

To: Perry Finelli, Jim Bickal, John Bischoff, and Kara Fiegenschuh
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jan 1, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Significant Weather Events and Episodes of 1998

The weather of 1998 made headline news on many occasions. From an international, national or local perspective it was a very eventful year and one that will be remembered for a long time.

Among the events that made the international news in 1998.....

- Some of the worst flooding in over 130 years occurred in China during the summer (June and July mostly) along the Yangtze River in south-central China, around the Gulf of Tonkin in the extreme south, and along the northern border areas. Approximately 4000 people died, 14 million were left homeless and estimated damages approached \$20 billion.

-During October, two super typhoons (Zeb and Babs) swept over the Philippines, Taiwan and Japan with winds exceeding 150 mph and torrential rainfalls (12-20 inches). There was widespread flooding and landslides, with perhaps hundreds of storm related deaths.

-In late October and early November, slow-moving Hurricane Mitch struck central America, dropping torrential rains, primarily over Honduras and Nicaragua. Flooding and landslides were prevalent and whole villages washed away. The storm claimed over 11,000 lives and destroyed or damaged the homes of 3 million people. Initial damage estimates exceed \$5 billion.

Among the events which made national news in 1998.....

-An early summer (June July) drought and heat wave across Texas, Oklahoma and Louisiana proved quite costly. Over 200 people died from heat-related illness and agricultural losses were estimated at nearly \$6 billion. Ironically, in August, tropical storm Charley crossed Texas, ending the drought, but causing severe damage and claiming 10 lives as a result of flooding.

-In August Hurricane Bonnie struck North Carolina causing about \$1 billion in damages, then in September Hurricane Georges struck the southeast coastal states causing another \$3-4 billion in damages, but only 3 storm related deaths.

-California was the recipient of a double dose of weather catastrophe, with damaging El-Nino related floods in February and then a disastrous freeze of the citrus crop in December. Estimated damages from both events exceed \$1 billion.

Among the events which made news in Minnesota during 1998....

-The warmest winter (1997-98) of the 20th century, followed by the earliest planting season ever, followed by one of the most abundant harvests. Unfortunately, both crop and livestock prices were depressed so the farm economy did not benefit.

-One of the earliest and most destructive outbreaks of tornado activity ever in the state occurred on March 29. Fourteen tornadoes were reported. The towns of Comfrey and St Peter were especially damaged. This was a precursor to a severe weather season that produced a record number of tornadoes for the state, totally 55 by the end of October.

-Severe thunderstorms and strong winds passed through the Twin Cities metropolitan area on May 15th and 30th, destroying many homes and uprooting or breaking thousands of old trees. Roofers and landscapers were swamped with work for the rest of 1998.

-Perhaps one of the nicest late fall seasons ever produced a record setting warm late November and early December. Many high temperature records were set around the state, along with near record low amounts of snowfall. Golf courses were open into late November and early December and many bird species were late in their migratory behaviors.

Topic: Coldest New Year's Day

The coldest New Year's Day in the upper midwest, including the Twin Cities, was probably January 1, 1864. Starting the night of December 30, 1863 a blizzard and arctic cold wave enveloped the Dakotas and Minnesota with snow squalls and strong northwesterly winds. The mercury plummeted over the next few days. The New Year's morning low in the Twin Cities was -37 degrees F, with overnight and early morning windchill readings of -80 to -90 F. New Years afternoon highs only made it up to -25 degrees F in the Twin Cities and -16 degrees F in Chicago. The cold wave lasted through the first week of January, keeping the mercury below zero for a period of 226 consecutive hours in the Twin Cities.

Twin Cities Almanac for January 1st:

The average MSP high temperature for this date is 23 degrees F (plus or minus 13 degrees standard deviation), while the average low is 7 degrees F (plus or minus 14 degrees standard deviation).

MSP Local Records for January 1st:

MSP weather records for this date include: highest daily maximum temperature of 48 degrees F in 1897; lowest daily maximum temperature of -12 degrees F in 1974; lowest daily minimum temperature of -30 degrees F in 1974; highest daily minimum temperature of 42 degrees F in 1897; record precipitation of 0.47 inches in 1891 and record snowfall of 4.4 inches in 1911. There have been thirteen measurable snowfalls on this date since 1948. Maximum snow depth has been 20 inches in 1969; the worst windchill conditions were -55 to -60 degrees F readings in 1920, 1928, 1945, and 1974.

Average dew point for January 1st is 8 degrees F, with a maximum of 36 degrees F and a minimum of -36 degrees F.

All-time state records for January 1st:

Scanning the state climatic data base: the all-time high for this date is 56 degrees F at Luverne (Rock County) in 1998; the all-time low is -44 degrees F at Pokegama Dam (Itasca County) in 1899 and at Tower (St Louis County) in 1974.

Word of the Week: Moby Dick Balloon

Most instrumented balloons are released and tracked by weather services around the world every 12 hours for the purpose of taking profile measurements of the atmospheric conditions aloft (pressure, temperature, humidity and wind). However, on occasion weather services have used an instrumented constant-level balloon for long duration flights (over 24 hours) to characterize atmospheric conditions over ocean or land transects. These balloons often reach elevations of 40,000 ft or higher and maintain a constant altitude as they move with upper level winds. With such low air pressure at these altitudes, these plastic balloons, initially inflated to 6 to 8 ft diameters at ground launching sites, expand to considerable dimensions (perhaps 20 or 30 ft diameters) and look perhaps like floating whales in the sky. Thus the nickname.

Outlook:

Continued colder than normal temperatures will prevail across most of the state for the first few days of January. Chances of snow statewide through late Saturday, perhaps in the southeast on early Sunday. Another chance for snow on Tuesday and Wednesday of next week, with some moderation in temperatures to near normal values. Snowfalls should be greater in southern counties than in northern ones. The week ahead will also be rather windy.

To: Bob Potter, Jim Bickal, John Bischoff, and Kara Fiegenschuh
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jan 8, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Physiological Responses to Cold Weather by Animals

With the onset of colder than normal temperatures this month, and some rather dangerous windchill conditions, most Minnesotans have begun to layer clothing, let cars warm up before driving somewhere, take more hot drinks and spend more time indoors around the fireplace. But what about animals, what are their protective responses to cold weather. Some are obvious and some not so obvious:

Many animals will curl up or roll into a ball to decrease the surface area of their bodies that loses heat; animals that often pant or have naturally high respiration rates will cease to pant or reduce their respiration to minimize the loss of body heat through vaporization; the rate of blood flow toward the skin surface is retarded to conserve metabolic heat; body hair may become more erect to increase the thickness of non-conducting air entrapped near the skin surface; and many animals begin shivering or rhythmic contraction of the muscles which generates several times more body heat than when the muscles are at rest.

In addition to these physiological responses, some changes in animal behavior can be observed such as their preference for staying in sunlit places during the day, finding protection from the wind, or staying in close proximity to haystacks or compost piles which generate their own heat through biochemical reactions.

MPR listener questions: Using historical averages which day in the Twin Cities is the coldest of the year? Is the date with the coldest historical average temperature the same for most Minnesota communities?

Answer: For this century (1900-1998) the date with the coldest average temperature in the Twin Cities is January 30th, with a daily mean of 11.3 degrees F. The table below shows the date of the coldest average daily temperature this century for other Minnesota communities. Though the dates vary, they all fall within a week of each other.

Community	Date of the coldest average daily temperature (1900-1999)
Minneapolis-St Paul	Jan 30 (11.3 F)
International Falls	Jan 27 (-0.7 F)
Rochester	Jan 26 and 30 (10.4 F)
Winona	Jan 31 (13.1 F)
Duluth	Jan 26 (5.9 F)
Grand Rapids	Jan 26 (3.2 F)
Morris	Jan 27 (6.9 F)
Crookston	Jan 26 (1.7 F)

Twin Cities Almanac for January 8th:

The average MSP high temperature for this date is 23 degrees F (plus or minus 13 degrees standard deviation), while the average low is 5 degrees F (plus or minus 14 degrees standard deviation).

MSP Local Records for January 8th:

MSP weather records for this date include: highest daily maximum temperature of 46 degrees F in 1902; lowest daily maximum temperature of -5 degrees F in 1976; lowest daily minimum temperature of -23 degrees F in 1977; highest daily minimum temperature of 32 degrees F in 1992; record precipitation of 0.27 inches in 1937 and record snowfall of 2.5 inches in 1909. There have been fifteen measurable snowfalls on this date since 1948. Maximum snow depth has been 18 inches in 1969; the worst windchill conditions were -55 to -60 degrees F readings in 1912, 1962, and 1978.

