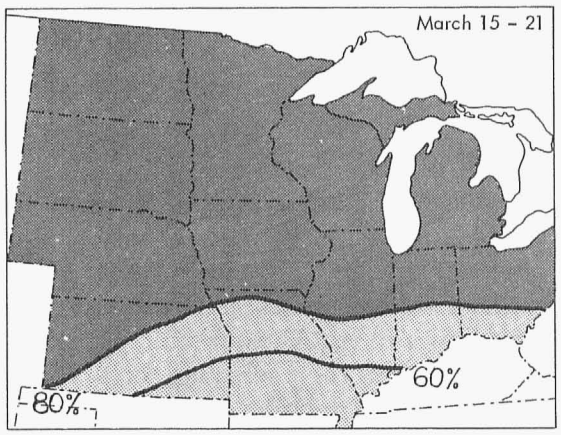
One striking difference between the likelihood for runs of days with minimum temperatures below 50°F. as compared with the tabulations from the previous section is that 50°F. temperatures do occur throughout the summer in the northern part of the region. Even during the last week in June there remains a 10 to 20 percent chance for five consecutive days with minimum temperatures below 50°F. in North Dakota, Minnesota, northern Wisconsin, and the upper peninsula of Michigan.

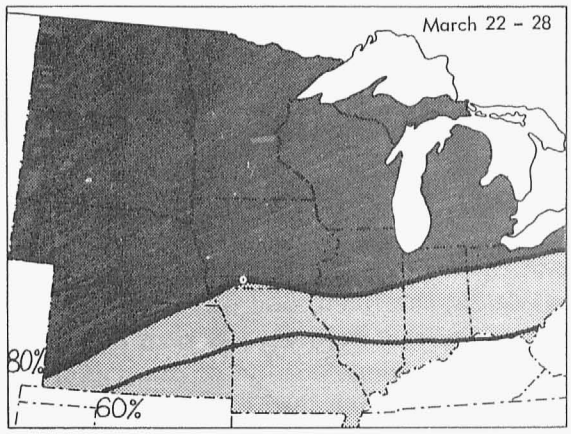
PERIODS OF VARIOUS LENGTHS WITH MINIMUM TEMPERATURES BELOW 40°F.

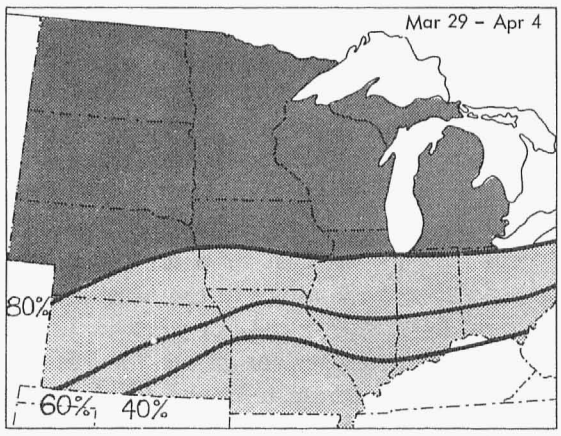
Runs of 5 Days or Longer with Minimum Below 40°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

