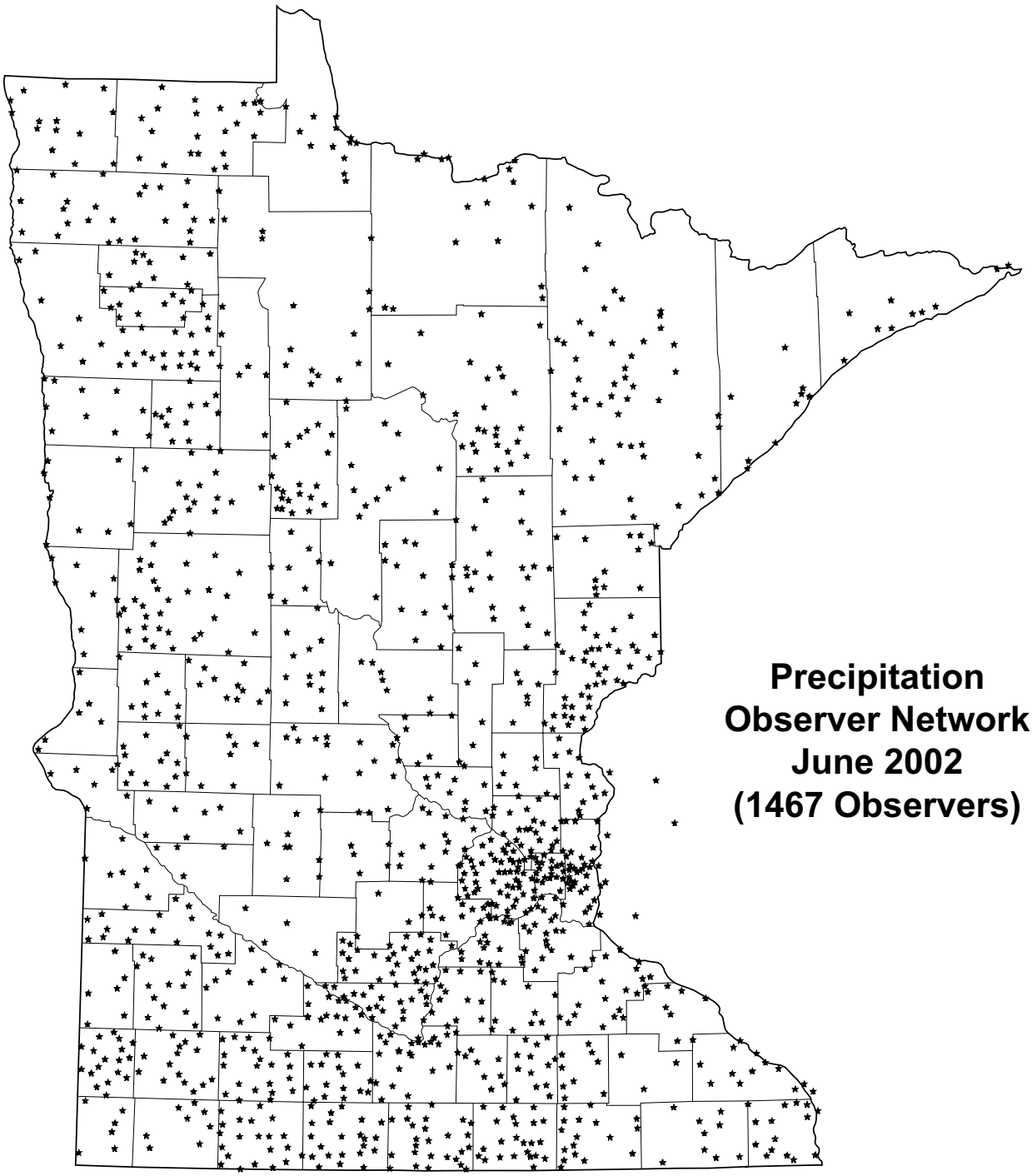
chapter one
climatology



Precipitation Observer Network June 2002 (1467 Observers)

Introduction

The DNR Waters State Climatology Office exists to gather and analyze climate data for the benefit of the State of Minnesota and its citizens. A variety of organizations provide climate data. These organizations rely primarily on the efforts of volunteer observers. The data are consolidated into a unified database and climate information is distributed to many users.

A review of climate information can assist in explaining a prior event or condition. Climate information aids long-range planning efforts by characterizing what is typical or extreme, likely or unlikely. Users of climate information include government agencies (local, state, federal), academic institutions, media, private sector professionals and the general public. Specifically, engineers use temperature and precipitation data to design roads and storm sewers. Wildlife managers use temperature and snow depth information to research animal health and mortality. Agricultural specialists use temperature and precipitation data to determine the types of crops that will grow in Minnesota. Others who rely on climate information include hydrologists, foresters, meteorologists, attorneys, insurance adjusters, journalists and recreation managers.

Climate Data Sources:

Soil and Water Conservation Districts
National Weather Service
University of Minnesota
Department of Natural Resources
- *– Division of Forestry*
- *– Division of Parks*
- *– Division of Trails and Waterways*

State Climatology Office Back Yard Network
Metropolitan Mosquito Control District
Minnesota Association of Watershed Districts
Metropolitan Waste Control Commission
Minnesota Power and Light Company
Emergency Management Offices
County Environmental Services

"Normal"

The word *'normal'* in this chapter refers to a 30-year mathematical average of measurements made over the period 1971-2000. Many individuals tend to (erroneously) perceive 'normal' weather as what they should expect. Dr. Helmut E. Landsberg, former Director of Climatology for the U.S. Weather Bureau, summarized this misconception as follows: "The layman is often misled by the word. In his every-day language, the word 'normal' means something ordinary or frequent … When (the meteorologist) talks about 'normal,' it has nothing to do with a common event … For the meteorologist, the 'normal' is simply a point of departure or index which is convenient for keeping track of weather statistics."

Water Year 2001

October 1, 2000 – September 30, 2001

Highlights

- Wet November 2000
- Cold December 2000
- Snowy Winter 2000-2001
- Near-record Mississippi River Flooding, April 2001
- Extraordinarily Wet Spring 2001
- Very Dry Mid- to Late-Summer 2001

Winter 2000-2001

Mid-November and late-November 2000 storms covered much of Minnesota with snow that lasted the entire winter. December accumulation in some southern counties was over two feet; two and even three times the historical average. By month's end, the entire state was covered by at least eight inches of snow. December temperatures were extremely cold, averaging 10 degrees below normal statewide. It was the coldest December since 1985 and one of the coldest Decembers ever. Minimum temperature records were set on the December 12, 22, 24 and 25.

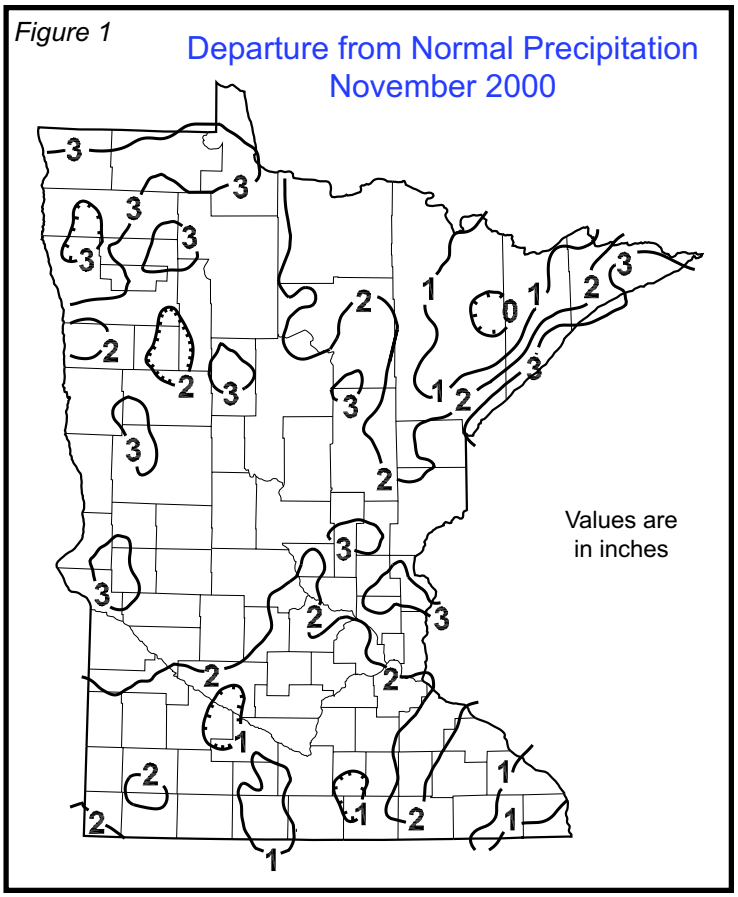
Autumn 2000

October 2000 precipitation was below normal with deficits of up to one inch in most communities. October temperatures were two to five degrees above normal. A cold snap on October 8-9 was counterbalanced by record high temperatures on October 19.