Average dew point for January 8th is 5 degrees F, with a maximum of 35 degrees F and a minimum of -33 degrees F.

All-time state records for January 8th:

Scanning the state climatic data base: the all-time high for this date is 59 degrees F at Lynd (Lyon County) in 1902; the all-time low is -46 degrees F at Tower (St Louis County) in 1973.

Word of the Week: Retreater

With the conversion to electronic maximum/minimum thermometers by most governmental weather services, this term is hardly used anymore. It has been used historically to refer to a defective mercury thermometer used for recording the maximum temperature. The mercury sometimes flows too freely through the constriction in the glass tube designed to prevent it from returning by gravity to the glass bulb at the base. However, because of a defect, the column of mercury expanded by increasing temperature during the daytime, retreats with the fall of temperature and does not properly register the maximum value. When this occurs the maximum temperature for the day is consistently registered too low and climatologists have to correct for such data by using temperature values from a nearby observation point.

Outlook:

Mostly dry on Saturday, then increasing cloudiness Sunday with a chance for snow. Continued chances for snow Monday and Tuesday, then again by the end of next week. Some moderation in temperature should occur by the middle of next week as southerly winds will develop for a few days bringing in warmer air.

To: Bob Potter, Jim Bickal, John Bischoff, and Kara Fiegenschuh
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jan 15, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: New Monthly and Seasonal Climate Outlooks

The most recent monthly and seasonal outlooks from the Climate Prediction Center slightly favor below normal temperatures across most of Minnesota for February and the entire February through April period. Much of this is premised on the cooling trend established the first half of January, which may break down at any time. The outlook for precipitation favors near normal conditions in Minnesota during February and a better chance for drier than normal conditions for the February through April period. This portion of the outlook is weighted on the historical associations with La Nina (cold episodes in the equatorial Pacific) events.

Topic: Winter Fog: Landscape and Vegetation Interactions

A high frequency of snowfalls has certainly dominated the scene in Minnesota this month. Consequently, much of the state has several inches of snow cover. This situation is conducive to the development of fog once the temperatures begin to rise from warm advection on southerly winds. Melting snow cover will release a good deal of water vapor to the lower atmosphere during the daytime, then, under the influence of long winter nights, radiative cooling will allow calm, cooled air near the ground to reach saturation, prompting fog formation. The longer nights and shorter days of winter permit fogs to persist for much longer periods than they do in other seasons.

Throughout Minnesota, the upcoming warming trend (proverbial January thaw) is likely to promote fog development in many areas. It is an interesting time to observe how local snow deposition, landscape and vegetation affect fog formation. Some climatologists have studied the influence of vegetation on fog formation and advocated that managed landscaping can help in fog containment, particularly in troubled airport or highway locations. They point out that a mixture of trees and shrubs can serve as a vegetative baffle, confining the spread of fog, and thereby reducing the total volume that must be dissipated or burned off by convection and wind during the day. Secondly, they argue that such a vegetation mixture slightly reduces the liquid water content of the shallow surface layer of the atmosphere by capturing many of the fog droplets on the vegetation itself.

MPR listener question: After a very mild start to winter, it seems like we have had an extraordinarily high frequency of snowfalls in the Twin Cities area so far this January. Is my perception correct?

Answer: Indeed, you are quite correct. Through the first fourteen days of the month, we saw measurable snowfall on eleven of them, and a trace of snowfall on another. Only on the 4th and the 7th was there an absence of snowfall. Incidentally, the eleven measurable snowfalls on the first fourteen days of the month is the highest frequency for any similar period in the past 108 years. There were ten days with measurable snowfall for January 1-14 in 1967.

Twin Cities Almanac for January 15th:

The average MSP high temperature for this date is 21 degrees F (plus or minus 14 degrees standard deviation), while the average low is 4 degrees F (plus or minus 15 degrees standard deviation).

MSP Local Records for January 15th:

MSP weather records for this date include: highest daily maximum temperature of 43 degrees F in 1990; lowest daily maximum temperature of -14 degrees F in 1972; lowest daily minimum temperature of -32 degrees F in 1963; highest daily minimum temperature of 33 degrees F in 1973 and 1980; record precipitation of 0.45 inches in 1969 and record snowfall of 3.2 inches in 1953. There have been twelve measurable snowfalls on this date since 1948. Maximum snow depth has been 17 inches in 1970 and 1984. The worst windchill conditions were -65 to -70 degrees F readings in 1972, 1977 and 1982.

Average dew point for January 15th is 4 degrees F, with a maximum of 36 degrees F and a minimum of -39 degrees F.

All-time state records for January 15th:

Scanning the state climatic data base: the all-time high for this date is 57 degrees F at New Ulm (Brown County) in 1908 and at Winnebago (Faribault County) in 1914; the all-time low is -53 degrees F at Moose Lake (Carlton County) in 1972.

Words of the Week: Mandatory Levels

Twice daily, at 12 hour intervals, the weather services around the world probe the atmosphere with balloon launched instrumentation, called radiosondes. These measurements of temperature, pressure, humidity and wind throughout the vertical profile of the atmosphere provide the input to a number of numerical forecast models. The design of the forecast models mandates numerical input from certain constant pressure levels in the atmosphere (e.g. 1000 mb, 850 mb, 700 mb, 500 mb, and others). These are called mandatory levels because they are required to make the forecast models work. Radiosondes are generally designed to sample the atmosphere up to an elevation of 19 miles, at which point the balloon may burst and the instrument package released will parachute back to the Earth's surface. The 19 mile elevation includes nearly 99 percent of the Earth's atmospheric mass. The radiosonde balloons are designed to ascend at a nearly constant rate of 300 meters/minute. Numerous precautions are taken to insure that high quality data are collected

to run the forecast models. For example if the balloon does not ascend to at least the 400 mb level (approximately 4.5 miles), then a second attempt is made with another balloon. Even if the balloon ascends properly to the 19 mile elevation or beyond, if for any reason it fails to transmit data for an interval of 10 minutes or longer, a second balloon is launched to try again. This reflects on the importance of maintaining a consistent and comprehensive data flow to run the operational forecast models.

The National Weather Service Forecast Office in Chanhassen, MN launches radiosondes twice daily. The data from these and other radiosondes around the United States are available online over the Internet at the following web site...

<http://www.osb.nws.noaa.gov/upper-air/>

Outlook:

A warm up is in store for the weekend and much of next week. Light winds will come more consistently from the south, ushering in warm, moist air. Cloudiness should prevail nearly everyday, with increased chances for mixed precipitation, including freezing drizzle, rain, sleet and snow showers. Precipitation on the weekend is more likely in the south, while later next week precipitation is more likely in northern counties.

To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jan 22, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: A Brief Note on Mapping the Temperature of Earth

For centuries scientists recognized that most of the sun's energy was received near the equator and distributed as heat and water vapor polarward, both north and south. This was thought to produce the differences observed in temperature conditions from place to place. Thus latitude was considered as the chief factor in temperature distribution. Perhaps the first person to geographically describe the temperature of Earth using isotherms (lines of equal value) was the German natural scientist Alexander von Humboldt (1769-1859). He published the first global map of isotherms in 1817, showing the mean annual temperature values as derived and interpolated from 58 climate stations. It was obviously a coarse map depiction heavily weighted to latitudinal position. However, it did provoke among the scientific community the need to measure the climate at more locations and to share the data. Subsequently, by 1852 a map of isotherms based on annual mean temperature was derived from 1100 climate stations. Over the last 150 years many depictions of the Earth's climate have derived using lines of equal value for pressure, precipitation, sunshine and other climate measures. Humboldt's initial map of isotherms in 1817 is thought by many to represent the birth of cartographical representation of the Earth's climate. Such maps today are literally based on tens of thousands of climate stations.

MPR listener questions: What have been the coldest estimated windchill conditions in Minnesota and when did they occur?

Answer: I have been saving this question for an appropriate time and today's date, January 22nd, is the proper time. January 22, 1936 (63 years ago today) brought perhaps the worst windchill conditions ever recorded in Minnesota. From 3 am to 11 am that morning, windchill conditions in the Twin Cities area ranged from -90 to -95 degrees F, while outstate areas experienced windchills colder than -100 degrees F. These conditions were brought on by a strong arctic high pressure system which swept in behind a blizzard on the 21st. Winds blew nearly constant at 25 to 30 mph for hours, as temperatures dropped through the -20s to the -30s and -40s F.

In the Twin Cities area, many citizens did not even attempt to go to work. Transportation problems included frozen street car switches and rail cars that were frozen to the tracks. With wind and temperature conditions that would freeze exposed skin in less than 30 seconds, many observed that when people ventured outside that morning in the downtown areas, they ran from building to building to minimize their exposure.