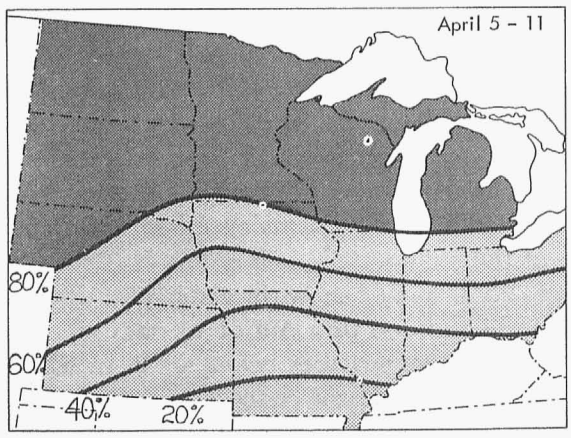


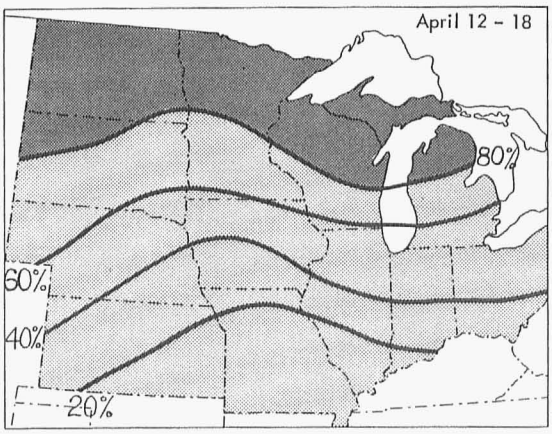


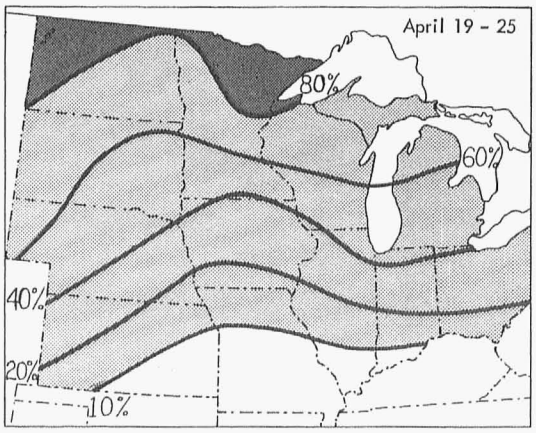


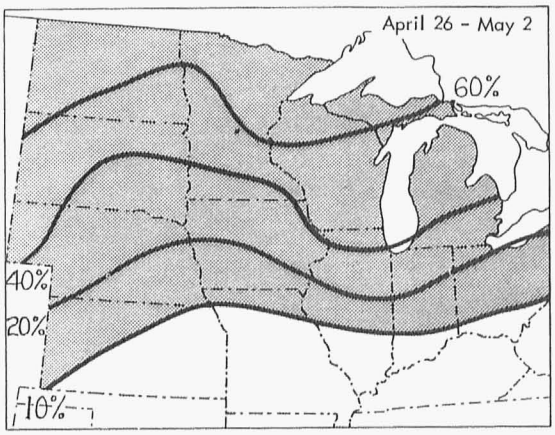


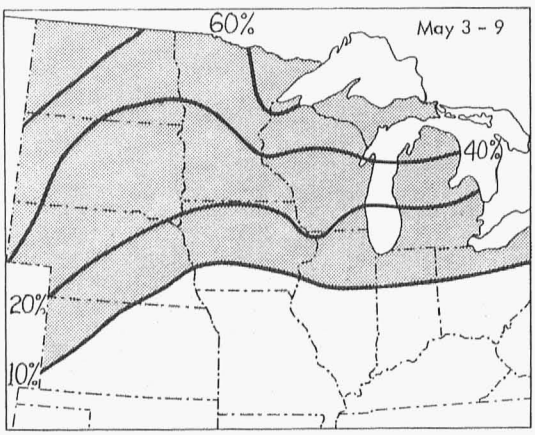


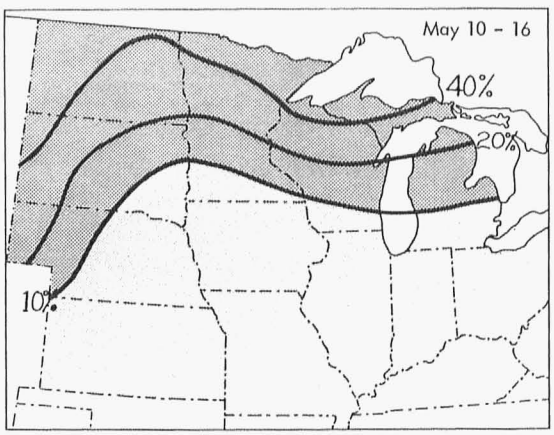


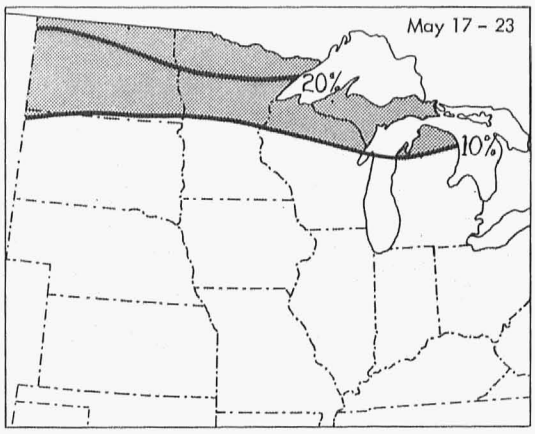

April 12 - 18
80%
60%
40%
20%

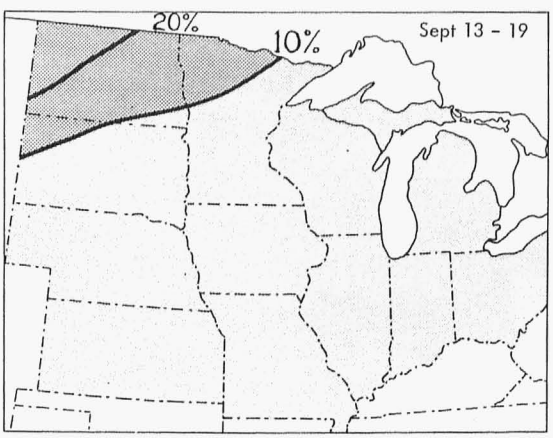

April 19 - 25
80%
60%
40%
20%
10%

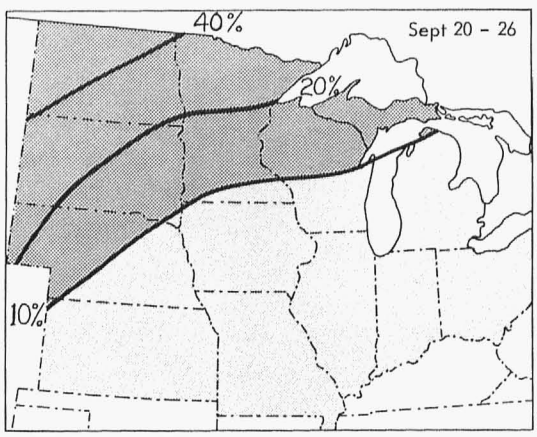

April 26 - May 2
60%
40%
20%
10%

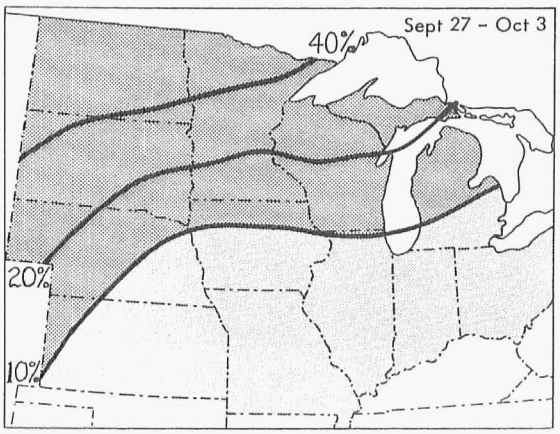

May 3 - 9
60%
40%
20%
10%

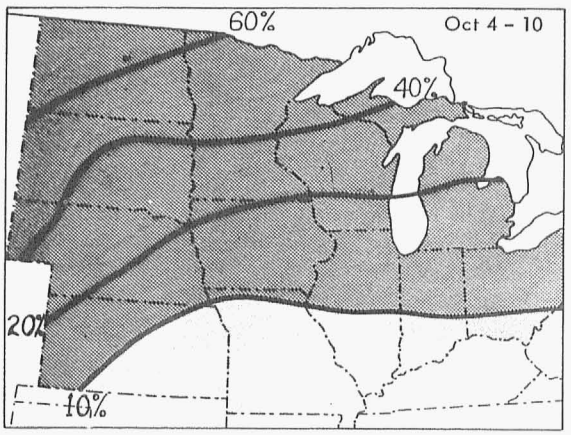

May 10 - 16
40%
20%
10%

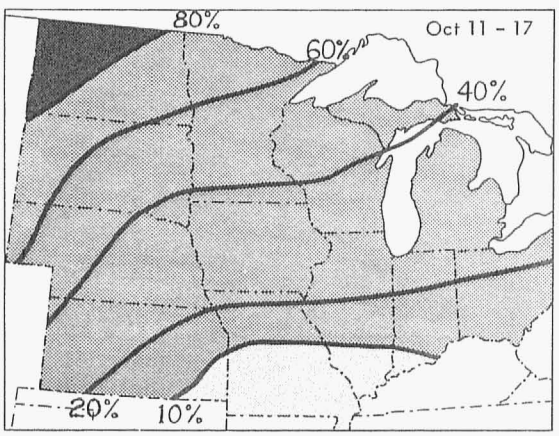

May 17 - 23
20%
10%

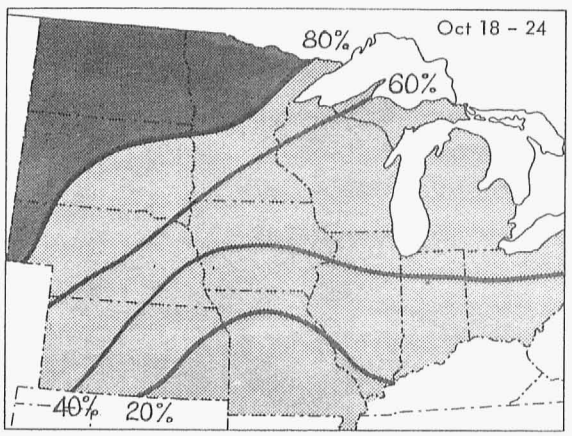

Sept 13 - 19
20%
10%

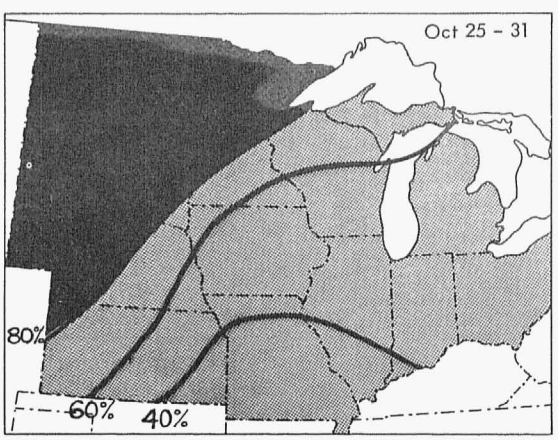

Sept 20 - 26
40%
20%
10%

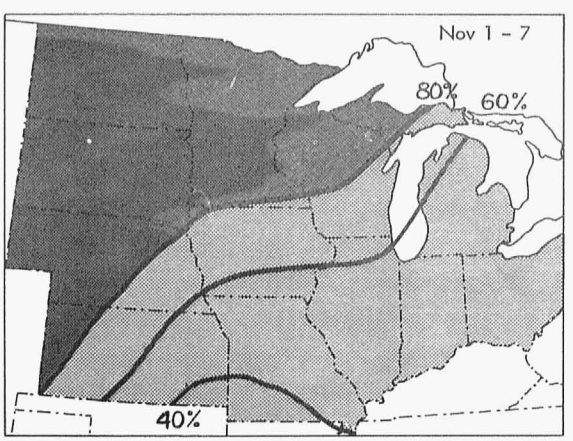

Sept 27 - Oct 3
40%
20%
10%

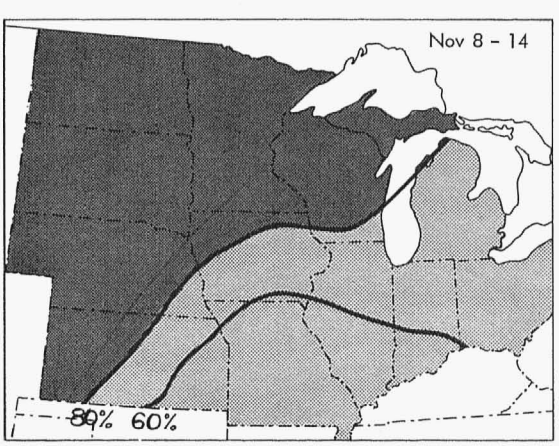

Oct 4 - 10
60%
40%
20%
10%

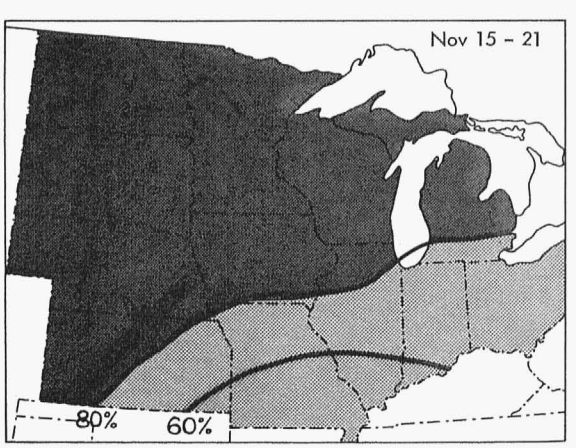

Oct 11 - 17
80%
60%
40%
20%
10%

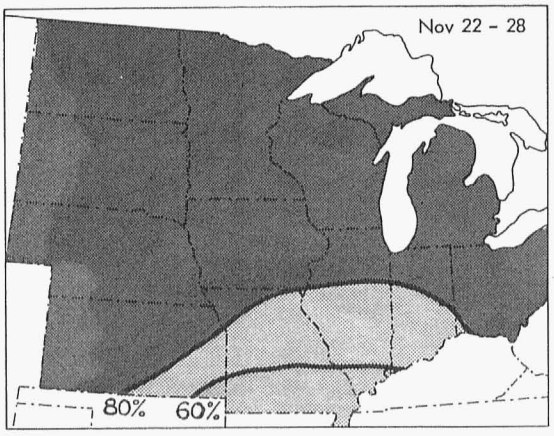

Oct 18 - 24
80%
60%
40%
20%

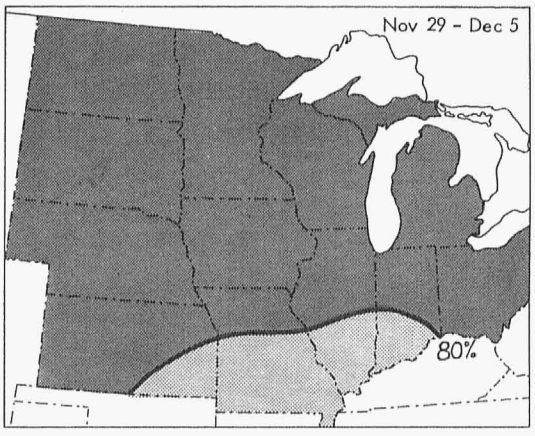

Oct 25 - 31
80%
60%
40%

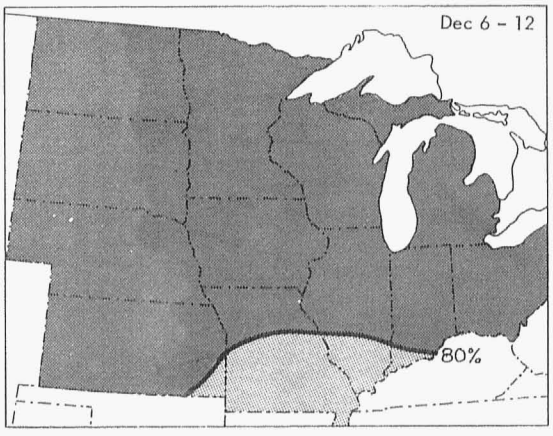

Nov 1 - 7
80%
60%
40%

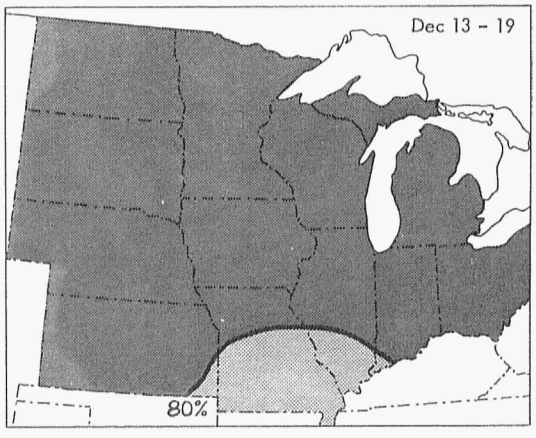

Nov 8 - 14
80%
60%

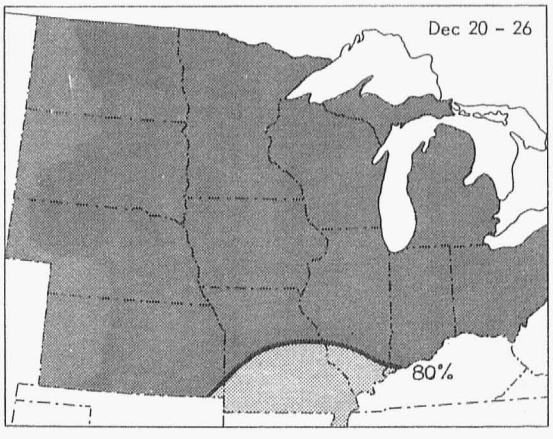

Nov 15 - 21
80%
60%

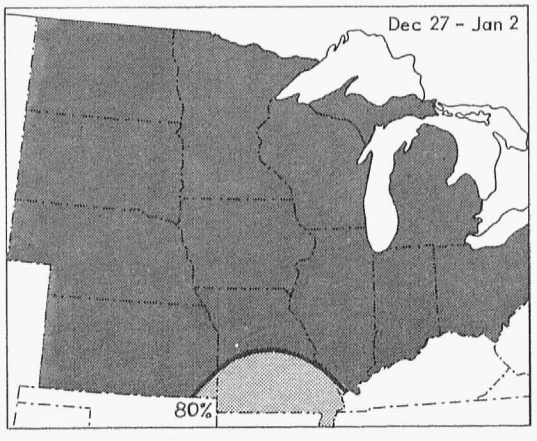

Nov 22 - 28
80%
60%


Nov 29 - Dec 5
80%

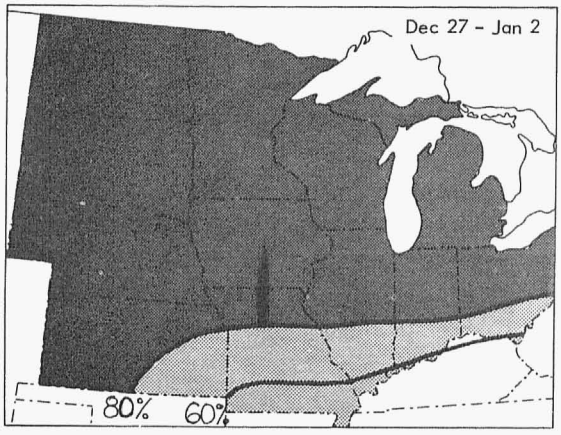

Dec 6 - 12
80%

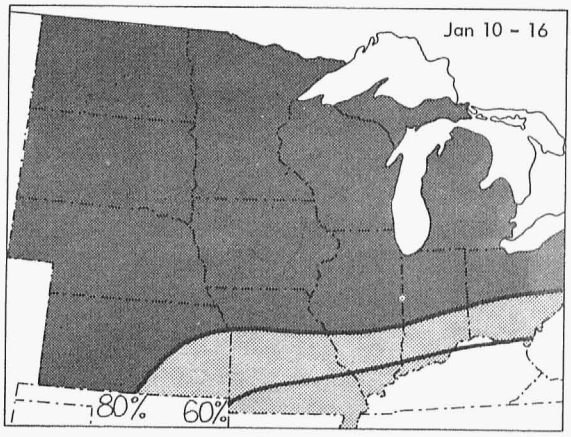

Dec 13 - 19
80%

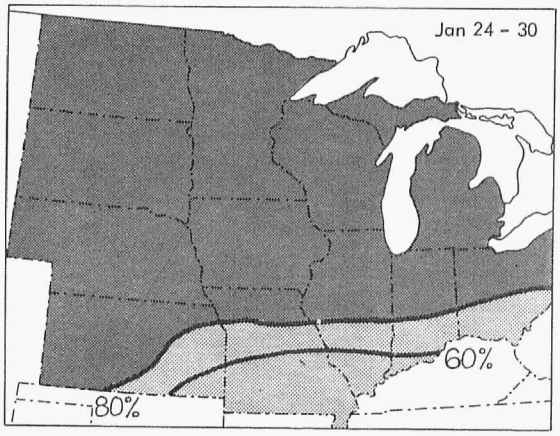

Dec 20 - 26
80%

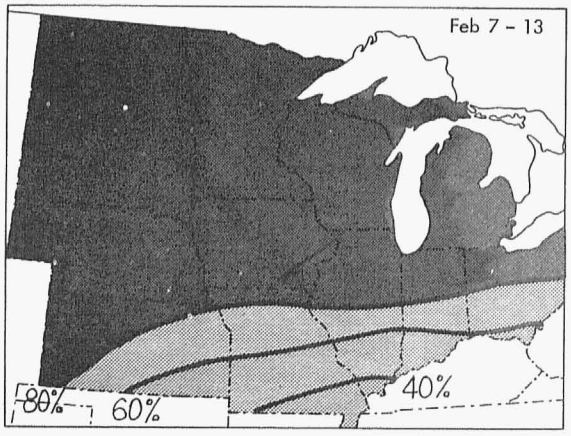

Dec 27 - Jan 2
80%

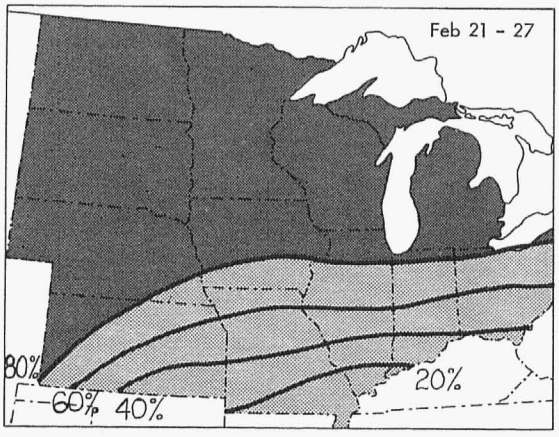
Runs of 15 Days or Longer with Minimum Below 40°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