Above-normal November rainfalls (Figure 1) brought relief to much of the state that was affected by significant precipitation deficits of the previous 15 months. However, precipitation totals over southwestern, central, east central and northeastern Minnesota remained four to seven inches below normal for the calendar year. In contrast, the November rains also fell over northwestern Minnesota, a region already wet from late summer and autumn rains. In many northwestern counties, streams were at or above bank full and crop harvesting conditions were poor.

November temperatures ranged from one to five degrees below normal in the southern two-thirds of Minnesota and from one to three degrees above normal in the northern third of the state. For only the third time in recorded history, Minnesota experienced a November tornado. On November 1, a tornado damaged power lines and outbuildings in Kandiyohi County.

Figure 1



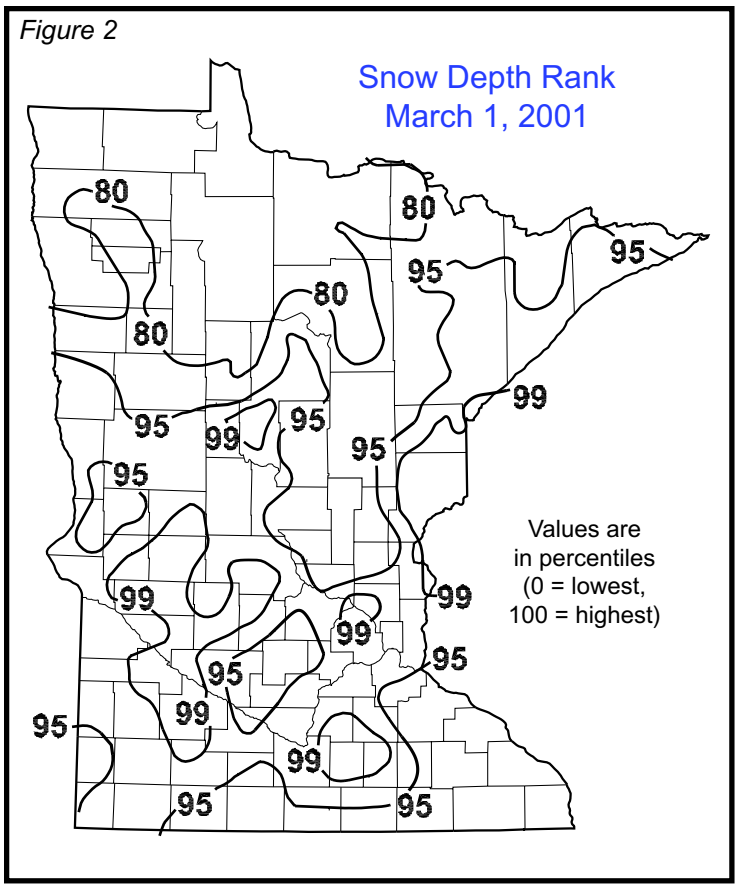
January 2001 precipitation was near to above normal across the southern two-thirds of Minnesota and below normal in the northern third of the state. January temperatures were mild and averaged six to 12 degrees above normal across Minnesota. However, temperatures remained cold enough to retain most of the snow cover accumulated during November and December. Snow depths exceeded 12 inches across large areas of Minnesota at the end of January.

February precipitation was two or three times the historical normal during this typically dry month. Much of the February precipitation fell during the weekend of February 23-25. Snowfall totals in excess of 12 inches were reported in west central and central Minnesota and approached 24 inches in portions of Minnesota's Arrowhead region. February temperatures were cold, at four to eight degrees below normal. It was the coldest February since 1994 and, for some communities, the coldest February since 1989.

March snow depths in the southern two-thirds of Minnesota ranked above the 95th percentile and were above the 60th percentile in the northern third of the state. In some areas of west-central and southwestern Minnesota, snow depths were at or near all-time record values for the date (Figure 2). Snow water equivalent data gathered by the National Weather Service and the Army Corps of Engineers revealed that the snow pack across the state generally contained three to six inches of water as of March 6. While March precipitation totals were about one inch below normal, much of the month's precipitation fell during a single storm of six to 10 inches of wet, heavy snow across southern, central and northeastern Minnesota. March temperatures were near normal in the northern third of Minnesota, but finished three to six degrees below normal elsewhere. Late winter snows and near-normal to below-normal temperatures caused snow cover to persist into early April in most areas.

The 2000-2001 winter season snowfall totals exceeded 60 inches throughout the west and south and were in excess of 72 inches in the northeast. Snowfall totals ranked above the 80th percentile across much of southern, western and northeastern Minnesota and, in some communities, exceeded the 95th percentile (Figure 3). In contrast, snowfall in areas of far north central Minnesota fell well below the median.

Figure 2



Spring 2001

April 2001 river levels approached floods of record in many locations as a result of four contributing climatic factors:

1. significant autumn precipitation (heavy early November rains before soil freeze-up);
2. heavy winter snowfall (18 to 24 inches above average in many southern Minnesota locations);
3. less than ideal snowmelt scenario (below-normal March temperatures);
4. record-breaking April precipitation.

April precipitation totals were extraordinarily high across most of the state. Parts of southwestern, central, east central and northeastern Minnesota received over six inches of precipitation from April 1 to April 23, surpassing normal by more than four inches in these areas (Figure 4). Three storm sequences (April 6-7, April 10-11 and April 21-23) accounted for most of the precipitation. During the later stages of the April 21-23 event, up to a foot of snow fell in a 100-mile wide band from Browns Valley into northeastern Minnesota.

April temperatures were near normal across much of the state, but finished nearly three degrees above normal in south central and southeastern locations. Lake ice-out in the southern three-fourths of Minnesota occurred one to two weeks later than historical averages, and close to historical averages in the far north. These conditions were notably in contrast to the early lake ice-out in the spring of 2000.

May precipitation totals were normal in some areas, while the remainder of the state was one to two inches above normal for the month. The precipitation was not only heavy in some areas, but also unusually persistent. A very slow-moving storm system brought daily rains to some locations for eight consecutive days (May 19-26). Compared with historical data, April-May precipitation totals ranked near all-time record high values for much of Minnesota (Figure 5). Field preparation, spring planting and early crop growth was far behind historical averages due to wet soil across the state. May temperatures were near to slightly above normal across most of Minnesota, but ranged from record highs at some locations on May 15 to record lows on May 22 and 23.