Twin Cities Almanac for January 22nd:

The average MSP high temperature for this date is 23 degrees F (plus or minus 14 degrees standard deviation), while the average low is 5 degrees F (plus or minus 15 degrees standard deviation).

MSP Local Records for January 22nd:

MSP weather records for this date include: highest daily maximum temperature of 51 degrees F in 1900 and 1942; lowest daily maximum temperature of -17 degrees F in 1936; lowest daily minimum temperature of -34 degrees F in 1936; highest daily minimum temperature of 36 degrees F in 1900; record precipitation of 0.89 inches in 1982 and record snowfall of 17.2 inches in 1982. There have been fourteen measurable snowfalls on this date since 1948. Maximum snow depth has been 20 inches in 1970; the worst windchill conditions were -90 to -95 degrees F readings in 1936.

Average dew point for January 22nd is 5 degrees F, with a maximum of 38 degrees F and a minimum of -38 degrees F.

All-time state records for January 22nd:

Scanning the state climatic data base: the all-time high for this date is 59 degrees F at Camden and Lynd (Lyon County) in 1900; the all-time low is -51 degrees F at Itasca State Park in 1922.

Words of the Week: Mercury on the chute

This is an expression rarely used anymore, but in the first 50 years of the National Weather Service it was used to describe the onset of a cold wave, when temperatures fall rapidly and reach levels that are a threat to agriculture and commerce. Often times when the mercury in the thermometer was dropping rapidly, meteorologists would report that the "mercury was on the chute." We have already had two episodes of mercury on the chute this month, the 8th to the 9th and the 18th to the 19th when the temperatures fell by more than 30 degrees F.

Outlook:

Two storm systems will affect Minnesota this weekend. The one arriving from the south early in the weekend may bring substantial snowfalls (4-10 inches) and gusty winds, especially to eastern sections of the state. The second wave will come more from a westerly direction and pass across the state Sunday and Monday. It may bring snowfall, but of the lighter variety. Temperatures will be closer to normal next week, but with increased chances for precipitation, especially for Wednesday through Friday. For the Twin Cities area, we may end up approaching the record of 19 days with measurable snowfall in January.

To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jan 29, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: The Earliest Weather Journal

We are somewhat familiar with the pioneer weather records in Minnesota, which have been of great value to climatologists and historians who have reconstructed past events, episodes and patterns that have had significant impact on the state. The old Ft Snelling climate records, the diary and records of Reverend A. B. Paterson of St Paul (1859-1876), the state weather reports of Professor William Payne of Carleton College in Northfield, and numerous other observers and accounts from surveyors, railroad workers, and pioneer settlers. What about other diary and journal accounts of the weather? How far back does some of this type of documentation date?

Perhaps the earliest known weather journal is that of William Merle, an English clergyman who worked in Oxford and kept a daily journal of the weather there from 1337 to 1344. Prior to the use of any instruments, Merle wrote in Latin his daily observations of heat (warm, hot, cool, cold), frosts, rain, snow, hail, thunderstorms, wind, and phenology of the landscape (flowering, leaf falls, etc). These written records were passed on to William Reed the Bishop of Chichester, who in 1386, bequeathed them to scholars of Merton College, Oxford. The original journal was a considerable stack of loose vellum sheets (probably from lambskin) and was not bound until 1634. The Merle records have been compared to those of modern times to assess seasonality and the frequency of rainfall. Merle also wrote two other documents about weather forecasting, however on this topic both Aristotle the Greek Philosopher and Virgil the Roman poet predate him by over 1000 years. Nevertheless, in scientific circles Merle's daily journal of weather observations is thought to be the earliest systematic written record.

MPR listener questions: How much water is contained in the present snowcover on the ground?

Answer: Snow water equivalence varies around the state. Snow depth currently ranges from 4 to 24 inches, with 6 to 12 inches being very common in most counties. Obviously, more water is present in the deeper snow cover. In general, there is 1 to 2 inches of water in much of the snow cover around the state. Parts of southeastern Minnesota which have received denser snowfalls than many areas have between 2 and 3 inches of water in the snow cover. In fact many communities have recorded one of the wettest Januarys in their historical record. The Twin Cities, Rochester, La Crosse (WI), Faribault, Rosemount, Waseca, and Winona all report well over 2 inches of precipitation for the month.

Weekly updates of snow water equivalence values are available on the Army Corps of Engineers web site....

<http://www.mvp-wc.usace.army.mil>

or on the North Central River Forecast Office web site...

<http://www.crh.noaa.gov/cgi-bin-ncrfc/uncgi/gas2>

Weekly snow cover and trail reports are available from the DNR State Climatology Office web site...

<http://www.soils.agri.umn.edu/research/climatology/doc/snowmaps.html>

Twin Cities Almanac for January 29th:

The average MSP high temperature for this date is 22 degrees F (plus or minus 14 degrees standard deviation), while the average low is 4 degrees F (plus or minus 15 degrees standard deviation).

MSP Local Records for January 29th:

MSP weather records for this date include: highest daily maximum temperature of 49 degrees F in 1931; lowest daily maximum temperature of -15 degrees F in 1951; lowest daily minimum temperature of -29 degrees F in 1951; highest daily minimum temperature of 34 degrees F in 1906; record precipitation of 0.42 inches in 1967 and record snowfall of 5.3 inches from the same storm. There have been fourteen measurable snowfalls on this date since 1948. Maximum snow depth has been 20 inches in 1969 and 1970; the worst windchill conditions were -70 to -75 degrees F readings in 1970.

Average dew point for January 29th is 3 degrees F, with a maximum of 36 degrees F and a minimum of -38 degrees F.

All-time state records for January 29th:

Scanning the state climatic data base: the all-time high for this date is 60 degrees F at Canby (Yellow Medicine County) in 1931; the all-time low is -54 degrees F at Pokegama Dam in 1899.

Words of the Week: Stuve Diagram

These diagrams are plots of radiosonde data, which are taken at 12 hour intervals by government weather services. They typically show the pattern of temperature, dewpoint, pressure, wind speed, and wind direction with height. Pilots find them useful in assessing how stable the atmosphere is, and what kinds of headwinds or tailwinds they might encounter. There are several web sites on the Internet, where Stuve diagrams can be found for major cities in the United States, Canada, and Mexico including

the following....

http://covis1.atmos.uiuc.edu/covis/visualizer/sounding_stuve.html
(University of Illinois Weather Visualizer)

<http://taiga.geog.niu.edu/cgi-bin/getmodel>
(Northern Illinois University)

<http://www-das.uwyo.edu/upperair/sounding.html>
(University of Wyoming)

Outlook:

The weekend will be mostly dry and warm around the state, with considerable thawing and melting of the snow cover. A chance for some snow or perhaps mixed precipitation in the south later on Sunday. Fog will be widespread as a result of considerable melting and release of water vapor. The warming trend should be in place for most of the first week of February, with above normal chances for precipitation nearly all of next week, especially by Friday.

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To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Feb 5, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Frequency of freezing rain and freezing drizzle

A recent listener question actually prompted me to do an analysis of these data. Historically, during the January-February period, or heart of winter, the Twin Cities and southern Minnesota areas record freezing rain or freezing drizzle about one day every other year, or in some cases close to one day per year. This range in frequency pre-dates the decade of the 1990s. It is interesting that during this decade, a much higher frequency of such events has been recorded. For example, the two month period produced seven days with freezing rain or freezing drizzle in both 1993 and 1998 in the Twin Cities area. Further, so far this winter, seven days with freezing precipitation have been recorded. To find a January-February combination in the Twin Cities that did not experience at least one day of freezing precipitation, you have to go all the way back to 1990. In fact the average frequency of such events during the 1990s in the Twin Cities area is nearly 4 per year or quadruple the average historical frequency.

This observation may be nothing more than random variation. On the other hand, it fits rather well with climatological evidence to suggest winters are getting warmer, dew points are getting higher, and the hydrologic cycle is intensifying. All of these features may be complementary in producing a higher frequency of freezing precipitation during Minnesota winters.

Topic: New NOAA Weather Radios Available Now

The new NOAA Weather Radio known as the SAME (Specific Area Message Encoder) version is now available again from Radio Shack stores. It is on sale during February for \$59.95 (about 25 percent off retail price). The SAME radio can be tuned to receive only the weather advisories, watches and warnings issued for a specific area. Thus it is ideal for the home, since you will not be disturbed by weather bulletins which are not pertinent to where you live. Secondly, it is a valuable resource for traveling by car since it can be tuned to receive information related to your route of travel or your travel destination.