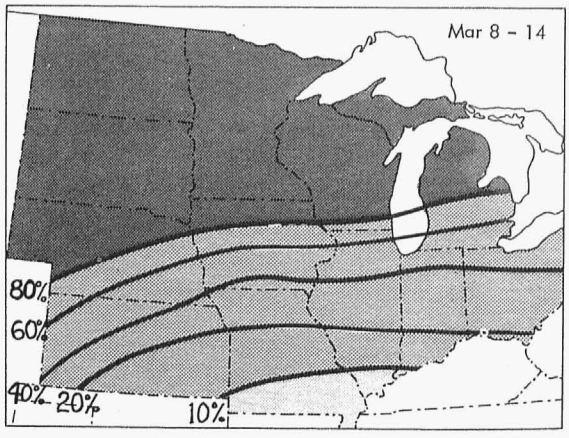


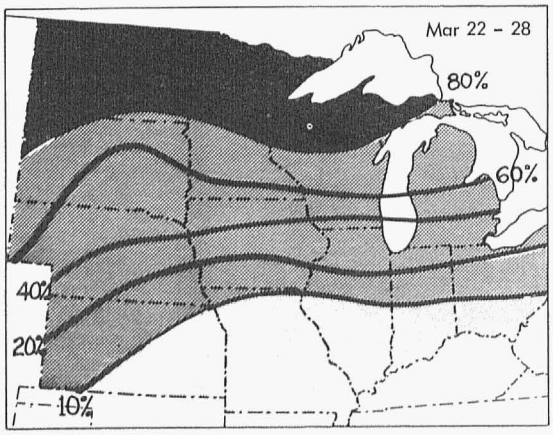


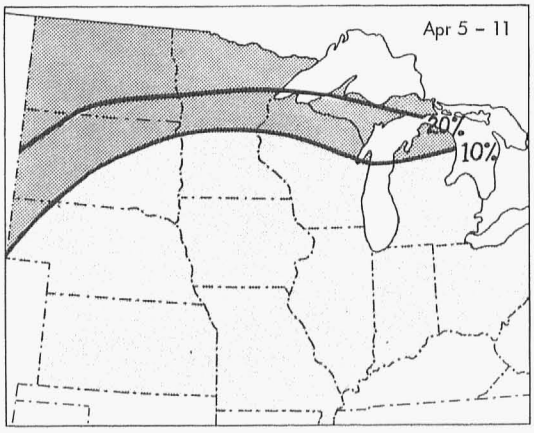


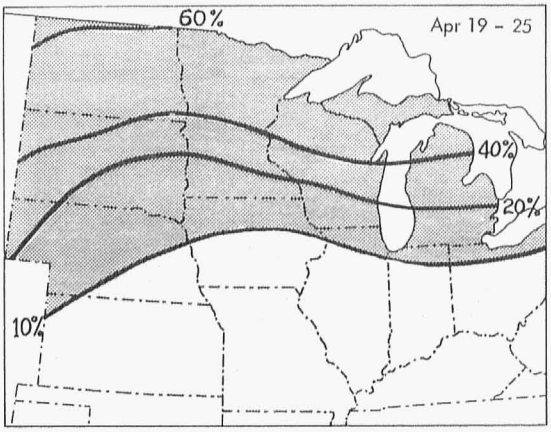


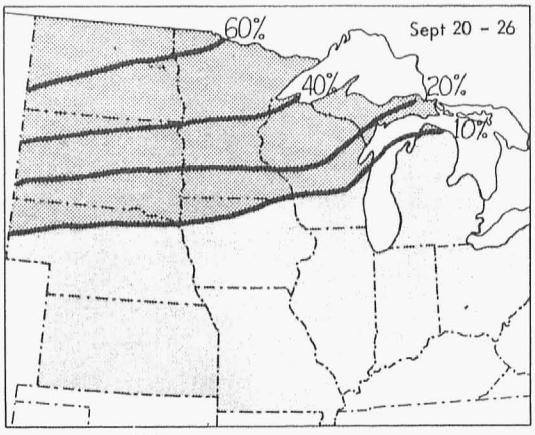


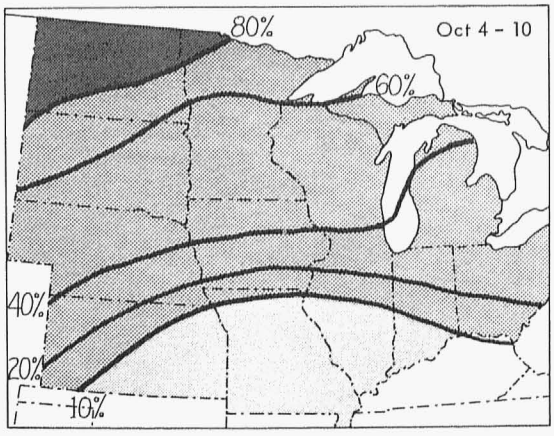


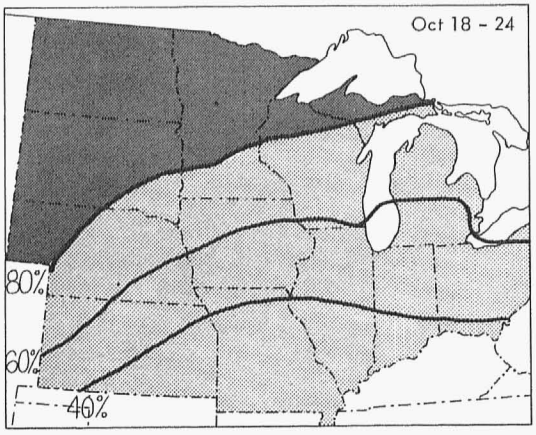

Mar 22 - 28
80%
60%
40%
20%
10%

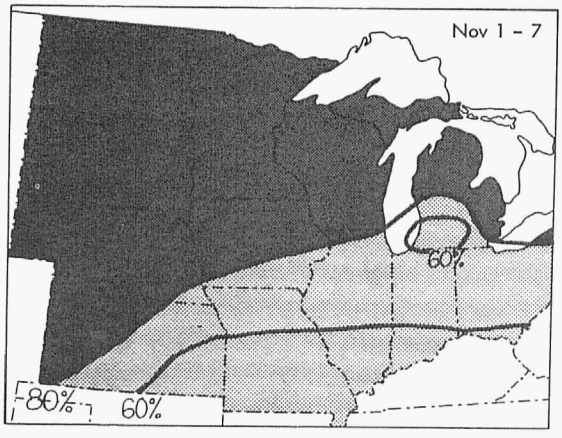

Apr 5 - 11
20%
10%

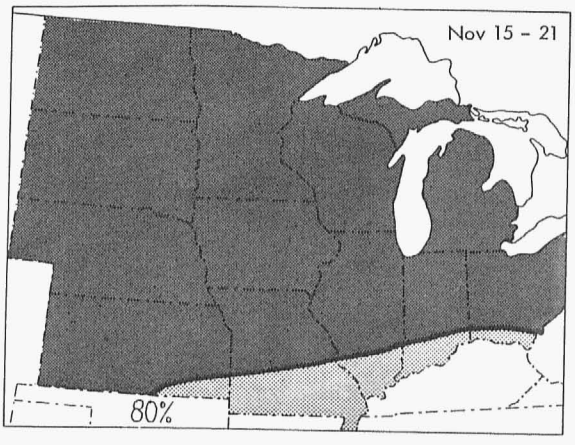

60%
Apr 19 - 25
40%
20%
10%

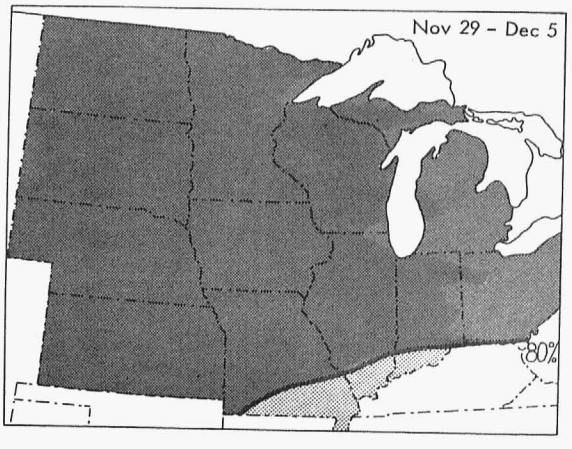

60%
Sept 20 - 26
40%
20%
10%


80%
Oct 4 - 10
60%
40%
20%
10%

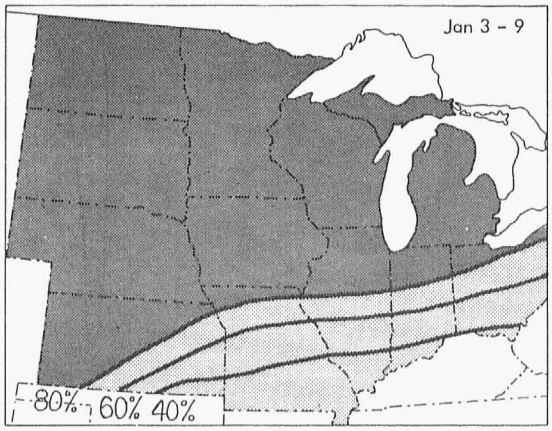

Oct 18 - 24
80%
60%
40%

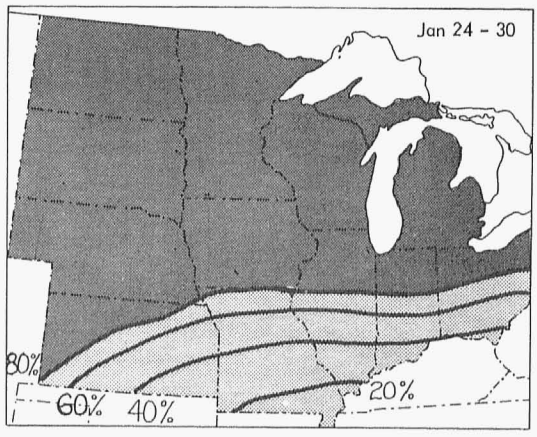

Nov 1 - 7
60%
80%
60%

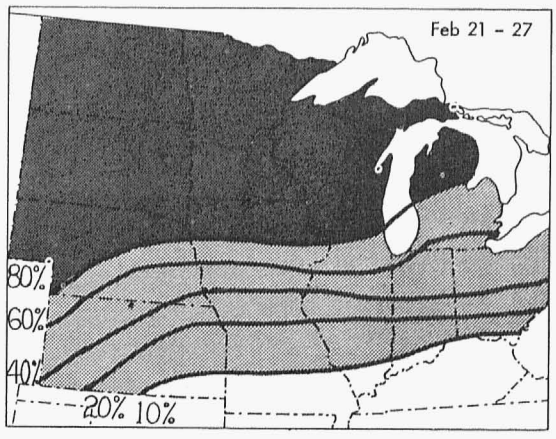

Nov 15 - 21
80%

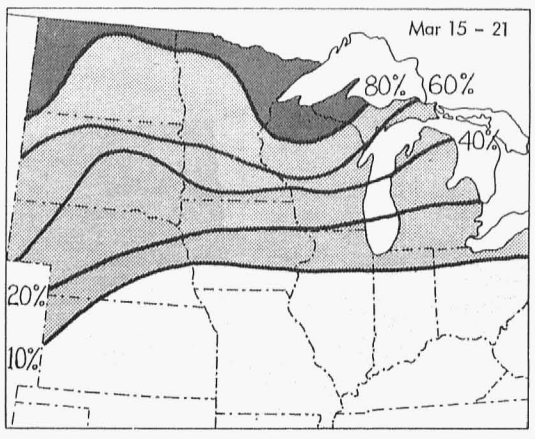

Nov 29 - Dec 5
80%

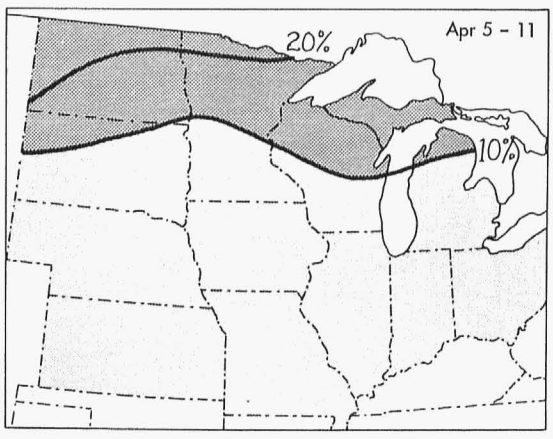
Runs of 25 Days or Longer with Minimum Below 40°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