Figure 3

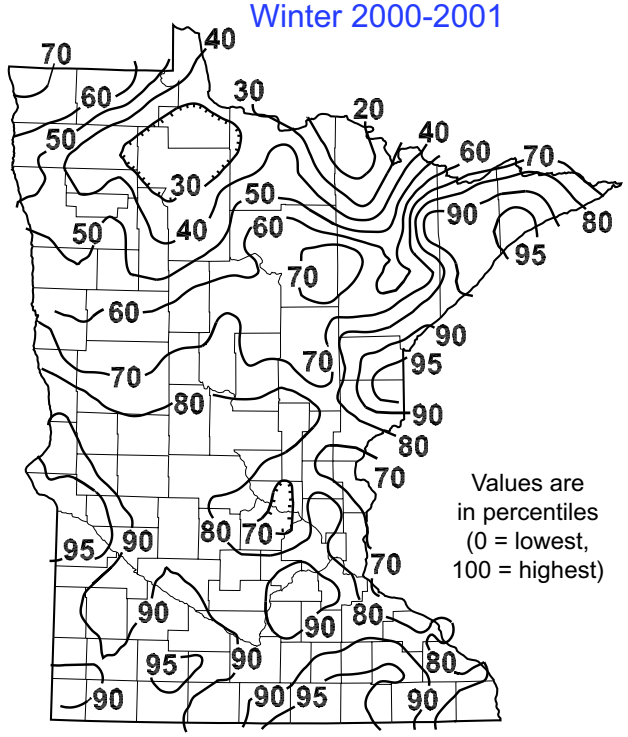
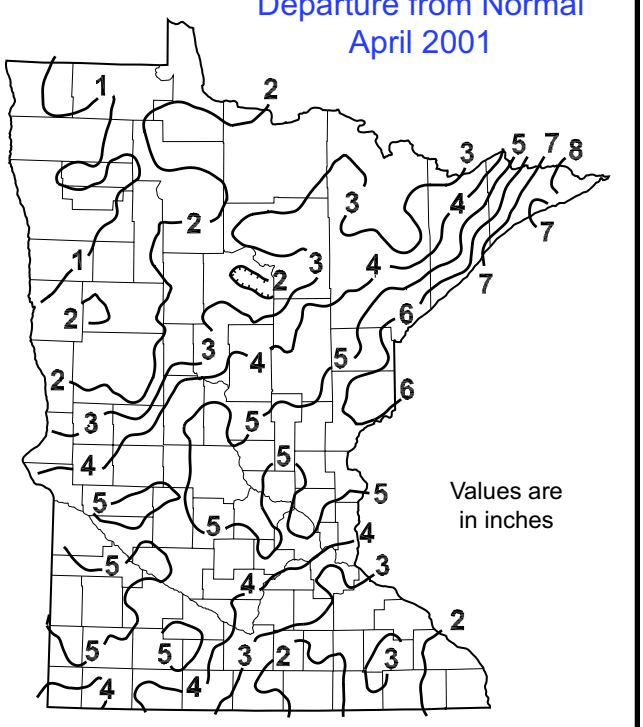


Figure 4



Summer 2001

June 2001 precipitation totals varied widely across Minnesota. Some areas reported above-normal amounts while the northern third of the state was as much as one inch below normal. Most measureable rainfall came from a sequence of storms that occurred on June 11-14, with cumulative totals of over four inches in many areas. Tornadoes, severe thunderstorm winds and hail accompanied the storms and caused significant damage. Precipitation totals were generally light for the final two weeks of the month. Overall, June temperatures finished very close to historical averages, but were the result of very warm, month-ending temperatures, which counterbalanced cool weather early in the month.

Continuing a dry spell that commenced during the second half of June, July precipitation totals were generally below average across most of Minnesota and fell short of historical averages by one to two inches. For the four-week period of June 19-July 16, precipitation totals were less than half of normal and shortfalls developed in areas of central and southeastern Minnesota. The exception to general July dryness was in far northern Minnesota, where thunderstorms occurred in mid-July and again on July 31. A band of two to six inches of rain was reported from Kittson County east to Cook County in late July. The heaviest amounts fell in portions of Lake of the Woods, Beltrami and Koochiching Counties, where five-inch totals were common. Precipitation totals were near or above all-time records for the April through early-August period in parts of north central and northeastern Minnesota. July average temperatures were slightly above historical normals, but were the result of very warm mid-month and late-month temperatures offsetting cool early-month weather. Most of Minnesota experienced significant episodes of extreme heat and humidity (July 17-18 and July 30-August 1), with temperatures in the 90s, dew points in the upper 70s and heat index values in excess of 100 degrees.

Similar to the second half of June and most of July, August precipitation totals across much of the southern two-thirds of Minnesota were generally short of historical norms by one to two inches. Scattered areas of the northwest and the southeast finished the month with above-normal precipitation, but August was generally dry from a statewide perspective. August average temperatures finished above historical norms by two to three degrees. Most of Minnesota experienced extreme heat and humidity on August 4-8, with temperatures in the 90s, dew points in the upper 70s and heat index values in excess of 100 degrees.

Figure 5

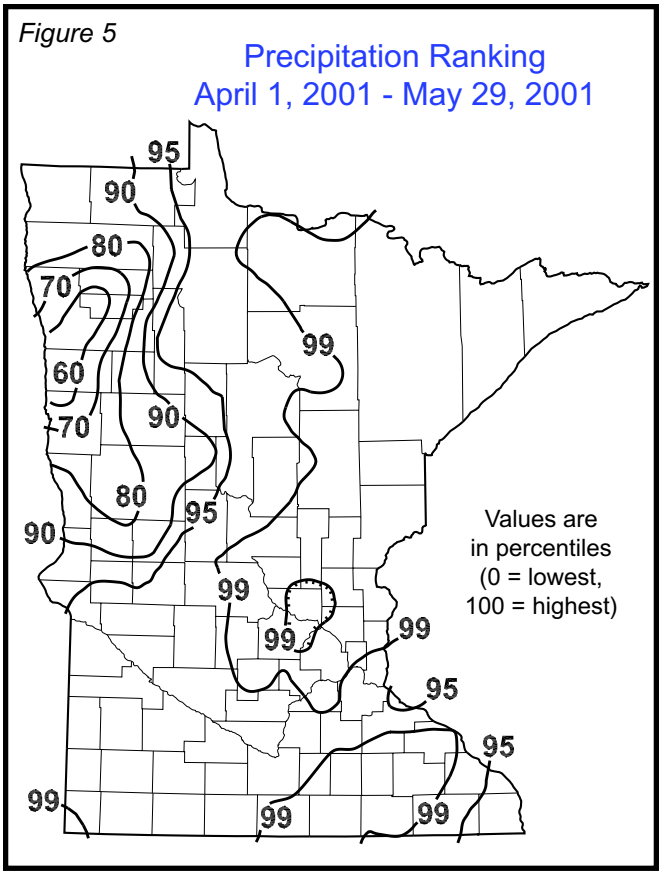
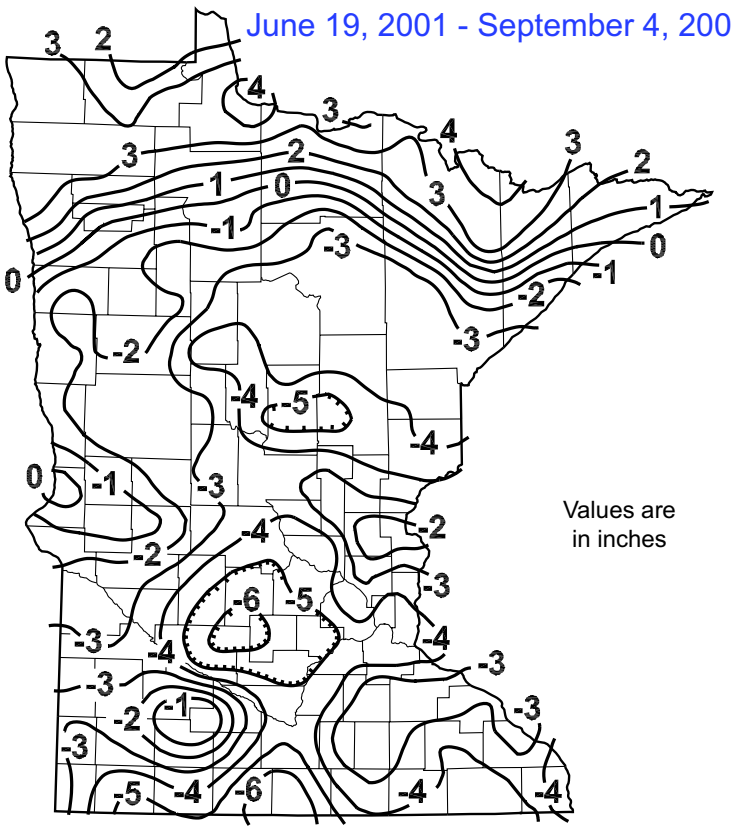


Figure 6



Mid-summer and late-summer rainfall was below historical averages in all areas except far northern Minnesota. During the 11-week period from June 19 through September 4, rainfall deficits were two to four inches in many areas and four to six inches in others (Figure 6). The dryness was especially acute in areas of central and southwestern Minnesota, where precipitation totals ranked below the 5th percentile compared to historical records for the period. Mid-to late-summer precipitation across most of the northern tier of counties was adequate to abundant, in some cases ranking above the 90th percentile for the period.