MPR listener question: When was the first weather satellite launched?

Answer: The former USSR launched the first satellite in 1957, but it was not a weather satellite. I believe the first satellite to provide meteorological data was Explorer VII launched by the United States in 1959. But its life was short-lived. The more renowned Tiros I was launched by the United States in April of 1960 for the express purpose of providing pictures of cloud cover to meteorologists. In fact a whole

series of Tiros satellites were launched in the 1960s to provide better information on cloud formations and movement.

Anniversary Date:

February 5 is National Meteorologist's Day (formerly called National Weatherman's Day), the anniversary of when in February 1870 that the Congress sent legislation for President U.S. Grant's signature forming a telegraphic weather service within the U.S. Army Signal Service. This organization is a predecessor to the present National Weather Service. The day has been said to also commemorate the birthday of John Jeffries in 1744. He was one of America's first weather observers, taking daily weather observations in Boston starting in 1774. Jeffries also took the first balloon observation in 1784.

Twin Cities Almanac for February 5th:

The average MSP high temperature for this date is 23 degrees F (plus or minus 13 degrees standard deviation), while the average low is 6 degrees F (plus or minus 14 degrees standard deviation).

MSP Local Records for February 5th:

MSP weather records for this date include: highest daily maximum temperature of 47 degrees F in 1990; lowest daily maximum temperature of -11 degrees F in 1895 and 1936; lowest daily minimum temperature of -27 degrees F in 1979; highest daily minimum temperature of 32 degrees F in 1927; record precipitation of 0.52 inches in 1908 and record snowfall of 7.5 inches from the same storm. There have been fourteen measurable snowfalls on this date since 1948. Maximum snow depth has been 22 inches in 1967. The worst windchill conditions were -55 to -60 degrees F readings in both 1933 and 1936.

Average dew point for February 5th is 6 degrees F, with a maximum of 42 degrees F and a minimum of -36 degrees F.

All-time state records for February 5th:

Scanning the state climatic data base: the all-time high for this date is 61 degrees F at Madison (Lac Qui Parle County and Beardsley (Big Stone County) in 1963; the all-time low is -54 degrees F at Pokegama Dam in 1895.

Words of the Week: Wind Ripple or Snow Ripple

These terms refer to a type of wave-like formation visible in the snow covered rural landscapes of western Minnesota in the winter. A series of small waves, about an inch high are observable running at right angles to the prevailing wind direction. These often occur several times over the course of a snow season if the land is undisturbed. They result more commonly from falls of light fluffy snow than heavier dense snow. Their orientation in Minnesota is frequently from SW to NE due to the dominance of northwesterly winds in the winter time.

Outlook:

A mostly dry weekend, with a chance for some showers in the north later on Sunday. Dry and mild Monday and Tuesday, with temperatures well above normal. Chance for mixed precipitation Wednesday and Thursday, with temperatures remaining above normal most of the week. It will be a windy week as well, as winds pick up from the south.

To: Perry Finelli, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Feb 12, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: U.S. Weather Research Program

Four U.S. government agencies have recently launched a five year research program to examine ways to mitigate the economic consequences of severe weather events and episodes, and to use weather forecast knowledge to increase economic competitiveness. The National Oceanic and Atmospheric Administration, National Science Foundation, National Aeronautics and Space Administration, and Department of Defense are collaborating with universities and other research institutions in this \$130 million effort.

Further information on this program can be found at their web site..

<http://box.mmm.ucar.edu/uswrp/>

They are concentrating efforts to mitigate and develop better warning systems against hurricanes, floods and severe winter storms. The escalating costs of addressing severe weather damages across the United States are a major concern. The insurance industry, agriculture, transportation, communication industries could greatly benefit from this program.

Topic: Recent Statistics on Damages from Weather Disasters

Recent statistics on the economic consequences of weather-related natural disasters are rather eye-opening. A compilation of damages from floods, tornadoes and hurricanes shows average annual losses of \$9.2 billion nationwide. All of the data presented are in 1997 dollars.....

In terms of flood damages over the period from 1983-1996, Minnesota ranks 9th highest among states (Iowa is first), with average annual damages of \$125 million. Of course flood damages do not occur every year, but can be extreme for any given year because of the size of major watersheds in the state. For example, total damages from floods in 1993 and 1997 were over \$1.8 billion alone.

In terms of tornado damages, Minnesota ranks 6th among states (Texas is first), with an average annual loss of \$22 million for the period from 1950 to 1994. This does not include the damages from 1997 when 47 tornadoes were recorded in the state, or 1998 when a record 57 tornadoes occurred. Tornadoes occur with a greater frequency than flooding, but the damage statistics are dominated by a few extreme years such as 1965, 1967 and 1998 when hundreds of millions of dollars in losses occurred.

In terms of damages and losses due to hurricanes, Minnesota naturally does not appear in the national statistics. Florida leads the way with average annual damages that exceed \$2 billion over the 1925 to

1995 period. Texas is ranked second with nearly \$1 billion in annual damages. These figures too, are dominated by a few extreme events such as hurricane Andrew in 1992 which inflicted nearly \$30 billion in damages.

More detail and figures are available from the Extreme Weather Source-Book developed by the National Center for Atmospheric Research and available online at the following web site....

http://www.dir.ucar.edu/esig/HP_roger/sourcebook/

MPR listener question: This February has been extraordinarily mild just like last year which was near record warmth. But exactly how does February of 1999 compare to last year?

Answer: Quite right! The first ten days of February this year have been nearly 15 degrees above normal, averaging 23.3 degrees F on a statewide basis. Last February, the warmest this century statewide, the average for the first ten days was 20.3 degrees F. So this year has been about 3 degrees F warmer for the first ten days. It was the second half of February last year, when the temperature averaged nearly 20 degrees F warmer than normal, which contributed the most to producing a record setting month.

From a precipitation point of view, last February and this February are both being drier than normal, though 1999 a bit wetter. Further, seasonal snowfall accumulations, at least in the Twin Cities area are roughly equal as well. By the 10th of February 1998, 32.4 inches of snowfall had been recorded, so far this year 38.3 inches have been recorded. It would appear that this February however is likely to take a wetter turn during the rest of the month, particularly in southern Minnesota. It will also be somewhat cooler.

Twin Cities Almanac for February 12th:

The average MSP high temperature for this date is 26 degrees F (plus or minus 12 degrees standard deviation), while the average low is 9 degrees F (plus or minus 15 degrees standard deviation).

MSP Local Records for February 12th:

MSP weather records for this date include: highest daily maximum temperature of 59 degrees F in 1990; lowest daily maximum temperature of -5 degrees F in 1905 and 1936; lowest daily minimum temperature of -21 degrees F in 1899; highest daily minimum temperature of 34 degrees F in 1908, 1928, and 1984; record precipitation of 0.42 inches in 1984 and record snowfall of 3.2 inches in 1965. There have been fourteen measurable snowfalls on this date since 1948. Maximum snow depth has been 22 inches in 1979. The worst windchill conditions were -50 to -55 degrees F in 1914.

Average dew point for February 12th is 11 degrees F, with a maximum of 37 degrees F and a minimum of -28 degrees F.

All-time state records for February 12th:

Scanning the state climatic data base: the all-time high for this date is 62 degrees F at New Ulm (Nicollet County) and Luverne (Rock County) in 1990; the all-time low is -50 degrees F at Roseau (Roseau County) in 1914.

Words of the Week: Little brother or little sister

These terms are sometimes used by meteorologists to refer to a subsidiary (smaller scale) storm which follows a major one. For example a tropical cyclone, typhoon or hurricane may be accompanied by a weaker low pressure system which trails along its path. Even in our continental climate here in Minnesota, an occasional little sister or little brother will trail along behind a major winter or spring storm system and bring some addition precipitation or wind following a significant snowfall.

Outlook:

Unsettled weather, stronger winds, will be evident over the next week. Chances for precipitation increase by Monday in the north and Tuesday across the rest of the state. The early week will be affected by a low pressure system passing to the north, while the Wednesday through Friday period will be influenced by a strong low pressure system passing to the southeast, perhaps bringing mixed precipitation to the state. Temperatures will remain above normal for the most part.

WeatherTalk for Friday, February 19, 1999

Topic: Value of Ships' Log-books to Climate Reconstructions

In recent decades climatologists have given more attention to 17th, 18th, and 19th century ship log-books to characterize climates of the past, and to analyze weather types, storm trajectories and frequencies of different weather conditions. It was common practice for ships' captains and masters to routinely log their position and weather conditions at noon each day, and sometimes several times per day associated with watch changes on deck.