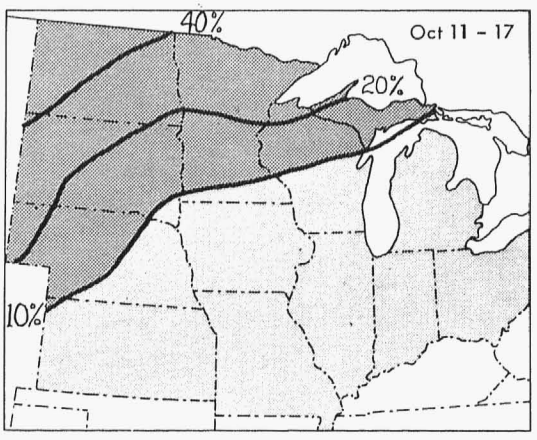


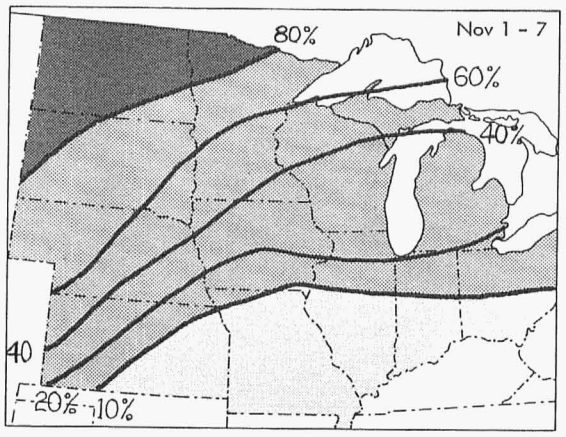


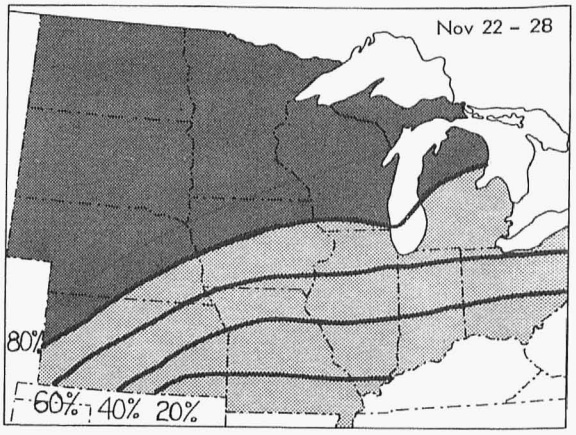


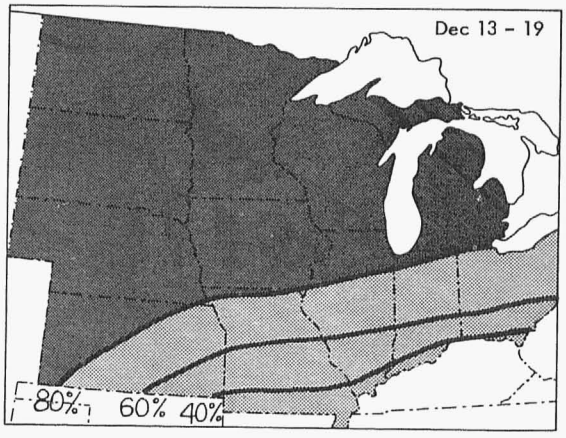




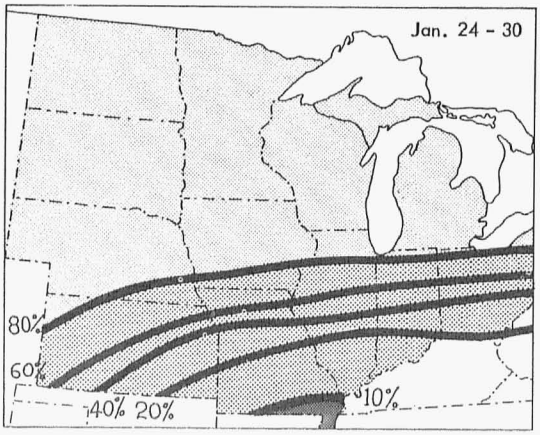


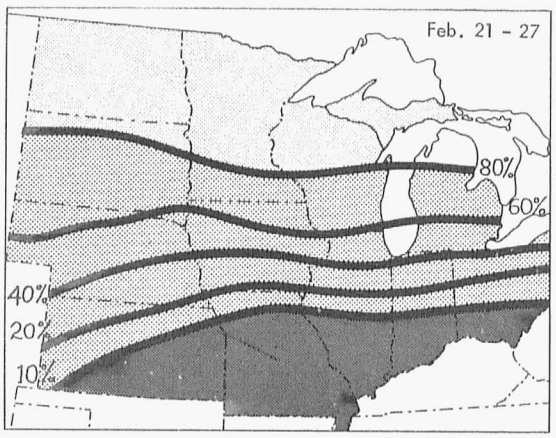

Nov 1 - 7
80%
60%
40%
40
20%
10%

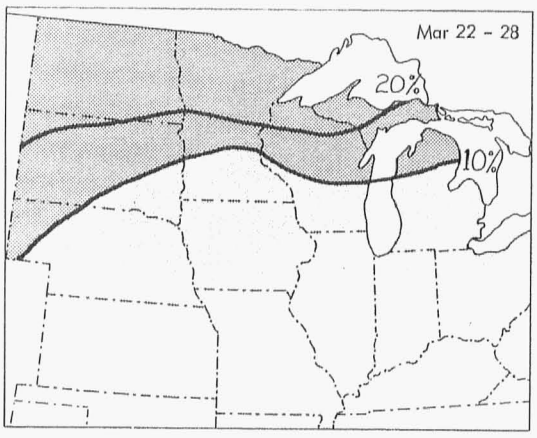

Nov 22 - 28
80%
60%
40%
20%

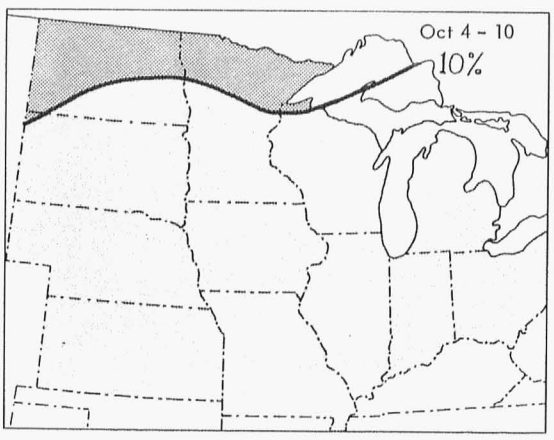

Dec 13 - 19
80%
60%
40%

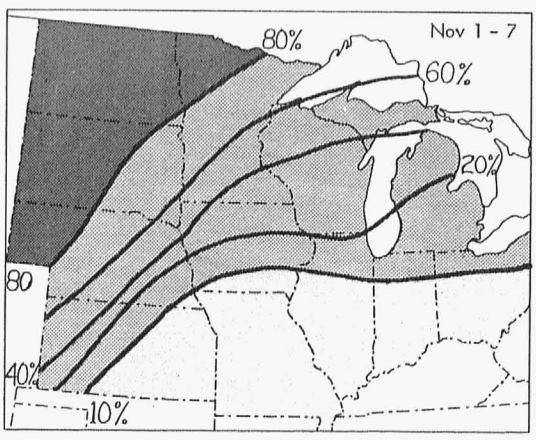
Runs of 35 Days or Longer with Minimum Below 40°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

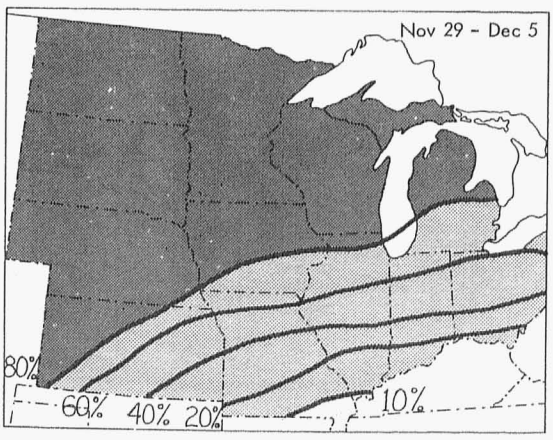


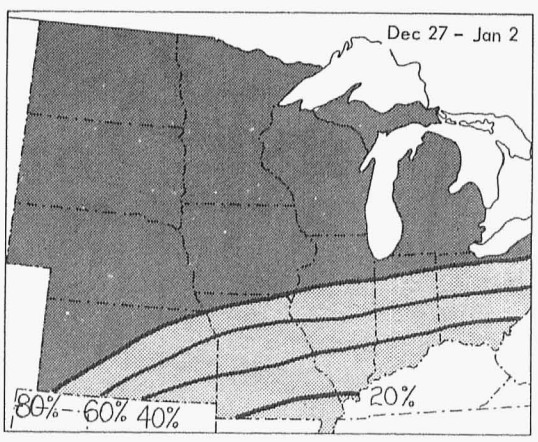






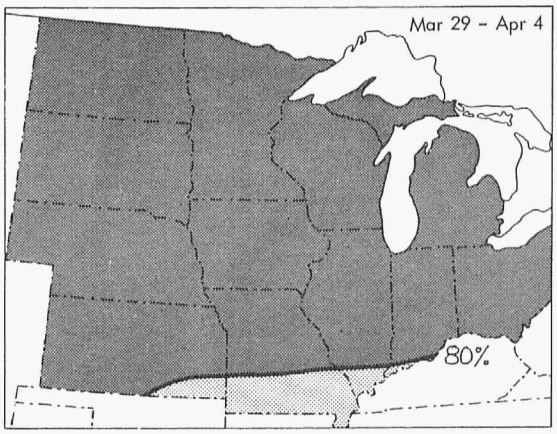


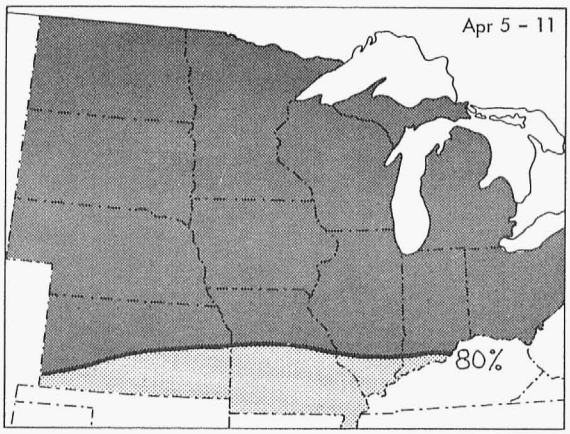


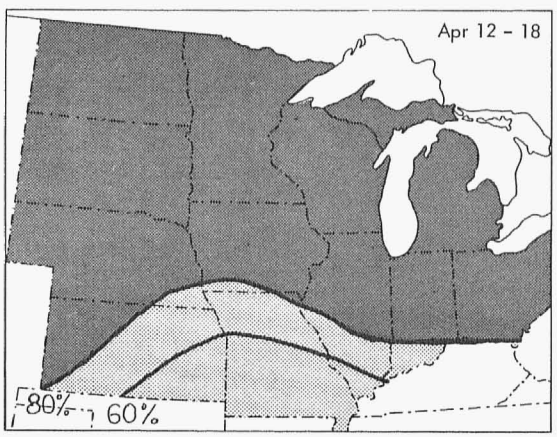


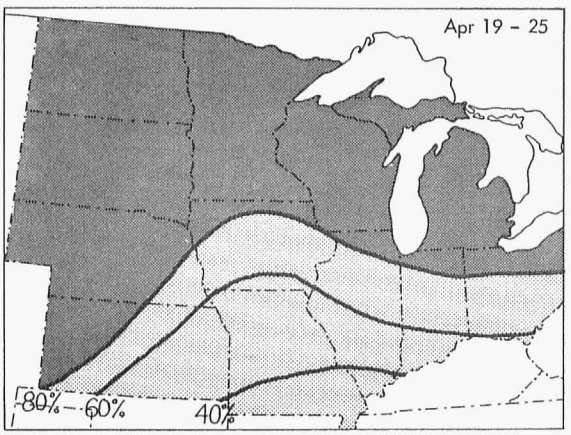
PERIODS OF VARIOUS LENGTHS WITH MINIMUM TEMPERATURES BELOW 50°F.