September 2001 precipitation patterns were highly variable, ranging from above average in northwestern and west central Minnesota, to as much as two inches below normal in the south central and northeast areas. Elsewhere across the state, September precipitation was close to the long-term mean. September average temperatures finished near historical averages statewide. Record warm temperatures early in the month were counterbalanced by cool mid- and late-September weather.

Water Year 2001

The 2001 Water Year (October, 2000-September, 2001) precipitation totals were above normal across all of Minnesota and exceeded the norm by eight or more inches in some areas (Figure 7). Precipitation totals ranged from less than 24 inches in portions of the northwest to more than 40 inches in the far northeast (Figure 8).

Figure 7

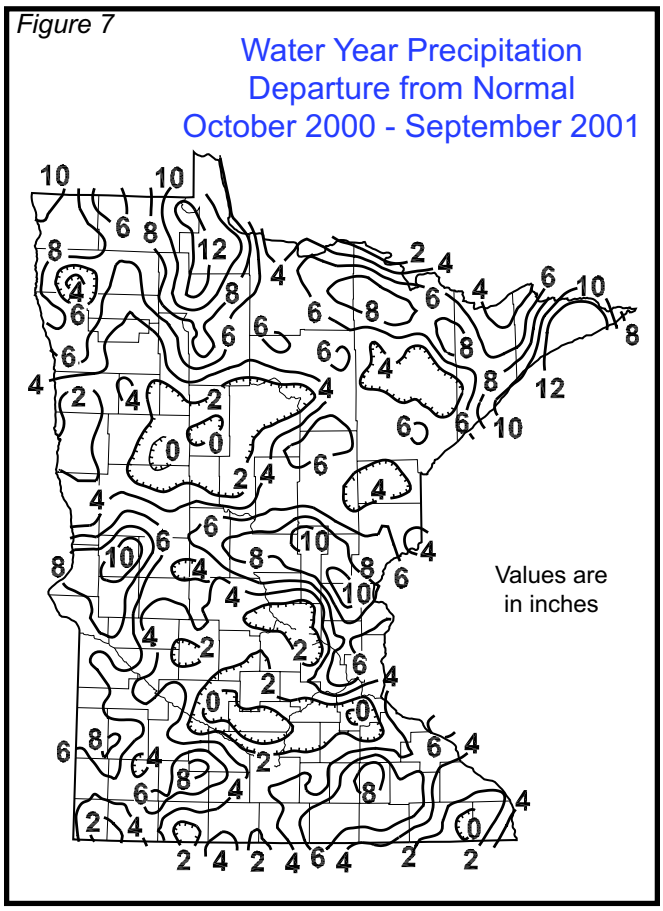
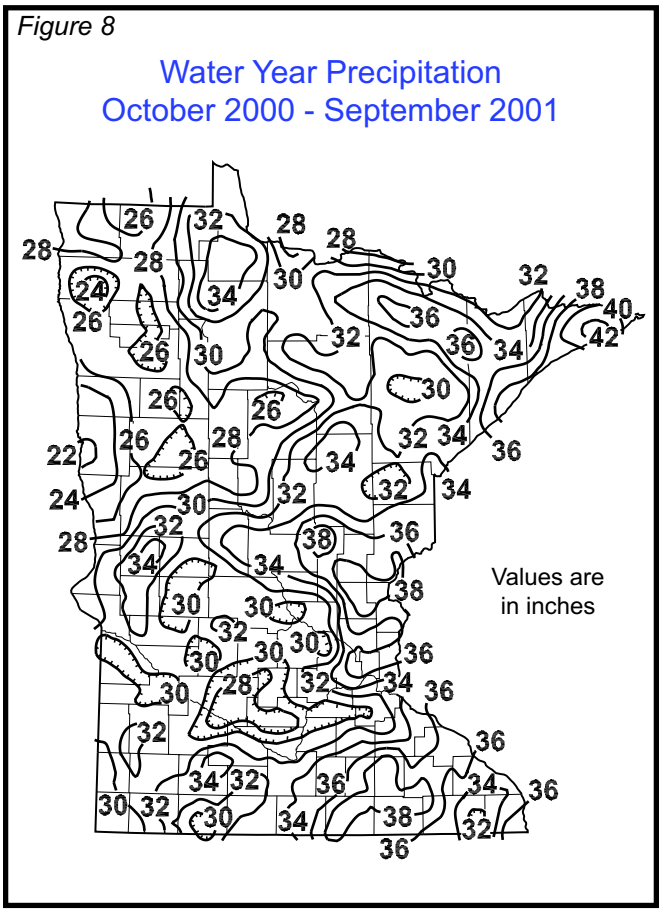


Figure 8



Water Year 2002

October 1, 2001 – September 30, 2002

Highlights

- Heavy, Late November 2001 Precipitation
- Warm November 2001 through February 2002
- Snow-Scarce December 2001 through February 2002
- Cold and Snowy Late Winter 2002
- Record-Breaking Rainfall June 2002
- Extraordinarily Wet Summer 2002

Autumn 2001

October 2001 precipitation was highly variable across Minnesota. The northern third of the state was somewhat average, whereas the remainder of the state fell short of normal by about one inch. The first blizzard conditions and heavy snow of the season occurred on October 24-25, setting records in many northwestern locations. The City of Argyle in Marshall County received 14 inches, while four inches was common across the northern half of the state. October temperatures were close to the historical norms but featured wide fluctuations, with record or near-record highs early in the month, followed by very chilly weather.

Dry autumn weather led to an expanded area of moisture deficits in southwestern, central and east central Minnesota. Lake levels dropped significantly in many areas from record or near-record elevations reported earlier in 2001. Unusually warm early November temperatures, a lack of rainfall and strong winds led to significant wildfires in central Minnesota.

The growing season of 2001 was divided into two very distinctive precipitation regimes. The period from April 1 through the third week of June was extraordinarily wet, ranking among the wettest springs on record. During the third week of June, the jet stream abruptly pushed north. The shift in the storm track prevailed into autumn, causing many storm systems to miss the state or to brush only the northern tier of counties. Surface hydrology in central Minnesota, including soil profiles, were maintained during the growing season only by reserves built up during the wet spring.

November precipitation was scarce during the first three weeks of the month. Then, a slow-moving storm system passed through the midwest on November 23-24, dropping one to three inches of rain across a large area of Minnesota. Yet another major storm moved through the region two days later, leaving a blanket of wet, heavy snow. Snowfall totals topped 24 inches in Kandiyohi County and exceeded 12 inches in many southwestern and central Minnesota communities. Heavy late-November rainfall and snowfall brought relief to areas affected by precipitation deficits during the later part of the 2001 growing season. November temperatures averaged nine to 13 degrees above the historical mean across the state and it was Minnesota's warmest November on record. Nearly every community set a monthly temperature record.