The Naval Instruction Manual published by the British Admiralty in 1731 was one of the first publications to suggest standards for ship observations of the weather. These observations often included the date, time of day, the ships' position, notes on wind conditions, state of the sea, sky conditions, visibility, and precipitation. Log-books and journals from as far back as 1678 have been reviewed by climatologists to reconstruct weather patterns along major ocean routes and even to detect El Nino events in the Pacific Ocean (particularly when sea surface water temperatures were also taken). Because ships' captains as a breed had such high respect for the weather, it is not surprising that they were keen observers and recorded their observations diligently and with common notations and codes.

Topic: New Monthly and Seasonal Outlooks

The Climate Prediction Center released the new monthly and seasonal climate outlooks on Thursday, February 18 covering the period from March through May. The temperature outlook favors near normal temperatures for the western Great Lakes region including all of Minnesota during the March - May period. Similarly, the outlook for precipitation during this period also calls for near normal values. To the southwest of Minnesota in the central and southern plains states it is expected to be warmer and drier than normal.

MPR listener question: What is the deepest frost depth recorded in Minnesota soils during the winter?

Answer: I cannot give you a definitive answer because of the relative scarcity of data on soil frost depths. Much of the historical data in Minnesota is derived from frost tube measurements which typically record depths to 5 feet, but not beyond. There is a report from the weather observer in Brainerd, MN during January of 1918 which gives a frost depth of 91 inches (7 ft 8 in) in a coarse sandy soil. This is the deepest I can find in the climatological records. It occurred during a winter of very little snow cover and very cold December-January temperatures (about 10 degrees below normal). There have probably been deeper frost depths that have not been measured. By the way, current frost depths around the state range from 20 to 30 inches for the most part.

Almanac Segment:

Twin Cities Almanac for February 19th:

The average MSP high temperature for this date is 27 degrees F (plus or minus 12 degrees standard deviation), while the average low is 10 degrees F (plus or minus 14 degrees standard deviation).

MSP Local Records for February 19th:

MSP weather records for this date include: highest daily maximum temperature of 57 degrees F in 1981; lowest daily maximum temperature of -3 degrees F in 1929; lowest daily minimum temperature of -20 degrees F in 1929 and 1941; highest daily minimum temperature of 40 degrees F in 1930; record precipitation of 0.72 inches in 1952 and record snowfall of 8.3 inches in 1952. There have been fourteen measurable snowfalls on this date since 1948. Maximum snow depth has been 30 inches in 1967. The worst windchill conditions were -55 to -60 degrees F in 1941.

Average dew point for February 19th is 12 degrees F, with a maximum of 40 degrees F and a minimum of -28 degrees F.

All-time state records for February 19th:

Scanning the state climatic data base: the all-time high for this date is 68 degrees F at Winona (Winona County) in 1981; the all-time low is -52 degrees F at Baudette 22S (Lake of the Woods County) in 1966.

Words of the Week: Sun-glade or sun glint

Both of these terms refer to a type of bright reflection of the sun from the surface of a water body. This may be observed from an aircraft flying over a large lake, or even in visible weather satellite imagery. In fact sun glint seen in visible satellite imagery often appears as a large bright region over the tropical ocean areas. Small brighter spots of sun glint over otherwise dark ocean surfaces indicate relatively calm seas (glassy and smooth) with very light surface winds.

Forecast for Feb 20-26, 1999:

Though the weekend will be mostly dry and near seasonal temperatures, much of next week looks to be unsettled, beginning later on Monday and Tuesday. Winds will increase and there will be chances for snow statewide early next week, then again by Thursday. Because of the trajectory of these low pressure systems, there will be better chances for precipitation in the southern part of the state.

Topic: Meteorological Philately

Stamp collecting is one of the world's popular hobbies. Stamps are often printed in recognition of individual achievement, scientific discovery, appreciation for the plant and animal kingdoms, recognition of sporting events and historical events, and many other themes. Stamps have been produced since the British Penny Black was printed in 1840.

But did you know that meteorology has been widely celebrated and commemorated in a variety of special stamps? Some stamps were printed in recognition of Benjamin Franklin who came up with the famous quote, "some people are weatherwise and most are otherwise." A stamp from Italy honored Evangelista Torricelli who discovered the principle of the barometer, while a stamp from Norway celebrated Vilhelm Bjerknes who developed the theory of air masses and fronts. Many countries have printed stamps to commemorate hurricanes, typhoons, or other severe historical storms. Some stamps have pictured different types of cloud formations or weather instruments (windvanes and anemometers). It is estimated that in the past 100 years, approximately nearly 130 countries have issued over 1000 different stamps about weather related topics, meteorological discoveries or weather personalities. We in the profession should be appreciative of the postal services for recognizing our branch of science so abundantly.

MPR listener questions: How do Heating Degree Days for this winter compare to those of last winter? It seems like the temperatures have been just as mild this winter as last.

Answer: Indeed, despite a forecast earlier this fall for winter temperatures to trend colder than normal, it has been another warm winter for Minnesota. Heating Degree Days which are used to assess energy consumption for home and commercial heating are based on the accumulation of daily mean temperature below a base value of 65 degrees F. The list below shows the departure from normal in Heating Degree Days (HDD) for this winter, through February 23 compared to the departures for last winter by February 23rd. The percentage departure is calculated from the averages for the 1961-1990 period.

Location	Seasonal departure in HDD through Feb 23, 1999	Seasonal departure in HDD through Feb 23, 1998
Fargo-Moorhead,ND-MN	10% fewer	13% fewer
International Falls,MN	10% fewer	17% fewer
Sioux Falls, SD	12% fewer	11% fewer
La Crosse, WI	17% fewer	16% fewer
Duluth, MN	13% fewer	12% fewer
Rochester, MN	13% fewer	11% fewer
St Cloud, MN	13% fewer	13% fewer
Twin Cities, MN	13% fewer	13% fewer

Since last winter was considered one of the warmest this century it is somewhat surprising to see similar HDD departures for this winter. With 10 to 15 percent fewer Heating Degree Days this winter, residents of Minnesota are enjoying a real savings on heating costs for the second year in row. In fact the Climate Analysis Center reports that most of the cities in the nation's midsection are benefitting from a winter with 8 to 14 percent fewer than normal Heating Degree Days so far.

Almanac Segment:

Twin Cities Almanac for February 26th:

The average MSP high temperature for this date is 30 degrees F (plus or minus 12 degrees standard deviation), while the average low is 13 degrees F (plus or minus 13 degrees standard deviation).

MSP Local Records for February 26th:

MSP weather records for this date include: highest daily maximum temperature of 64 degrees F in 1896; lowest daily maximum temperature of -2 degrees F in 1919; lowest daily minimum temperature of -21 degrees F in 1897; highest daily minimum temperature of 41 degrees F in 1998; record precipitation of 0.51 inches in 1971 and record snowfall of 7.0 inches in 1936. There have been eleven measurable snowfalls on this date since 1948. Maximum snow depth has been 26 inches in 1962 and 1967; the worst windchill conditions were -55 to -60 degrees F readings during the early mornings hours in 1925.

Average dew point for February 26th is 15 degrees F, with a maximum of 44 degrees F and a minimum of -22 degrees F.

All-time state records for February 26th:

Scanning the state climatic data base: the all-time high for this date is 73 degrees F at Pleasant Mounds (Blue Earth County) in 1896; the all-time low is -49 degrees F at Pokegama Falls (Itasca County) in 1897.

Words of the Week: Snow Penitents

This term is used to describe a peculiar formation of old snow that is melting mostly as a result of sunlight rather than ambient air temperature. As snow cover ripens and decays in cold temperatures, the sun's rays begin to melt the snow where its density is lowest. Hollows form and deepen in the snow crust. These hollows are able to concentrate the sun's rays by reflection and the absorption of radiation is increased. As the hollows deepen, dewpoint and air temperature within these pockets rise, further accelerating the melting process. Finally, the surface looks like a series of miniature snow peaks or snow spikes somewhat oriented toward the midday sun. This phenomena is observed routinely in a number of places around the world, including the Himalayas, the Andes, the Alps, mountains of East Africa, Greenland, and Antarctica. Sometimes even in Minnesota, within river valleys, heavily forested areas or sloping terrain, the ripening and melting of the snow cover in late winter under stronger sunlight, but cold air temperatures will yield this appearance of snow penitents. I think that the name is derived from an old church practice where sinners doing penitence were required to remain standing during the entire worship service.