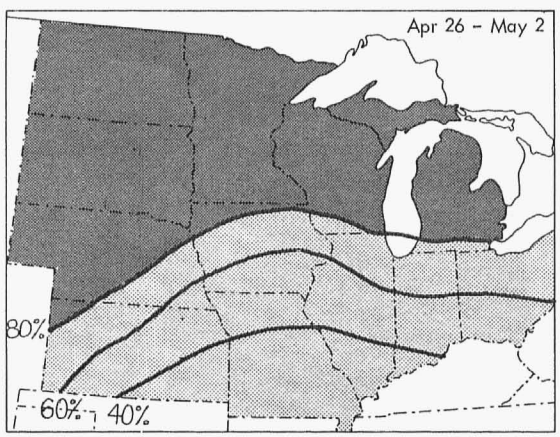
Runs of 5 or More Days with Minimum Below 50°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

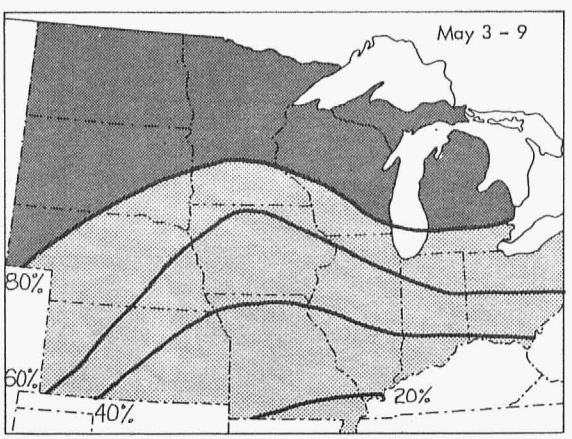


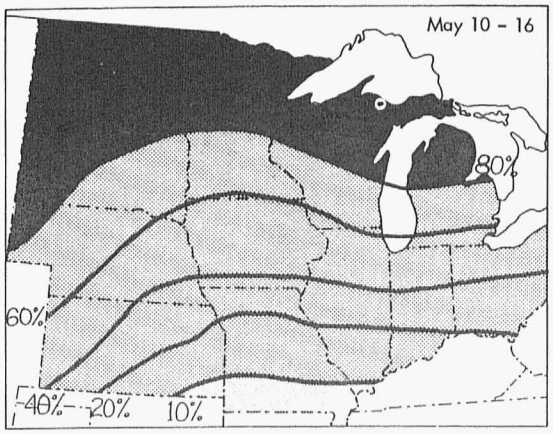


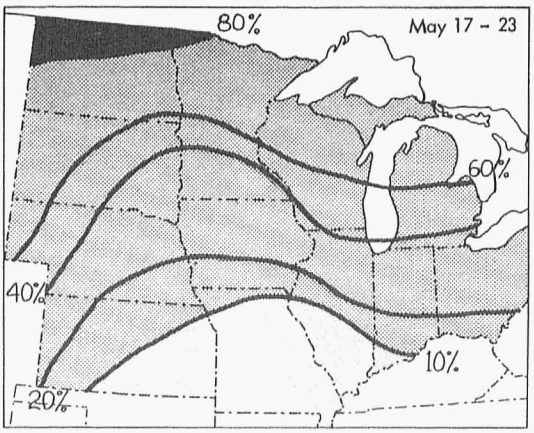


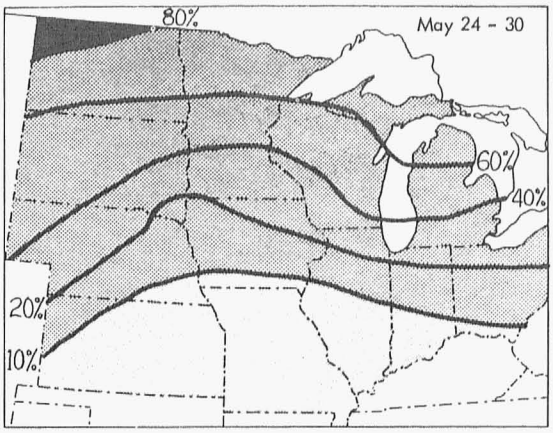


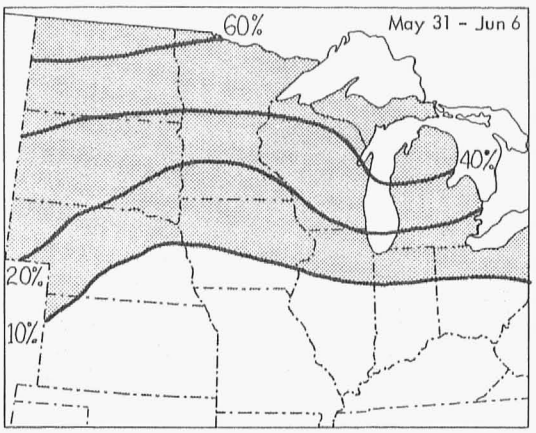


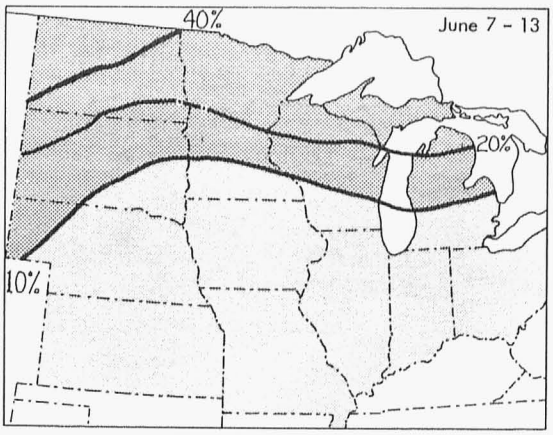


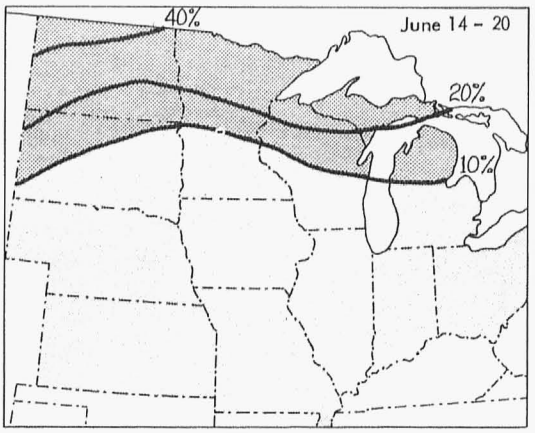

May 10 - 16
80%
60%
40%
20%
10%

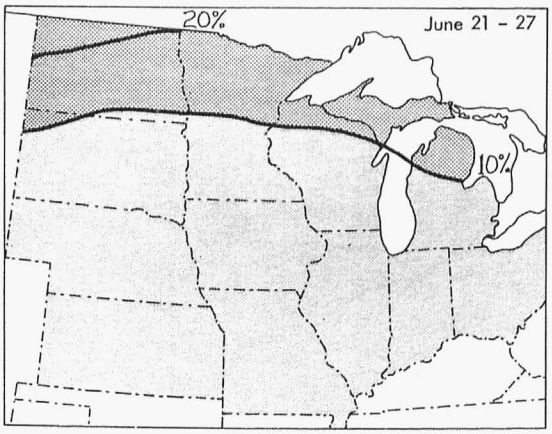

May 17 - 23
80%
60%
40%
10%
20%

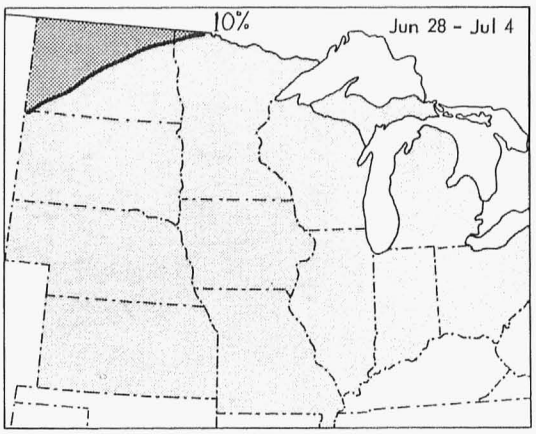

May 24 - 30
80%
60%
40%
20%
10%

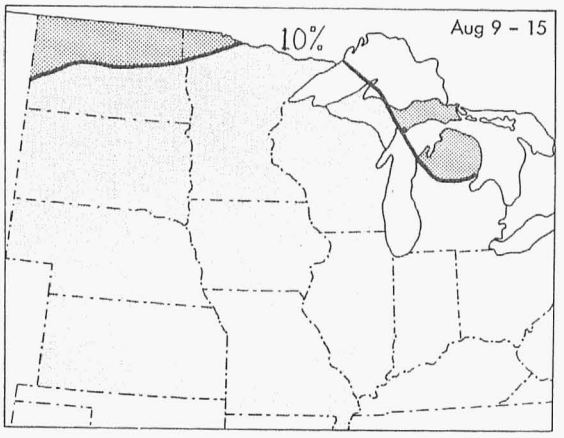

May 31 - Jun 6
60%
40%
20%
10%

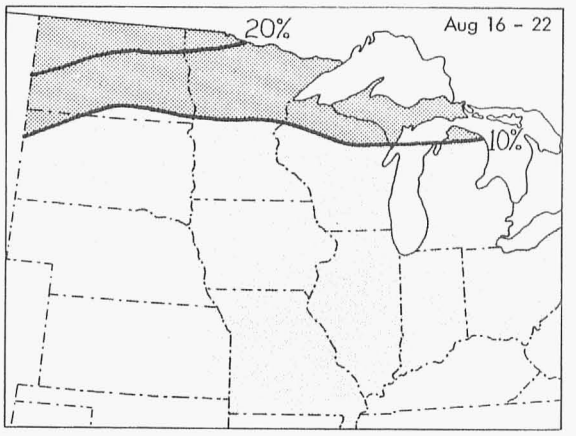

June 7 - 13
40%
20%
10%

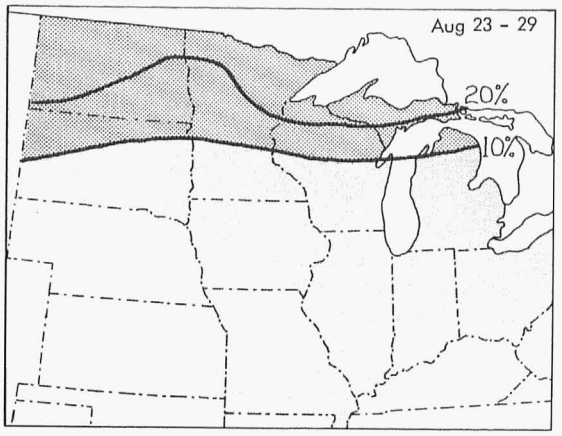

June 14 - 20
40%
20%
10%

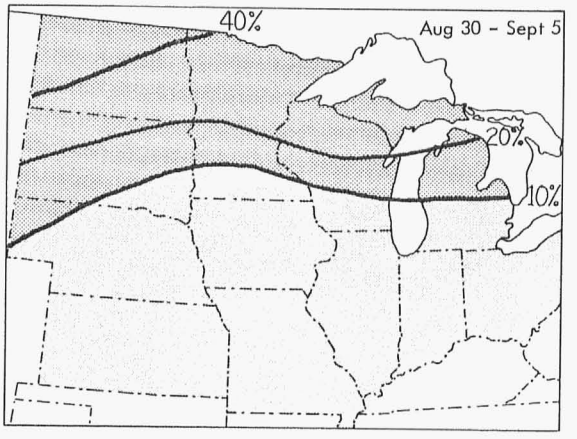

June 21 - 27
20%
10%

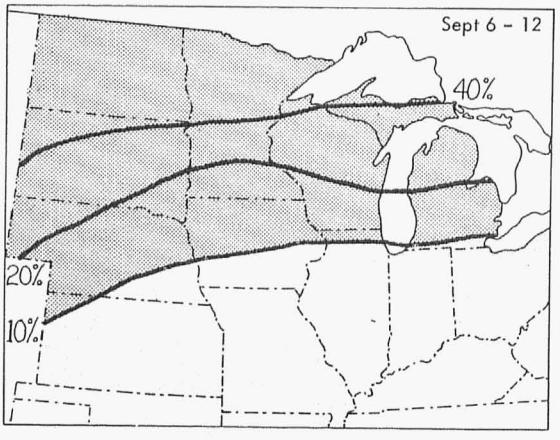

Jun 28 - Jul 4
10%

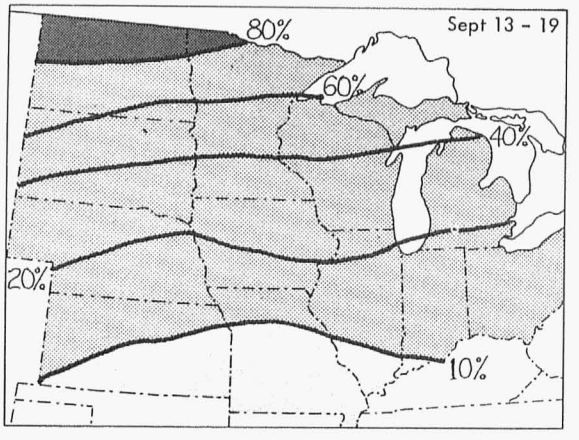

Aug 9 - 15
10%

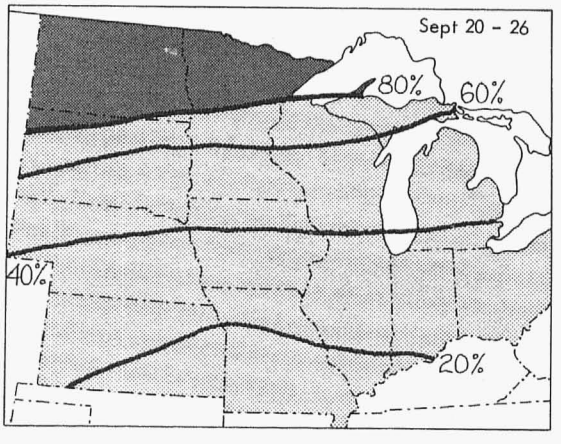