Winter 2001-2002

December 2001 precipitation was below normal, although a rare (but not unprecedented) complex of thunderstorms dropped nearly one-half inch of rain on December 5 in southeastern Minnesota. A December 22 snow event deposited two to six inches of snow across much of the state, just in time for the holiday season. Like November, December temperatures were unusually warm, at eight to 11 degrees above normal. Many southern Minnesota communities experienced maximum temperature records on December 5. For the 57-day period, October 28 to December 23, the Twin Cities International Airport reported above-normal average temperatures each day.

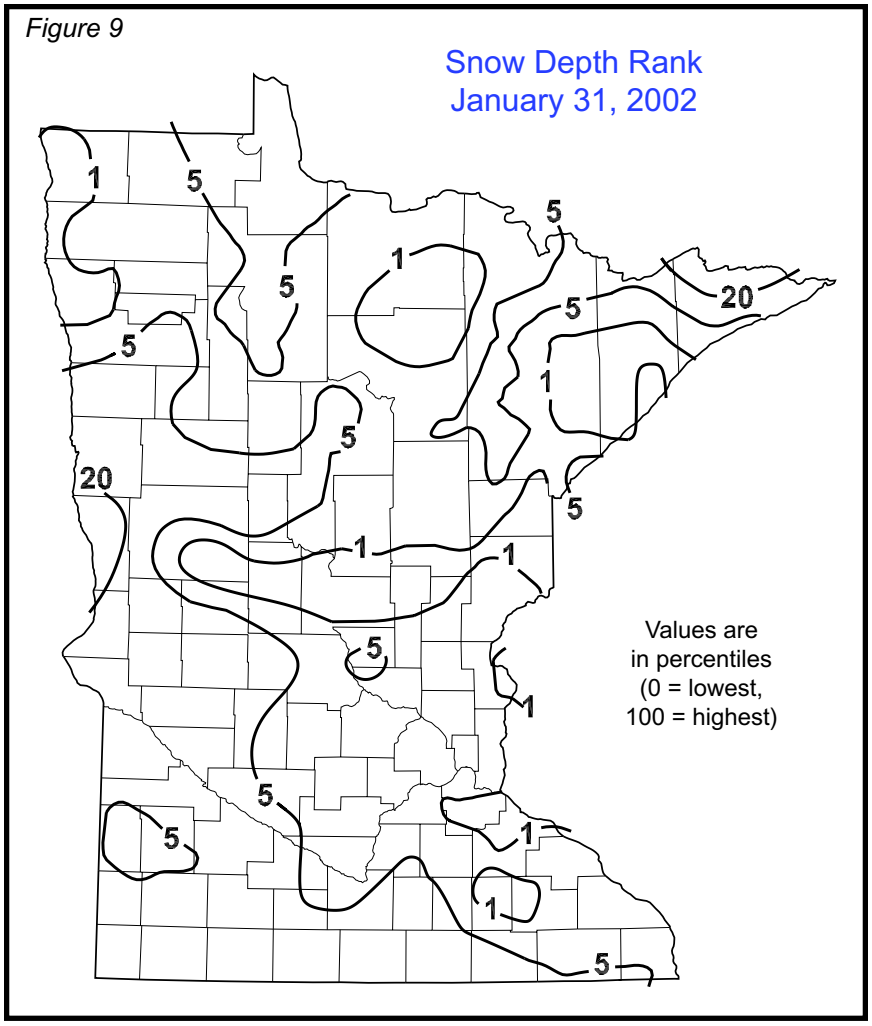
January 2002 precipitation was very light and by late January, snow depths were less than four inches in the southern two-thirds of the state and in the far northwest. The January 31 snow depth ranking map indicated that nearly all of Minnesota ranked below the 20th percentile for the date (Figure 9). Snow depths in many areas were below the 5th percentile and a significant number of locations were at the 1st percentile. January temperatures exceeded normal by nine to 14 degrees in many Minnesota communities, setting maximum temperature records on January 8, 9

and 25. The November 2001 through January 2002 period was the warmest such period for Minnesota by more than two degrees.

February precipitation was generally below normal, although moderate to heavy rains fell on some southeastern communities on February 18-19, with totals ranging from one to two inches. Late February snow depths were less than eight inches and large sections of northwestern and southern Minnesota reported less than two inches. Snow depths ranked below the 20th percentile for the date and, combined with warm temperatures, contributed to unusual February grassland and peat fires. February temperatures were eight to 13 degrees above normal, for Minnesota's fifth warmest February on record. Minnesota experienced the second warmest December through February ("meteorological winter") period in the modern record and some communities reported the warmest meteorological winter in history. For the third time in five years (1997–1998, 1999-2000, 2001-2002), winter temperatures ranked among the warmest on record.

March precipitation was generally normal across much of the state. During the three-day period, March 7-9, two major winter storms dropped heavy snow on central and northeastern Minnesota, and freezing rain fell in the southeast. A third storm, from March 13-15, dropped 15 inches of snow along a 70-mile wide band from Canby to Hinckley, while six or more inches of snow was reported over much of the remainder of the southern two-thirds of the state. In sharp contrast with a winter-long trend of unusually warm weather, March temperatures finished significantly below normal. Temperatures across the state were four to nine degrees below the historical average. The March mean temperature was colder than any of the preceding winter months in many communities.

Figure 9



Spring 2002

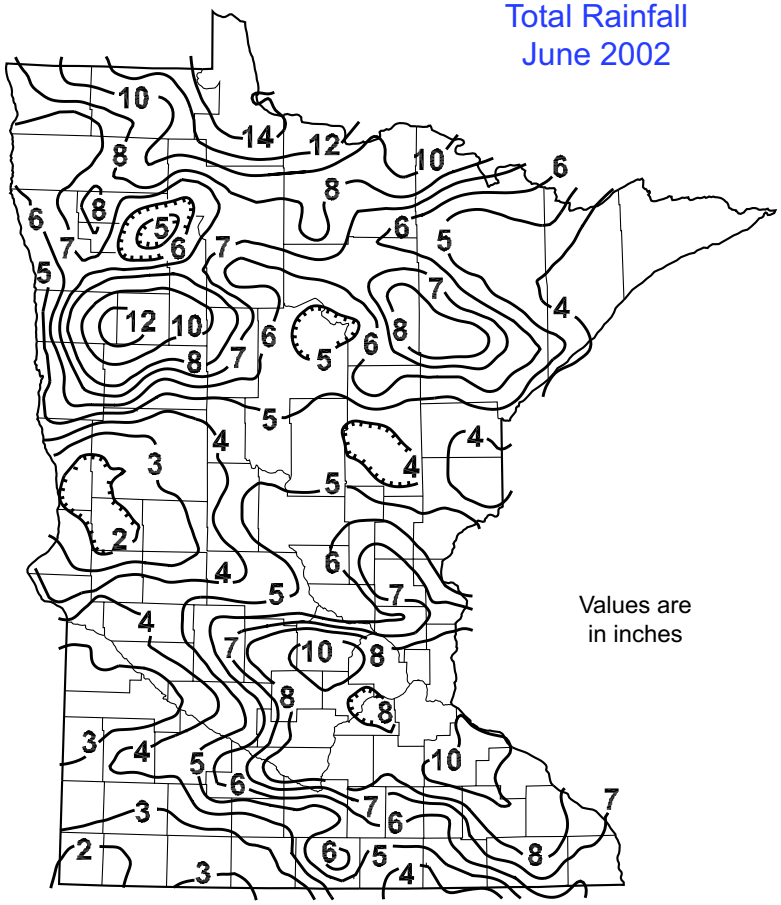
April 2002 precipitation varied widely, although total amounts were either slightly above or slightly below normal. Precipitation fell in many forms, including snowstorms on April 1, 21 and 27. Both St. Cloud and the Twin Cities area reported the second-snowiest April on record. Thunderstorms on April 16, 18 and 24 produced damaging wind, hail and heavy rain. April temperatures were near to somewhat below normal statewide, but were extraordinarily variable during the month. Early April temperatures were 10 to 15 degrees below normal, while mid-April temperatures were above historical averages by more than 20 degrees. Lake ice-out dates were quite close to historical averages, ranging from early April in southern Minnesota to early May along the Canadian border.