Forecast for February 27 - March 5th:

A series of low pressure systems will bring mixed precipitation to the state beginning on Saturday. Sunday may be a mostly dry day, but then the rest of the week should be cloudy and unsettled, with a mixture of precipitation ranging from light snow to sleet rain showers. Temperatures will average several degrees above normal through the early part of next week then taper off to near normal toward the end of the week. It will be humid with a good

deal of melting on the Minnesota landscape.

To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Mar 3, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Climate and Art

In the current issue of Weatherwise magazine there is an article about climate impacts on the European Impressionist painters of the late 19th century, including Monet, Pissarro, and Renoir, among others. Curator Eliza Rathbone of the Phillips Collection, an art museum in Washington, D.C. studied the historical winter weather records of France from 1864 to 1893. She found that the most severe winters occurred in 1879-80 and 1890-91. This research helped Rathbone date some heretofore undated Impressionist paintings from the period. Further, some of the features of ice and snow so vividly depicted in famous paintings clearly date from these severe winters. The artists either painted from memory or in some cases actually set up their aisles and canvas in the harsh winter environment to paint outside. In the extreme winter of 1879-1880, Monet produced 17 ice floe paintings from his observations of the Seine River in France.

MPR listener question: Everytime the news media mention the current La Nina episode, they mention that it is the opposite of El Nino? But, I have heard you say that they are not exactly opposites of each other. What's the catch?

Answer: The central and eastern equatorial Pacific Ocean exhibits both an abnormally warm phase (El Nino) and an abnormally cold phase (La Nina) every few years. In this sense, warmer than normal versus colder than normal ocean temperatures, these phenomena are opposites. In some cases, the climate effects of these phenomena are opposite as well, such as the tendency for the northern high plains (including Minnesota) to record a warmer than normal winter during El Nino episodes and a colder than normal winter during La Nina episodes.

However, in other characteristic attributes El Nino and La Nina are not truly opposites. Some examples are: El Nino episodes have occurred with a higher frequency than La Nina episodes; the magnitude of temperature departure with El Nino episodes tends to be larger than that of La Nina episodes; associated climate patterns are not always in the opposite direction nor do they always encompass the same geographic regions of the world.

For those monitoring the El Nino/La Nina feature in the Pacific Ocean, there is a web site to examine current and historical buoy observations. The site is called the Interactive Marine Observations homepage, and can be reached at the following URL.....

<http://www.nws.fsu.edu/buoy>

On the same site, one can examine buoy observations from the Atlantic Ocean, North Pacific, Gulf of Mexico, and even the Great Lakes.

Twin Cities Almanac for March 3rd:

The average MSP high temperature for this date is 33 degrees F (plus or minus 11 degrees standard deviation), while the average low is 16 degrees F (plus or minus 13 degrees standard deviation).

MSP Local Records for March 3rd:

MSP weather records for this date include: highest daily maximum temperature of 56 degrees F in 1927 and 1987; lowest daily maximum temperature of 8 degrees F in 1901; lowest daily minimum temperature of -14 degrees F in 1960; highest daily minimum temperature of 46 degrees F in 1983; record precipitation of 0.70 inches in 1961 and record snowfall of 11.2 inches in 1915. There have been fifteen measurable snowfalls on this date since 1948. Maximum snow depth has been 26 inches in 1962. The worst windchill conditions were -40 to -45 degrees F in 1913, 1920, 1932, and 1936.

Average dew point for March 3rd is 14 degrees F, with a maximum of 49 degrees F and a minimum of -23 degrees F.

All-time state records for March 3rd:

Scanning the state climatic data base: the all-time high for this date is 67 degrees F at Marshall (Lyon County) in 1987; the all-time low is -40 degrees F at Warroad (Roseau County) in 1943.

Words of the Week: Garcia Method

No, this does not refer to a style of guitar play or to a method of fishing, even though the Garcia name is known in both these areas! It is a method for forecasting the amount of snowfall expected from a given winter storm system. Named for Chris Garcia, a lead forecaster with the National Weather Service in Milwaukee, WI, this method was published in 1994 and has become a favorite tool of National Weather Service. The method is empirical and considers a number of parameters (ingredients) which cause snowfall, including vertical velocity (upward lift which carries air aloft to a condensation level) and mixing ratio (the mass of water vapor per mass of dry air expressed as g/kg). The method also considers the wind speed aloft because it is important to the advection (transport) of water vapor into the storm system (increasing the mixing ratio) and also because it dictates how fast the winter storm moves over a given area. The level of the atmosphere where these processes are considered important for winter storms ranges from 7,000 to 10,000 feet. A number of studies in recent years have shown that the Garcia Method is superior to many others in forecasting the amount of snow to expect over a 12 hour forecast period. In fact, thanks to the new computing and display power provided by the Advanced Weather Interactive Processing System (AWIPS) installed at the National Weather Service Forecast Offices, the Garcia Method has become a favorite tool of their meteorologists in forecasting snowfall amounts 6 to 18 hours ahead.

Outlook:

The week ahead appears to be somewhat unsettled with a series of low pressure systems affecting Minnesota. There will be chances for snow and mixed precipitation most days, with temperatures fluctuating a few degrees either side of historical averages for early March. It will be mostly cloudy and very windy as well.

To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Mar 12, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Top Ten MSP snowfalls (1891-1999)

Taken from the Minnesota State Climatology Office records, the table below summarizes the top ten heaviest Twin Cities snowfalls, the water equivalent and the ratio of snow/water (density)....

DATE	Total Snowfall (in)	Liquid Water Equivalent (in)	Ratio (snow/water)
1. Oct 31-Nov 3, 1991	28.4	2.83	10
2. Jan 22-23, 1982	20.0	1.10	18
3. Jan 20-21, 1982	17.4	0.81	21
4. Nov 11-12, 1940	16.8	2.66*	6
5. Mar 3-4, 1985	16.7	1.41	12
6. Mar 11-14, 1940	16.7	1.17	14
7. Dec 27-28, 1982	16.5	1.52	11
8. Jan 20-21, 1917*	16.0	0.81	20
9. Mar 8-9, 1999*	16.0	1.20	13
10. Mar 31, 1985	14.7	1.25	12

* virtual tie for 8th place....

It is interesting that in 110 years of record keeping, three years (1940, 1982, and 1985) provide 7 of the top ten snowfall events. The three January snowfalls clearly show the least density with snow/water ratios of about 20:1. The fluffy snow from these storms was likely due to the cold temperatures (less than 17 degrees F) and low dewpoints. The famous Armistice Day blizzard of 1940 shows the greatest density with a snow/water ratio of 6:1. This heavier snow was at least partially the result of higher dewpoints and warmer temperatures (mid 30s F) when the storm entered Minnesota. The storm from Monday and Tuesday of this week is tied for 8th on the list. Only one snowfall event in the top ten occurred in a single day, March 31, 1985.

Topic: Public Expectations of Meteorologists

Criticism leveled at meteorologists for under-forecasting the total snow from the storm this week prompted me to think about public expectations for weather forecasters. It is probably fair to say that not one of the top ten snowfalls listed in the table above was forecasted accurately. Most meteorologists approach the forecasting of snowfall in a somewhat conservative manner and therefore rarely if ever forecast a record setting event. Similarly, during the severe weather season of the summer, meteorologists like to be certain of the presence of hail or tornadoes before they alert the public. They use severe weather watches to alert the public to the possibility of severe weather, then provide a warning when it actually occurs. Perhaps one day such a system will be applied to heavy winter snowfalls as well, so that the public will be alerted to the possibilities of storm intensity, even if it fails to materialize.

MPR listener question: I read in the paper that the heavy snow in the Twin Cities on Monday and Tuesday of this week was the greatest for a March storm since 1985. How often do we get a snow storm of at least 12 inches in March?

Answer: Checking the MSP climate records back to 1891, the storm this week that delivered 16 inches of snow to the Twin Cities area was only the 11th measurable snowfall of 12 inches or greater during during the month of March. The eleven largest March snowfalls in the Twin Cities records are listed below, along with the water equivalents and the snow/water ratios..

DATE	Total Snowfall (in)	Liquid Water Equivalent (in)	Ratio (snow/water)
1. Mar 11-14, 1940	16.7	1.17	14
2. Mar 3-4, 1985	16.7	1.41	12
3. Mar 8-9, 1999	16.0	1.20	13
4. Mar 31, 1985	14.7	1.25	12
5. Mar 22-23, 1952	14.1	1.44	10
6. Mar 10-12, 1899	14.0	1.64	9
7. Mar 4-5, 1915	13.7	0.67	20
8. Mar 22-23, 1966	13.6	1.41	10
9. Mar 10-12, 1962	12.9	1.17	12
10. Mar 17-18, 1965	12.2	0.96	13
11. Mar 28-29, 1924	12.0	1.04	12

With the exceptions of the 1915 storm and the 1899 storm, heavy March snowfalls have contained between 1 and 1.5 inches of water. Snow containing one inch of water weighs 5.2 pounds per square foot, thus most of these March snowfalls would have deposited between 2 and 3 tons of weight on a 1000 square foot roof area. Thankfully, with the longer days and warmer temperatures of March, deep snow cover is rather short-lived.