Aug 16 - 22
20%
10%

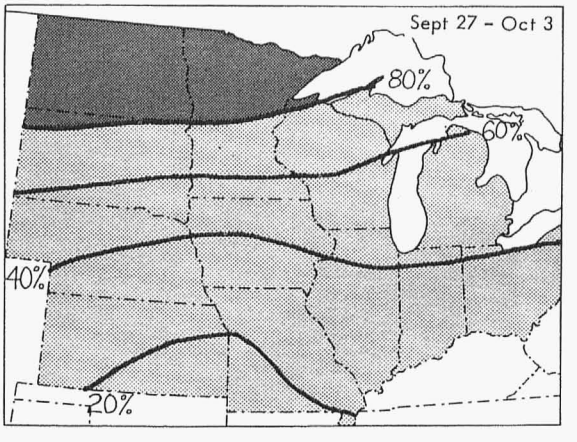

Aug 23 - 29
20%
10%

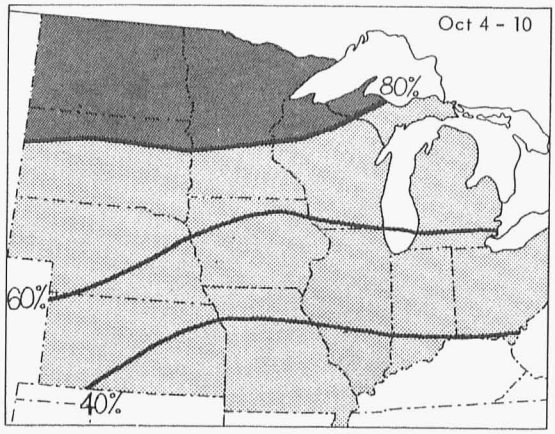

Aug 30 - Sept 5
40%
20%
10%

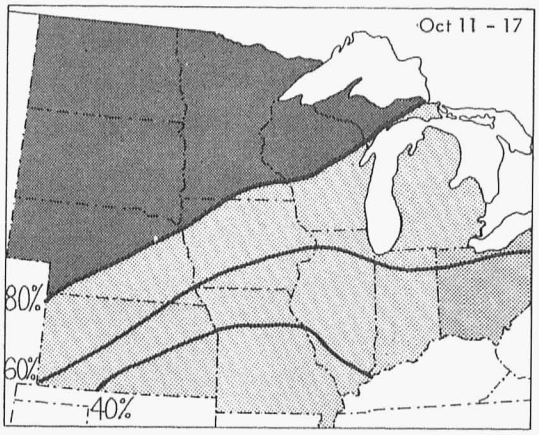

Sept 6 - 12
40%
20%
10%

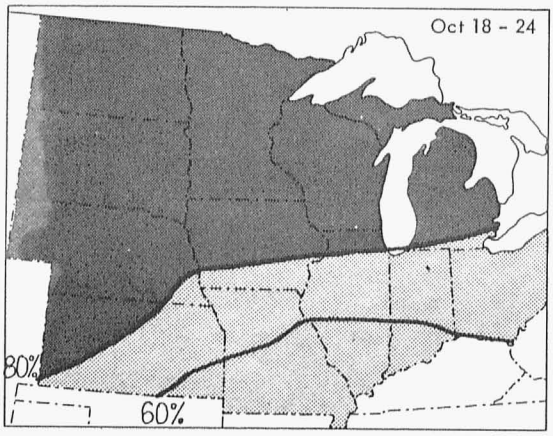

Sept 13 - 19
80%
60%
40%
20%
10%

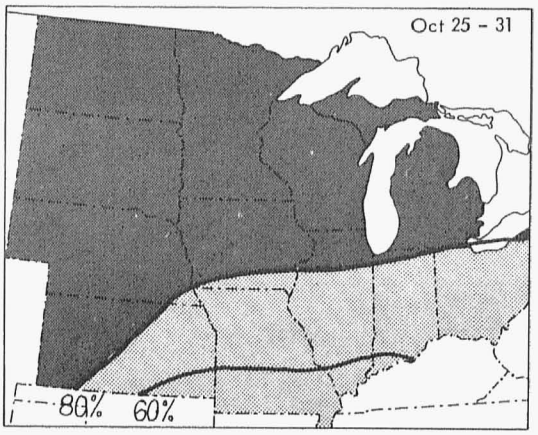

Sept 20 - 26
80%
60%
40%
20%

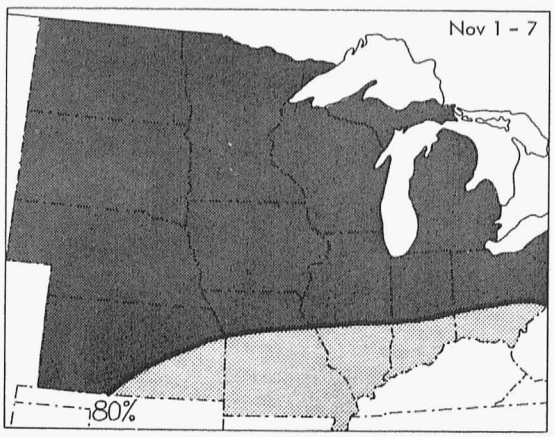

Sept 27 - Oct 3
80%
60%
40%
20%

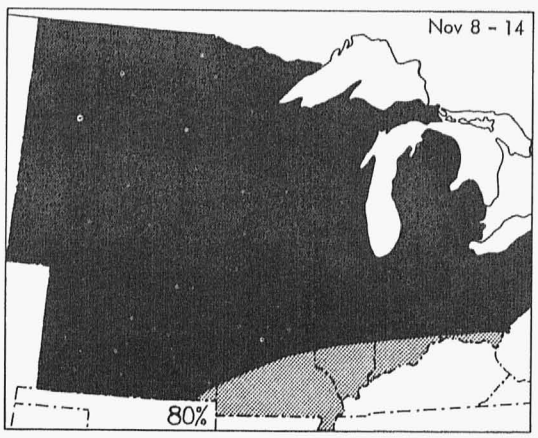

Oct 4 - 10
80%
60%
40%

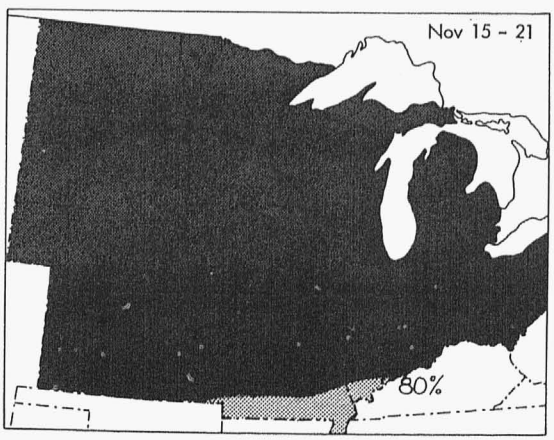

Oct 11 - 17
80%
60%
40%

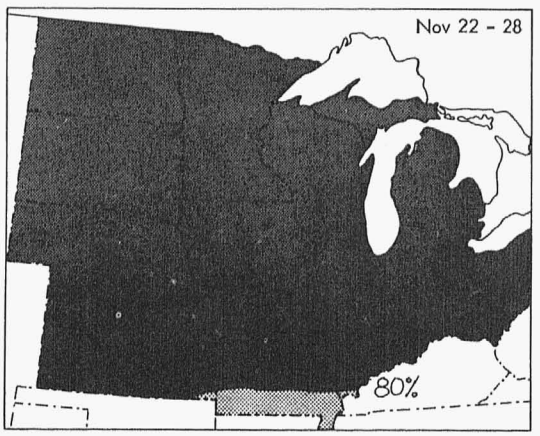

Oct 18 - 24
80%
60%


Oct 25 - 31
80%
60%

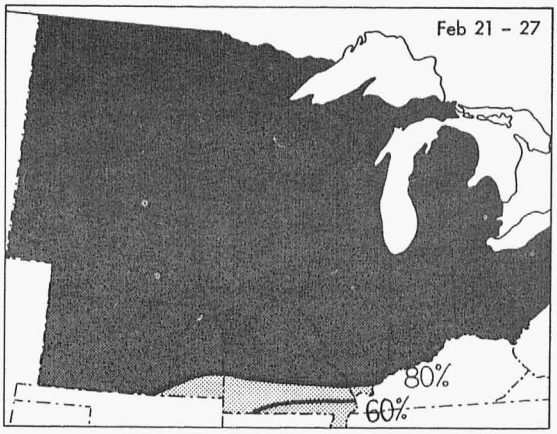

Nov 1 - 7
80%

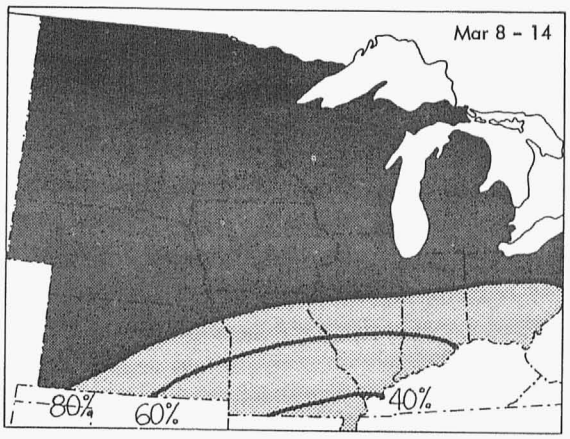

Nov 8 - 14
80%

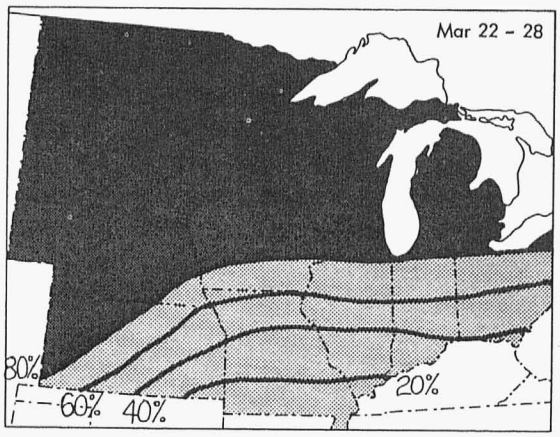

Nov 15 - 21
80%

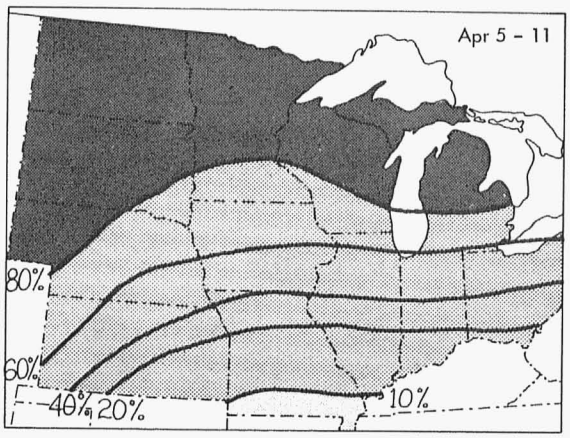

Nov 22 - 28
80%

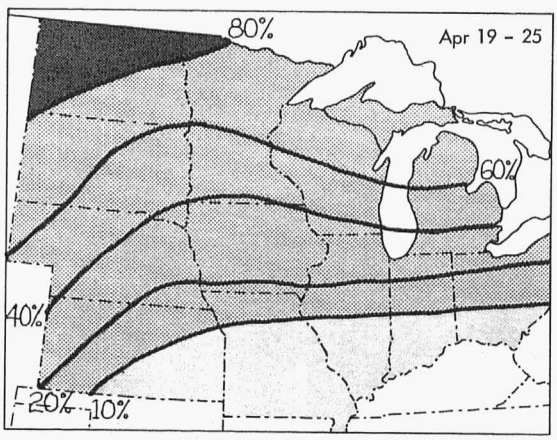
Runs of 15 or More Days with Minimum Below 50°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