May precipitation totals were generally below normal by one-half to one and one-half inches. By late May, the potential for wildfires was rated "high to extreme" in many north central and northeastern areas. May temperatures were four to eight degrees cooler than normal, and continued a pattern that persisted throughout the spring. Without the brief warm spell in mid-April, the meteorological spring (March – May) would have ranked among the coldest on record.

Summer 2002

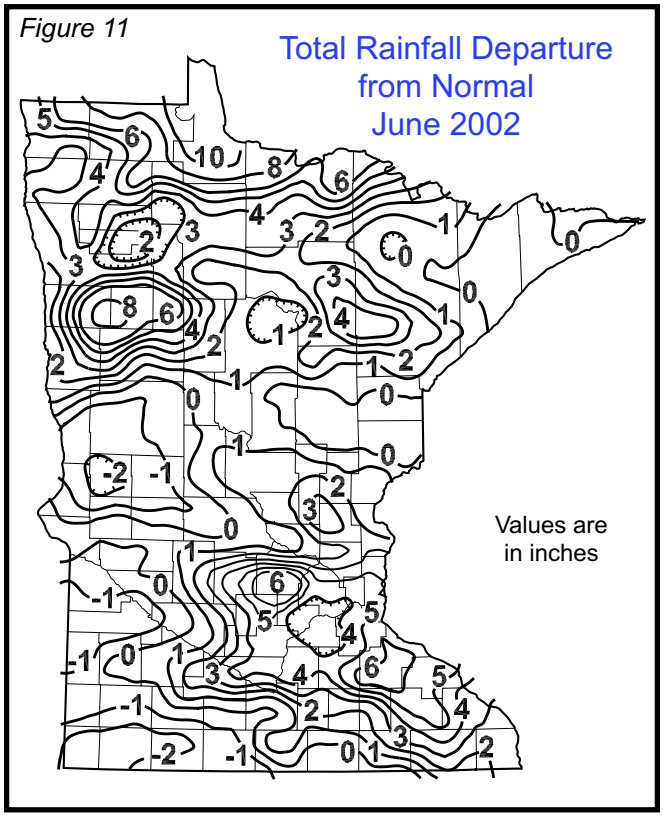
June 2002 was one of the wettest months in Minnesota's post-settlement history. Precipitation totals exceeded 10 inches in many areas, and surpassed 12 inches in many others (Figure 10). Precipitation departures from normal ranged from a **half foot** to nearly **one foot** (Figure 11). In some northwestern communities, rainfall on June 9-10 alone exceeded half the normal **annual** precipitation. The excessive rainfall led to devastating flooding in northwestern communities such as Roseau, Ada and Mahnomen.

Figure 10



On June 9-10, portions of northwestern and north central Minnesota experienced one of the most significant precipitation events ever recorded (Figure 12). While not unprecedented, the event was extraordinarily rare in its intensity and geographical extent. Rainfall totals for the 48-hour period exceeded six inches over a multi-county area and topped eight inches in portions of Norman, Mahnomen, Marshall, Kittson, Roseau and Koochiching Counties. All of Lake of the Woods County fell within the eight inch contour and an incredible 12 inches of rain fell over portions of Roseau, Lake of the Woods and Koochiching Counties. The maximum rainfall reported was 14.55 inches near Lake of the Woods on the Roseau/Lake of the Woods County border, with anecdotal reports of 15 or more inches in other areas of Lake of the Woods County. Two weeks later, on June 22-23, a broad area of northern Minnesota received four inches to as much as eight inches of additional rainfall. Some of the communities that received six to eight inches of rain earlier in the month were again drenched by another six to eight inches.

Figure 11

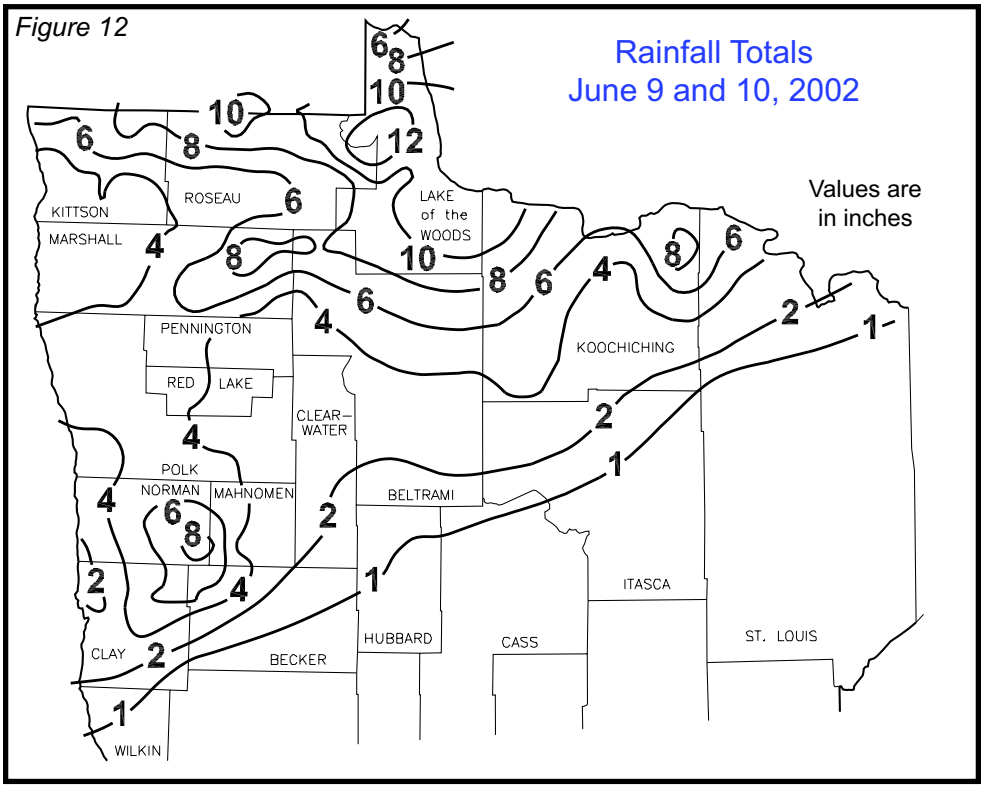


Heavy June 2002 rains were not limited to northern counties. Four to six inches of rainfall was reported in Wright County and surrounding areas during a relatively short period on the evening of June 24. The rain fell on a landscape that was already saturated from a two to three inch event that occurred on June 21. Rainfall totals exceeding seven inches over the four-day period were reported in sections of Wright, McLeod, Meeker, Carver and Hennepin Counties. Flooding rains were also reported on June 18 in portions of Faribault County and on June 20-22 in parts of Rice and Goodhue Counties. June temperatures were generally two to three degrees warmer than normal.

The final few days of June were sweltering with temperatures in the mid-90s, dew points above 70 degrees and heat index values exceeding 100 degrees.

With some exceptions, July was a wet month across much of the northern three-fourths of Minnesota. Rainfall totals exceeded normal by two inches, to as much as four inches, in parts of Minnesota as a result of two very intense rainfall events during the first half of July. The first event drifted across central Minnesota on July 6 and continued into the early morning hours of July 8. The highest multi-day totals were 10 inches in northern Kanabec County and more than nine inches in southwestern Aitkin County. The second event occurred on July 9-10, with rainfall totals exceeding four inches in some communities. The maximum rainfall total from this event was 8.33 inches in western Polk County. July temperatures were generally two to four degrees warmer than normal. Maximum temperatures topped 90 degrees numerous times during the month and minimum temperatures above 70 degrees were common. The summer heat reached its peak on July 20, when some locations in west central and southern Minnesota reported dew points in excess of 80 degrees. High dew points combined with air temperatures in the mid-90s to create heat index values topping 110 degrees.