Twin Cities Almanac for March 12th:

The average MSP high temperature for this date is 37 degrees F (plus or minus 12 degrees standard deviation), while the average low is 22 degrees F (plus or minus 12 degrees standard deviation).

MSP Local Records for March 12th:

MSP weather records for this date include: highest daily maximum temperature of 69 degrees F in 1990; lowest daily maximum temperature of 11 degrees F in 1956; lowest daily minimum temperature of -8 degrees F in 1956; highest daily minimum temperature of 50 degrees F in 1990; record precipitation of 1.10 inches in 1899 and record snowfall of 11 inches in 1899. There have been fifteen measurable snowfalls on this date since 1948. Maximum snow depth has been 26 inches in 1962. The worst windchill conditions were -35 to -40 degrees F in 1948.

Average dew point for March 12th is 21 degrees F, with a maximum of 45 degrees F and a minimum of -17 degrees F.

All-time state records for March 12th:

Scanning the state climatic data base: the all-time high for this date is 70 degrees F which occurred at Canby (Lyon County) in 1933, at Beardsley (Big Stone County) in 1934, and at St Paul, Stillwater, and St James in 1990; the all-time low is -34 degrees F at Ada (Norman County) in 1896.

Words of the Week: Hostile Ridge

This term, used earlier in the week by forecaster Byron Paulson of the National Weather Service Forecast Office in Chanhassen, MN can be safely called a meteorological colloquialism. But among friends and colleagues of the Weather Service it might be referred to as a Paulsonism. Ridge used by itself refers to an area of high pressure, characterized by low dewpoints, sunny skies, and light winds. However, when combined with the word hostile it has a somewhat different meaning. A relatively strong high pressure ridge will deflect or weaken approaching low pressure systems, diminishing their potential to deliver any significant precipitation. This is the character of a hostile ridge noted by forecasters who might otherwise forecast significant snowfall from an approaching low pressure center in the high plains. It is thus appropriate that those who might be hoping for more snowfall should call this particular weather feature hostile. Similarly, a hostile ridge may be the undoing of an approaching thunderstorm complex in the summer severe weather season. In this context, this weather feature might be more appropriately referred to as a protective ridge or a ridge shield.

Outlook:

A low pressure system will bring changes for mixed precipitation to southern portions of the state this weekend, perhaps lingering into early Monday. The northern part of the state will be mostly dry. A warming trend will start by Tuesday and Wednesday next week, bringing a return of temperatures into the highs 30s and 40s with plenty of sunny skies.

To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Mar 19, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: March 1910 one for the record books

One of the most remarkable climate aberrations in Minnesota weather history occurred in March of 1910. It was the warmest March in the record books statewide by nearly 5 degrees F, averaging about 17 degrees F above normal. It was also very dry. Many central and southern counties reported no measurable precipitation for the month, and even the statewide average precipitation was little more than a quarter of an inch. The Twin Cities reported only three days with measurable precipitation, totally a record monthly low of 0.09 inches. Snow vanished from the landscape in the southern half of the state by March 7th and soils thawed, allowing for some tillage and planting activity by Minnesota farmers. By the 23rd even northern lakes were ice-free and open for fishing, the earliest such occurrence in history.

The dryness was exacerbated by very low humidity, bright sunny skies, and strong winds. Twenty days were characterized by clear skies, 7 days by partly cloudy skies, and only 4 days by cloudy skies. Winds averaged nearly 14 mph for the month. A nasty wind storm with 54 mph winds knocked down telephone lines, broke out windows, and disabled streetcars in the Twin Cities on the 6th. The warmth and dryness produced many forest, brush and prairie fires that spring.

Many high temperature records still stand from March of 1910. On the 23rd, several communities recorded temperatures in the 80s F, topped by Montevideo which reported 88 degrees F. These temperatures are approximately 40 degrees F above the average for March 23rd and equivalent to normal high temperatures for the month of July, a four month climate displacement. There are only a handful of temperature records in Minnesota that represent this degree of temperature departure. Most daily temperature records in Minnesota represent departures of 25 to 35 degrees F from historical averages.

Topic: New Monthly and Seasonal Climate Outlooks

I will review these when available on Thursday afternoon of this week.

MPR listener question: Wind speeds around the state on St Patrick's Day this week (March 17) exceeded 40 and 50 mph, even 60 mph in western counties. It was impossible to march in the parade and keep my hat on. How often do wind speeds in March reach this level?

Answer: Not very often. A quick check of the wind statistics for the Twin Cities shows that wind speeds exceed 30 mph

during the month of March only about 1 percent of the time (one day in a hundred). In western Minnesota, March wind speeds reach 30 mph about 4 to 5 percent of the time (4 or 5 days in a hundred). For St Patrick's Day specifically, the following table shows the average wind speed on March 17 for each year from 1945 to 1998 in the Twin Cities...

Average wind speed reported from MSP International Airport on St Patrick's Day, March 17th (1945-1999)

Year	Ave Wind Speed (mph)	Year	Ave Wind Speed (mph)
1945	15.8	1946	12.4
1947	9.7	1948	5.9
1949	11.7	1950	16.6
1951	8.3	1952	13.6
1953	10.9	1954	14.5
1955	16.4	1956	8.9
1957	9.7	1958	10.7
1959	8.4	1960	9.0
1961	10.9	1962	6.9
1963	13.8	1964	14.5
1965	20.1	1966	16.4
1967	11.3	1968	17.4
1969	7.6	1970	7.5
1971	4.6	1972	8.7
1973	11.8	1974	6.7
1975	12.0	1976	8.4
1977	13.9	1978	11.2
1979	15.4	1980	12.3
1981	15.8	1982	5.6
1983	10.3	1984	14.5
1985	9.2	1986	9.0
1987	20.2	1988	9.8
1989	11.3	1990	18.3
1991	7.2	1992	12.3
1993	6.8	1994	14.1
1995	10.9	1996	10.3
1997	10.3	1998	12.7

1999 preliminary ave wind speed 19.8 mph (3rd highest) and a wind gust to 46 mph.

St Patrick's Day of 1965 and 1987 were certainly the windiest based on average wind speed. Wind advisories (sustained wind speeds of 30 mph or gusts to 45 mph) were also issued for those celebrations as well. Based on average wind speed this year's St Patrick's Day was the third windiest since WWII in the Twin Cities.

Twin Cities Almanac for March 19th:

The average MSP high temperature for this date is 40 degrees F (plus or minus 11 degrees standard deviation), while the average low is 24 degrees F (plus or minus 11 degrees standard deviation).

MSP Local Records for March 19th:

MSP weather records for this date include: highest daily maximum temperature of 72 degrees F in 1910; lowest daily maximum temperature of 14 degrees F in 1965; lowest daily minimum temperature of -7 degrees F in 1923; highest daily minimum temperature of 48 degrees F in 1910; record precipitation of 1.09 inches in 1897 and record snowfall of 8.8 inches in 1943. There have been ten measurable snowfalls on this date since 1948. Maximum snow depth has been 26 inches in 1951. The worst windchill conditions were -35 degrees F in 1965.

Average dewpoint for March 19th is 23 degrees F, with a maximum of 52 degrees F and a minimum of -11 degrees F.

All-time state records for March 19th:

Scanning the state climatic data base: the all-time high for this date is 76 degrees F which occurred at Albert Lea (Freeborn County) in 1910; the all-time low is -40 degrees F at Meadowlands (St Louis County) in 1923 (following a blizzard two days earlier).

Words of the Week: The Laplace Formula

Pierre Simon Laplace was born in Normandy in 1749. Residing in Paris for much of his life, he was a mathematical genius and published many pioneering works in fluid mechanics, calculus and probability theory. His best known work is *Mecanique celeste* in which he describes a formula for the determination of height from barometric pressure. The fall of air pressure with elevation had been observed for many years, but few had attempted to develop an equation to describe it. This is one of the most important formulas in meteorology and has been used for generations to standardize barometric pressure readings taken from all kinds of landscape elevations to mean sea level values. Aircraft altimeter settings are based on the Laplace formula.