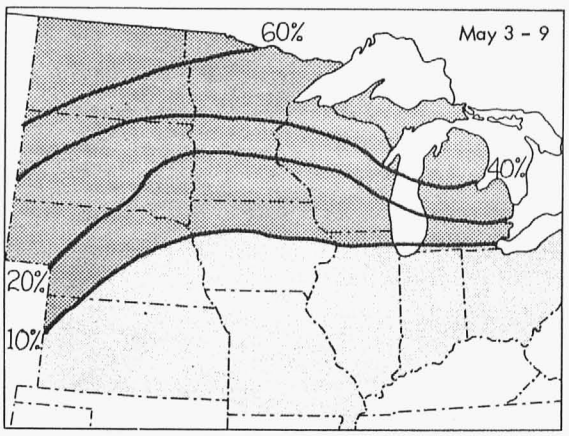


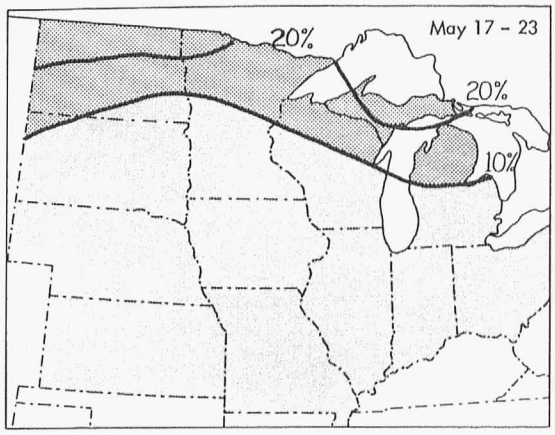


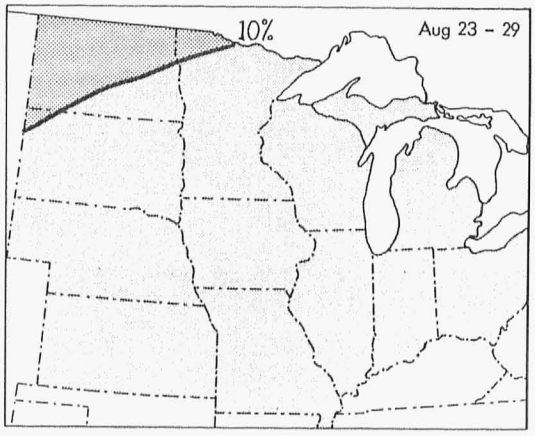


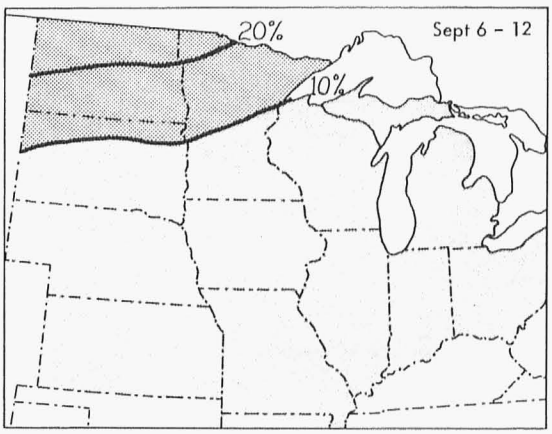


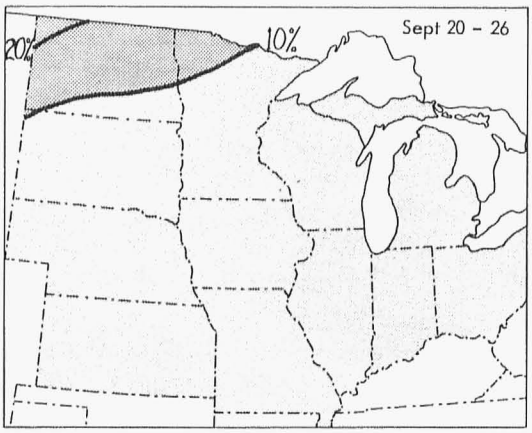


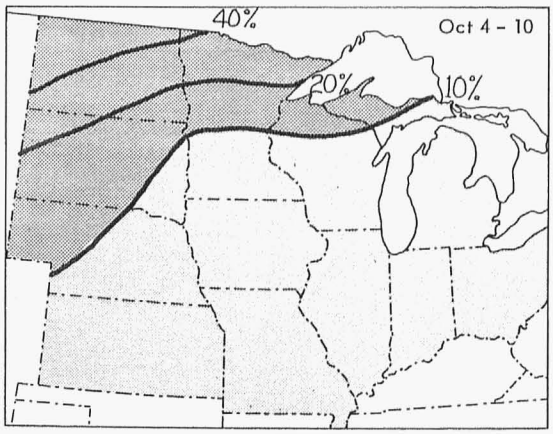


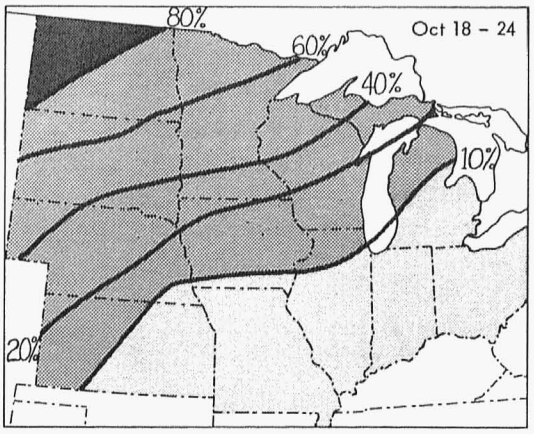

May 17 - 23
20%
20%
10%

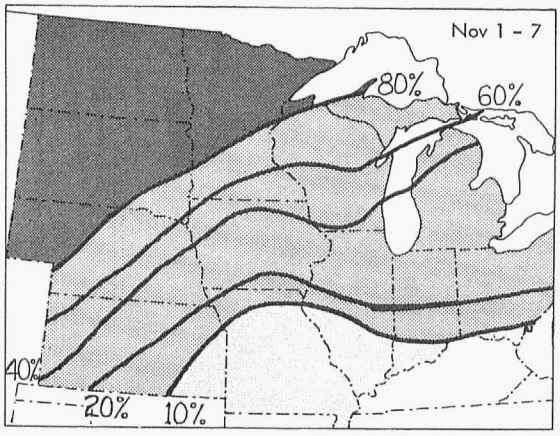

Aug 23 - 29
10%

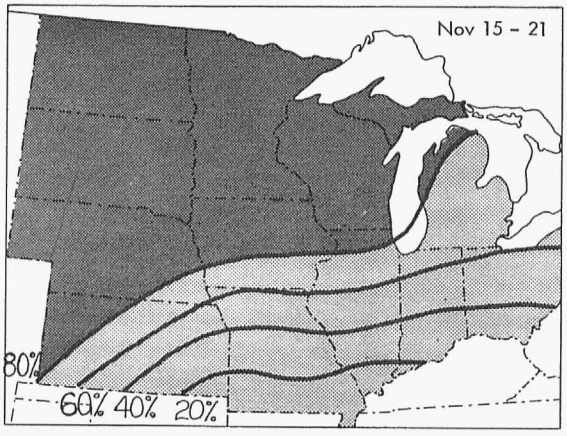

Sept 6 - 12
20%
10%

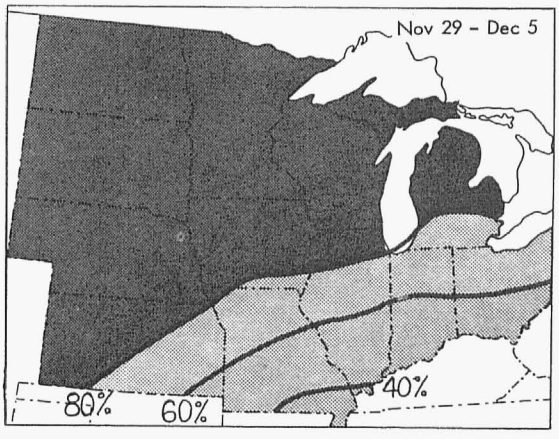

Sept 20 - 26
10%

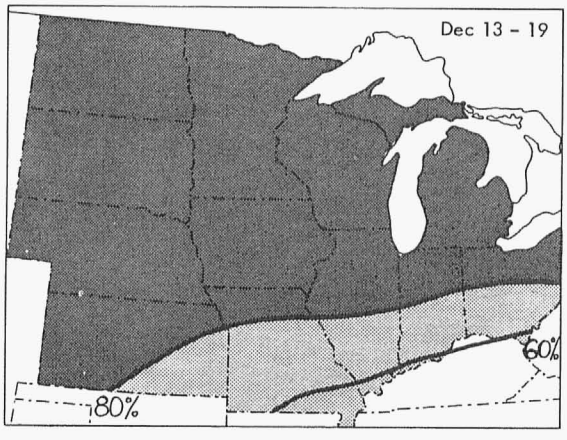

Oct 4 - 10
40%
20%
10%


Oct 18 - 24
80%
60%
40%
10%

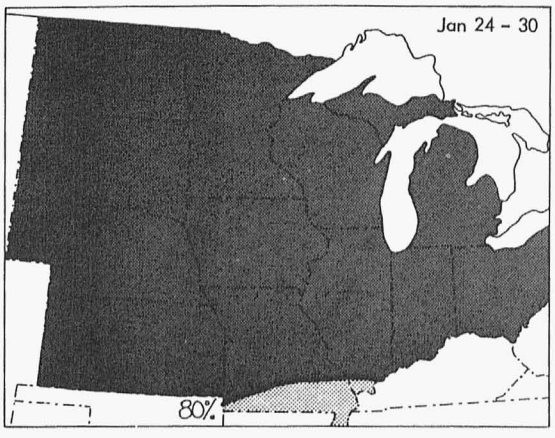

Nov 1 - 7
80%
60%
40%
20%
10%

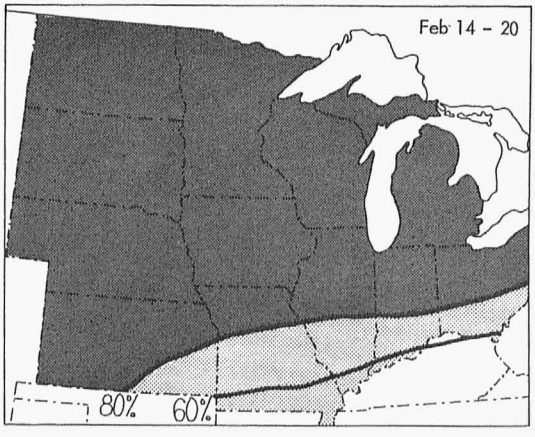

Nov 15 - 21
80%
60%
40%
20%

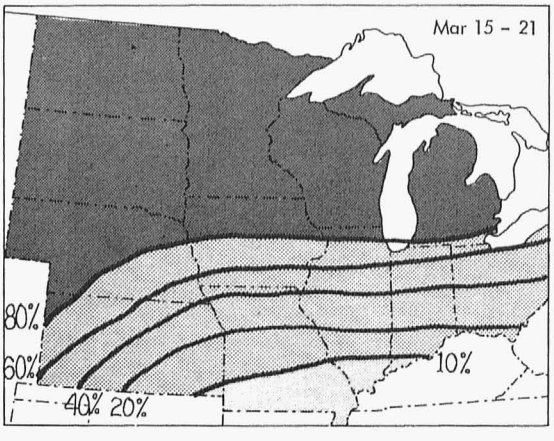

Nov 29 - Dec 5
80%
60%
40%

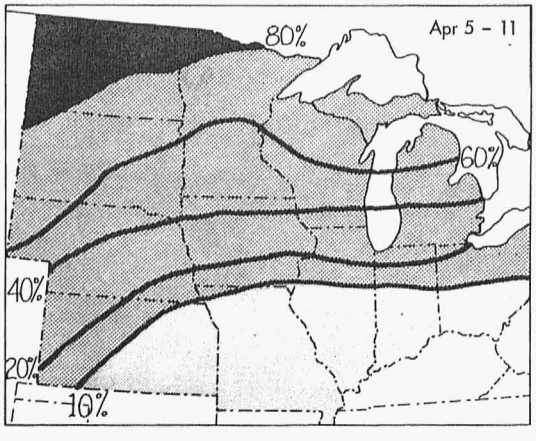

Dec 13 - 19
80%
60%

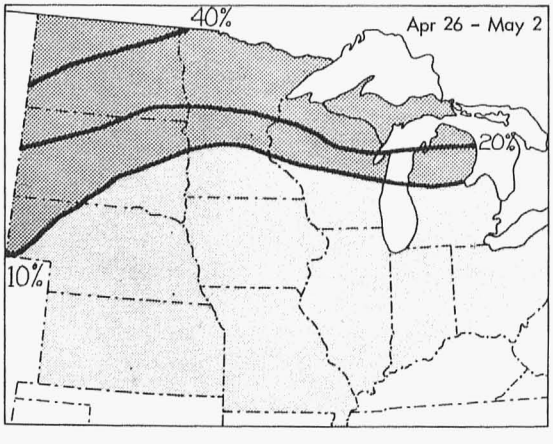
Runs of 25 or More Days with Minimum Below 50°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