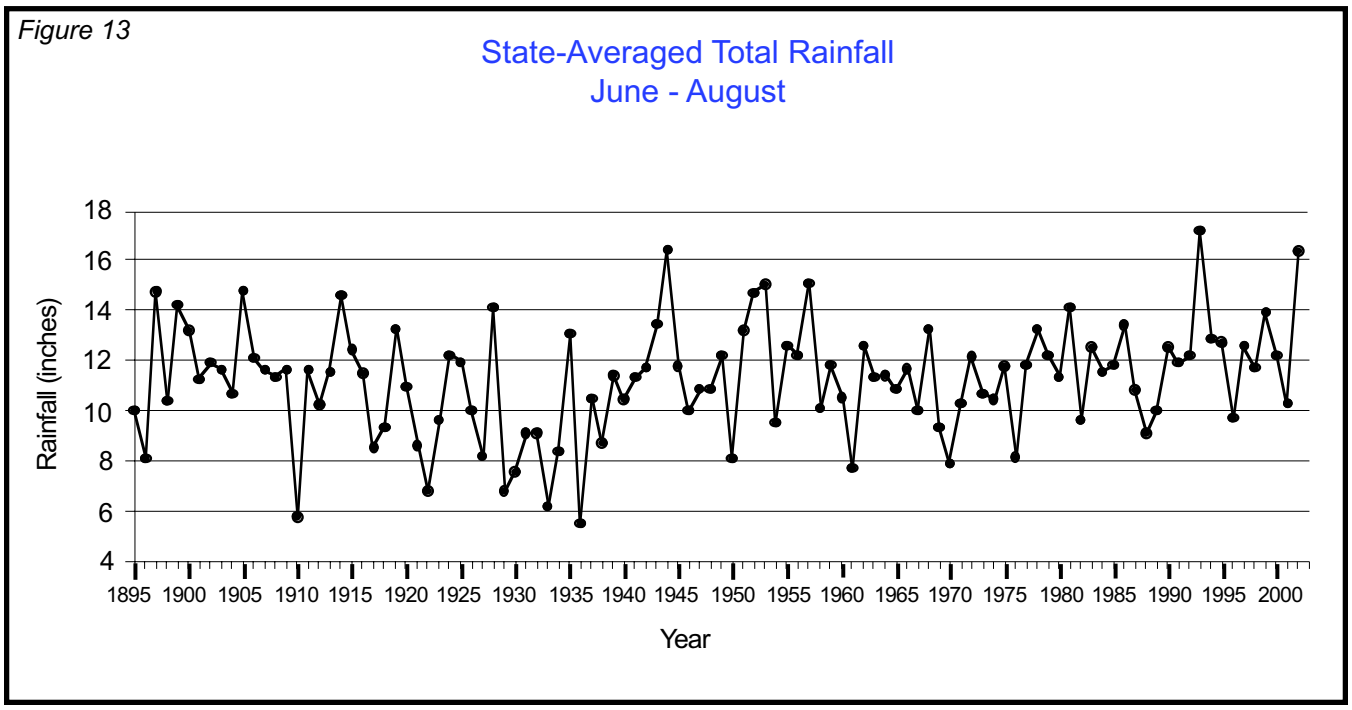
Figure 12



For the third consecutive month, August 2002 rainfall totals across much of Minnesota were well above historical norms. Rainfall totals of more than eight inches were reported at a number of locations around the state. Intense rainfall events occurred on numerous dates during August, however, in most cases the heaviest rain fell over geographically isolated areas. The most substantial rainfall event of the month occurred in central and southern Minnesota on August 20-21. A succession of slow-moving thunderstorms spanned the width of the state, and rainfall totals exceeded five inches in some locations. August temperatures were very close to historical averages. A chilly period during the middle of the month was counterbalanced by warm temperatures at the end of the month.

During the summer of 2002, Minnesota was an oasis of wetness, wedged between drought-ravaged states to the west and east. The June through August period was Minnesota's third wettest on record, with the state-averaged summer (June-August) rainfall total at 16.35 inches (Figure 13). Growing season precipitation totals through late summer were very high relative to historical values across large sections of Minnesota and exceeded averages by more than 50 percent (Figure 14). In contrast, some sections of northeastern Minnesota reported significant rainfall deficits for the season. In portions of Cook County, for example, growing season precipitation totals fell short of the historical average by 30 to 50 percent.

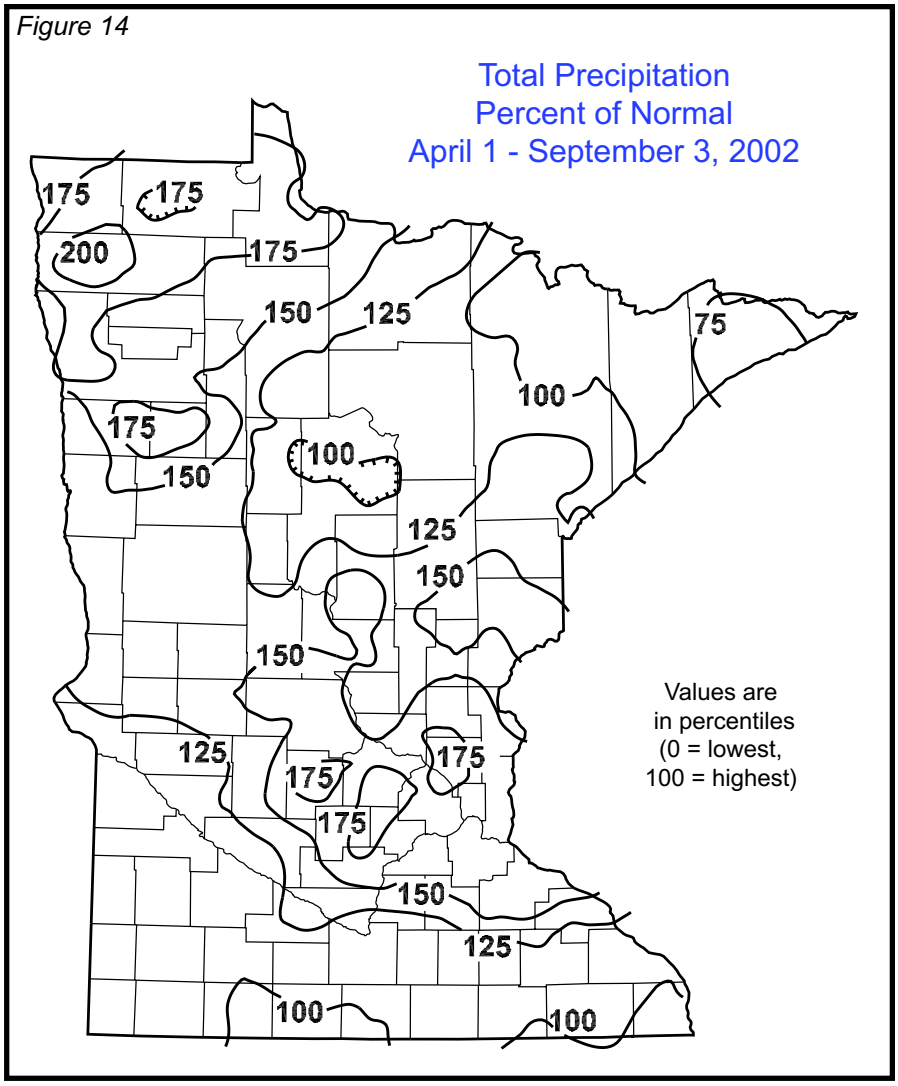
Figure 13



Early Autumn 2002

September 2002 rainfall totals were generally below normal, notably in the western and northern areas of the state, where monthly totals were below the historical average by more than one inch. Exceptions could be found in central and east central Minnesota, where some communities topped normal precipitation by more than two inches, much of it due to intense rainfall on September 5-6. During this event, two waves of thunderstorms dropped three to five inches of rain on portions of Benton, Stearns, Sherburne, Wright, Hennepin and Dakota Counties, causing urban flooding and road washouts. September temperatures were generally above normal for the first half of the month, then cooled to somewhat below normal readings. On average, September temperatures finished three to five degrees warmer than normal, although widespread frost occurred on the morning of September 24.

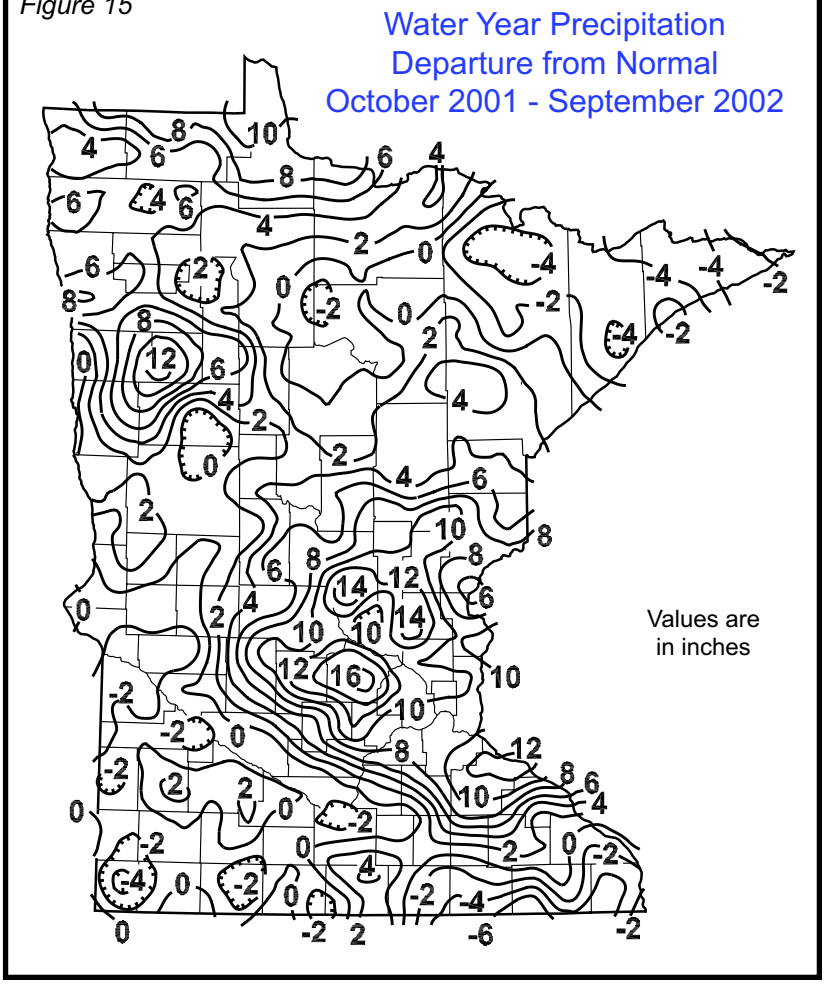
Figure 14



Water Year 2002

The 2002 Water Year (October, 2001-September, 2002) was highlighted by extraordinarily heavy precipitation totals that exceeded historical averages by more than eight inches across significant portions of Minnesota. In contrast, relatively small areas in the southwest and northeast fell short of normal (Figure 15). Precipitation totals ranged from less than 24 inches in far western counties to over 44 inches across much of Wright County (Figure 16).

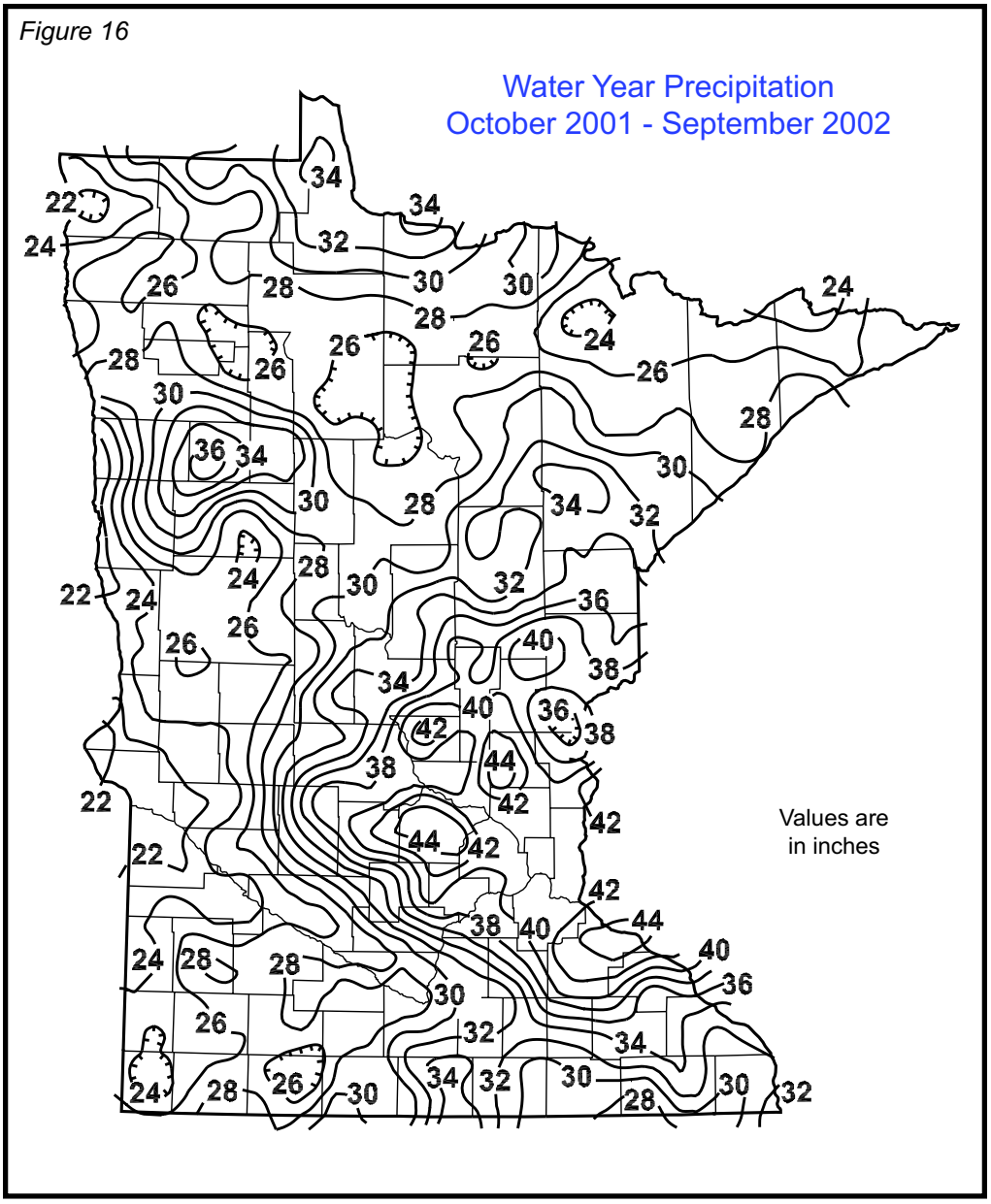
Figure 15



The State Climatology Office analyzes rainfall events that lead to significant damage or events where rainfall totals are near or above the threshold established as a 1 percent probability occurrence (often referred to as the "100-year storm"). For communities in Minnesota, a 1 percent probability occurrence is six or more inches of rain in a 24-hour period. The State Climatology Office evaluated 12 such rainfall events during the 2002 growing season (at right):

- June 9-10, Northwest and North Central Minnesota
- June 20-21, Southeast Minnesota
- June 21-24, Wright County and Vicinity
- June 22-23, Northern Minnesota
- July 6-8, Central Minnesota
- July 9-10, Northwest, Central and South Central Minnesota
- August 3-4, Central and Southern Minnesota
- August 6-7, North Central Minnesota
- August 20-21, Central and Southern Minnesota
- August 27-28, Marshall County
- August 28, Wilkin County
- September 5-6, Central Minnesota

Figure 16


Water Year Precipitation
October 2001 - September 2002
Values are in inches