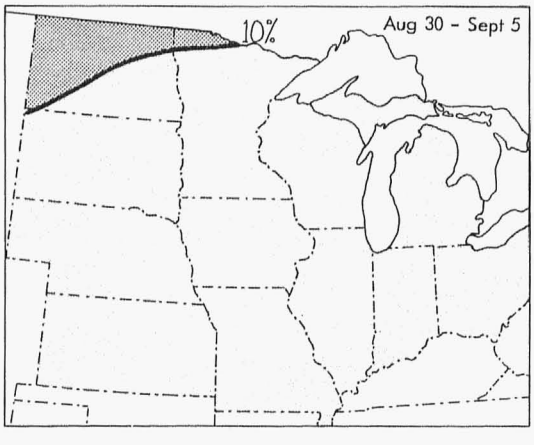


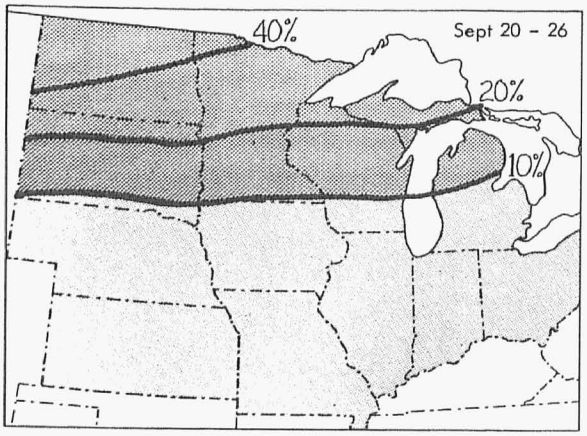


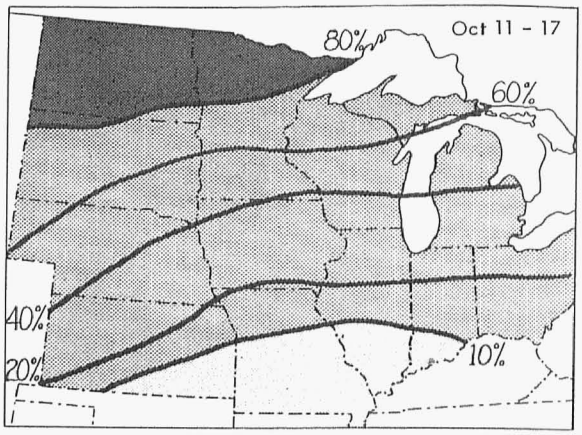


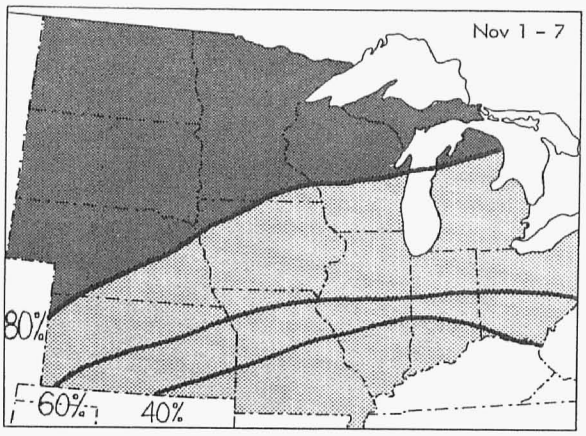


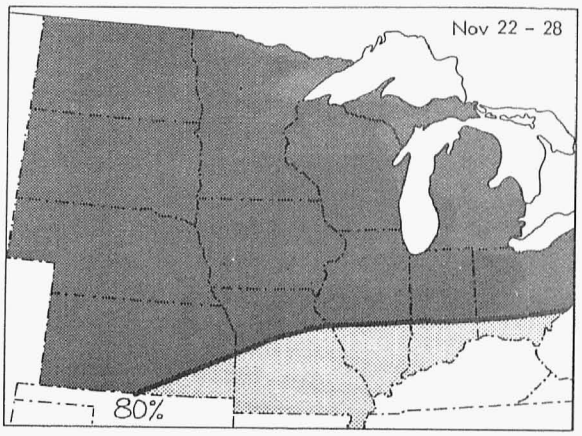


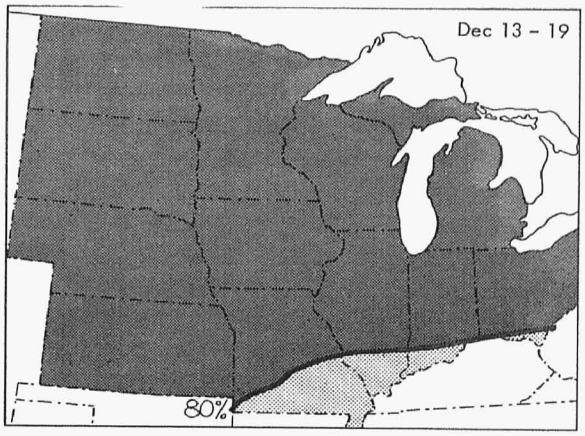



Sept 20 - 26
40%
20%
10%

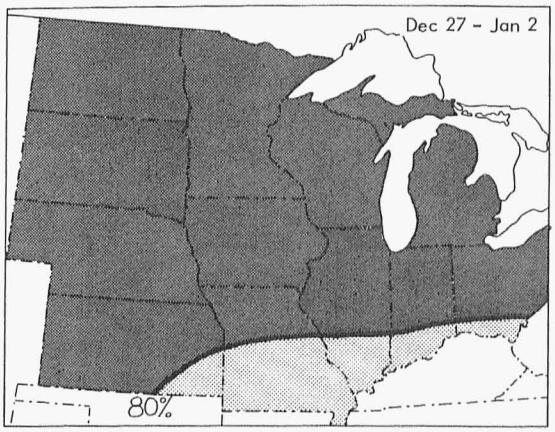

Oct 11 - 17
80%
60%
40%
20%
10%

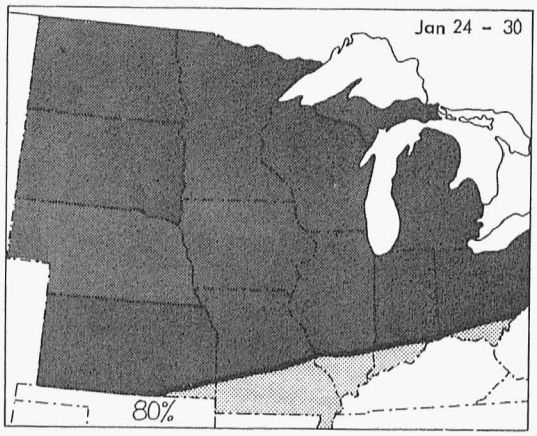

Nov 1 - 7
80%
60%
40%

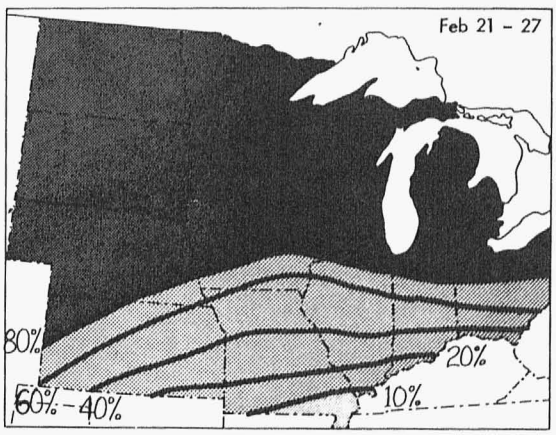

Nov 22 - 28
80%

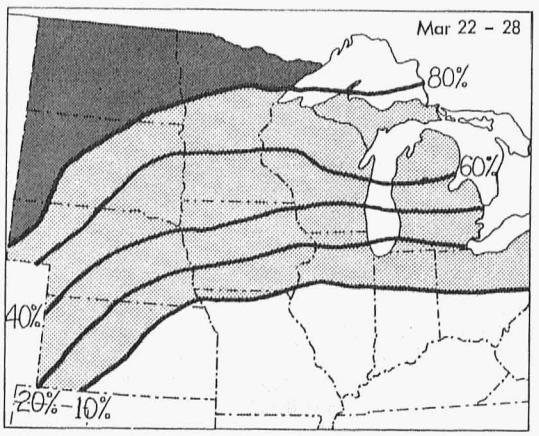

Dec 13 - 19
80%

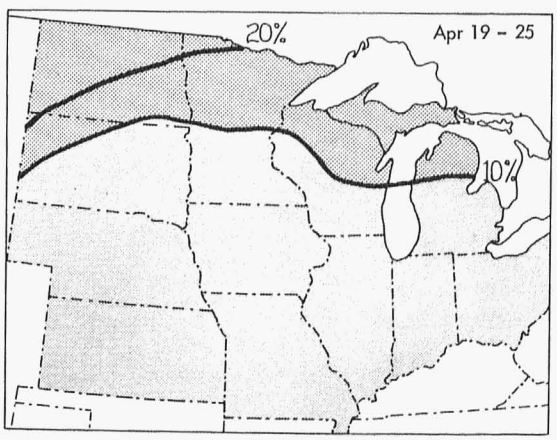
Runs of 35 or More Days with Minimum Below 50°F. Each Map Presents the Percentage of Years Having Such Periods Begin During the Week Indicated.

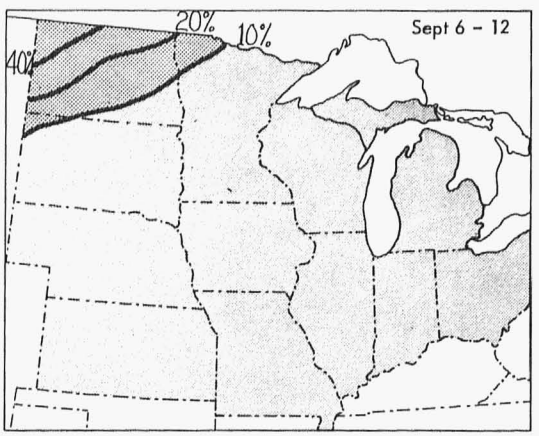


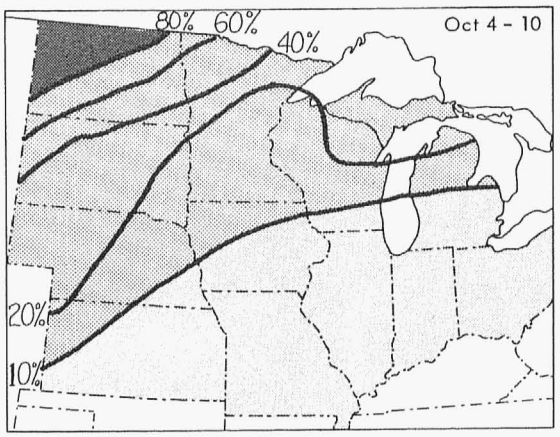


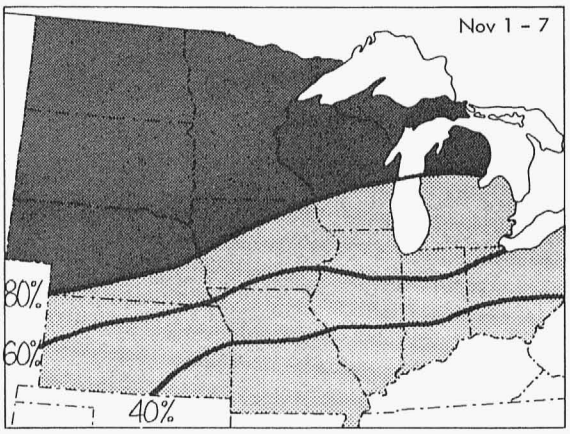


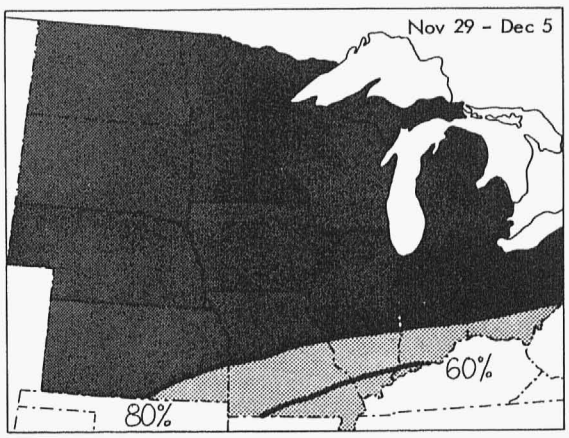












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2. Environmental Data Service, *Climates of the States,* Climatography of the U.S. No. 60, Environmental Sciences Services Administration, 1959.
3. Environmental Data Service, *Climatic Maps of the U.S., Mean Date of Last 32°F. Temperature in Autumn.* Environmental Science Services Administration, 1966.