Outlook:

A trough and cold front will bring a chance for widely scattered snow showers in the north and light rain or snow showers in the central counties Saturday dry. There will be another chance for showers during Wednesday through Friday of next week as a strong low pressure system passes to the south. Temperatures over the period will be a few degrees above normal.

To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Mar 26, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Two Important Designated Days this Week

World Meteorological Day 1999

Tuesday, March 23 this week marked the 49th anniversary for World Meteorological Day, a time to recognize the formation of the World Meteorological Organization (WMO) under the United Nations in 1950. The WMO promotes the adoption of standard observational and forecasting procedures among all national meteorological and hydrological services. This year the theme of the observance was "Weather, Climate and Health." The WMO is recommending stronger cooperation among meteorological services and public health authorities in the provision of relevant information to citizens. They emphasize more attention be given to promoting the use of comfort indices (heat index and windchill), air stagnation and pollution warnings, pollen and dust counts, and the ultraviolet radiation index or sunburn forecasts.

More on World Meteorological Day significance and celebration can be found at the WMO web site.....

<http://www.wmo.ch:80/index.html>

World Day for Water 1999

In 1992 the United Nations General Assembly designated March 22nd of each year as the "World Day for Water." This was done to recognize the importance of water to everyday life and the need to protect and preserve water quality and quantity. The theme this year is "everyone lives downstream." Because many countries share common watersheds and the associated rivers, lakes and wetlands, the U.N. is stressing the need for greater international cooperation in managing these water resources to insure their sustainability.

United Nations officials highlight several international treaties that have dealt effectively with "hydropolitics" to insure that waters are both efficiently utilized and preserved among nations, including....

the 1909 Boundary Waters Treaty between Canada and the United States to share and preserve the watersheds of the Great Lakes.

The Rhine River Plan in Europe, the Ganges River Plan between India and Bangladesh, and the Southern Africa Development plan for the Zambezi River all represent international agreements to share, conserve and preserve the quality of water in major rivers.

More on the World Day for Water is also available at the WMO web site listed above....

Topic: Sundial Rhymes

Now that the sun is climbing so high in the sky and people are spending more time outside, I thought it might be a good time to reflect on the ancient practice of telling time by the sun. Sundials are perhaps one of the oldest instruments known. Many are quite ornate and used in gardens or public parks. There are several which have appropriately inscribed rhymes. Some of these include:

Serene I stand among the flowers;
And only count life's sunny hours.

When the hour is bright and clear,
You'll find the time recorded here.

Set me right and use me well;
And I the time to you will tell.

Of shade and sunshine for each hour,
See here a measure made.
Then wonder not if life consists,
Of sunshine and of shade.

Anyone know of others?

Topic: Interpreting Sky Conditions

National Weather Service public forecasts contain statements about the condition of the sky, almost always related to the degree of cloudiness. The specific categories are defined below. Distinguishing between partly cloudy and partly sunny is still a matter of perspective.

The following descriptions are used in public forecasts:

SKY CONDITION CATEGORIES

Sky Condition	Cloud Coverage
Cloudy	9/10 to 10/10 of sky covered
Mostly cloudy, Considerable cloudiness	7/10 to 8/10
Partly cloudy or Partly sunny	3/10 to 6/10
Mostly clear or Mostly sunny	1/10 to 3/10
Fair	Less than 4/10, no precipitation pleasant weather conditions

(from NWS, Media Guide to National Weather Service Terminology, 1996)

Further descriptions of the terminology used in National Weather Service forecasts, including the Media Guide, can be found at the following web site:

<http://www.crh.noaa.gov/mkx/media.htm>

MPR listener question: Even though temperatures have not been extremely warm this month, we have seen the rapid disappearance of the abundant snow cover we received back on the 8th and 9th. Is this due to the number of bright sunny days and longer daylength?

Answer: Certainly it is partially correct to say that the sun has helped to melt and evaporate the snow cover in fairly short order. However, other elements of the environment have been driving these processes as well. Higher than normal wind speeds this month have helped to accelerate evaporation rates. In addition, something called the vapor pressure deficit has been effective in driving evaporation rates as well. This is the difference in water vapor content between saturated air (air at 100 percent relative humidity) and ambient air (the surrounding outside air). This creates a water vapor gradient which promotes water vapor to move from high concentration areas such as over puddles, ponds and wet surfaces to areas of less concentration such as the air flowing above the surface. Evidence for this vapor gradient is found in the low dewpoint temperatures reported around the state this week, values in the single digits and teens. Even though afternoon temperatures have reached the 40s and 50s, the relative humidity has been only in the teens and 20s many places. Static electricity shocks have been pretty common with such dry air.

Twin Cities Almanac for March 26th:

The average MSP high temperature for this date is 43 degrees F (plus or minus 12 degrees standard deviation), while the average low is 26 degrees F (plus or minus 10 degrees standard deviation).

MSP Local Records for March 26th:

MSP weather records for this date include: highest daily maximum temperature of 74 degrees F in 1991; lowest daily maximum temperature of 12 degrees F in 1996; lowest daily minimum temperature of -10 degrees F in 1996; highest daily minimum temperature of 49 degrees F in 1945, 1961, and 1998; record precipitation of 1.02 inches in 1921 and record snowfall of 10 inches in 1936. There have been seven measurable snowfalls on this date since 1948. Maximum snow depth has been 18 inches in 1965; the worst windchill conditions were -25 to -30 degrees F readings in 1955.

Average dew point for March 26th is 25 degrees F, with a maximum of 54 degrees F and a minimum of -8 degrees F.

All-time state records for March 26th:

Scanning the state climatic data base: the all-time high for this date is 77 degrees F at Morris (Stevens County) in 1939 and at Luverne (Rock County) in 1998; the all-time low is -31 degrees F at Fosston (Polk County) in 1996.

Words of the Week: "The water tower of Europe"

These words are used to describe the country of Switzerland, specifically the Swiss Alps which serve as a source region for

many of Europe's great rivers. Many major watersheds in Germany, France, Austria, and Italy are fed by the spring and summer runoff from the Swiss Alps. These waters are vital to the European community in terms of hydroelectric power generation, agricultural and municipal water supply, and recreation.

Outlook:

A chance for scattered rain showers late Saturday and into Sunday, with perhaps even some thunder and lightning. It will be rather windy over the weekend as well, with temperatures well above normal. Then another chance for some precipitation by Tuesday and Wednesday, with strong winds. Temperatures will continue to average above seasonal normals.

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To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Apr 2, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Signs of an early spring

The absence of snow cover, combined with longer days, above normal temperatures, and recent rains have helped to drive the frost out of the ground. Some soils are frost-free now, while others have a layer of frozen soil between 12 and 18 inches. Many soils will probably be tillable soon, as Minnesota farmers prepare for the 1999 crop season. With expected above normal temperatures during the first half of April, the DNR State Climatology Office is estimating that Minnesota lakes will lose their ice cover a week or more earlier than normal. Some crocus are blooming and buds are swelling on elderberry, lilac, and maple trees, so it would appear spring will advance with great pace during April...

Topic: Preliminary March Climate Summary

Warm, dry, and windy would characterize the month of March for most communities in Minnesota. Temperatures averaged from 3 to 5 degrees above normal in most places. Winds averaged well above normal as well, with many places reporting wind gusts over 40 mph on more than one day. Precipitation was generally close to normal, but the month was perceived as a dry one because measurable precipitation was recorded on only 5 or 6 days, and relative humidity on most days was very low. Rapid loss of snow cover and melting lake ice occurred during the second half of the month.

MPR listener question: What are the all-time temperature extremes for Minnesota during the month of March and what were the extremes for this recent March?

Answer: The range of temperature in March is the largest of any month of the year in Minnesota. Historically the extremes have ranged from 88 degrees F at Monetvideo on March 23, 1910 to -49 degrees F at Pokegama Dam on March 15, 1897. That's a 137 degree F temperature range and is beyond the range of annual temperature for most other places in the world. Locally, the range in March temperature for the Twin Cities has been 115 degrees F, based on an 83 degrees F maximum temperature (a few times) most recently on March 29, 1986, and a minimum of -32 degrees F on March 1, 1962.

From preliminary data, the range in temperature around Minnesota for the recent month of March (1999) was about 90 degrees F. The high occurred on March 30, with an afternoon temperature of 74 degrees F reported from Redwood Falls. The lowest minimum temperature I could find was -16 degrees F at Tower on the morning of March 6th.

Twin Cities Almanac for April 2nd:

The average MSP high temperature for this date is 47 degrees F (plus or minus 12 degrees standard deviation), while the average low is 30 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for April 2nd:

MSP weather records for this date include: highest daily maximum temperature of 78 degrees F in 1981; lowest daily maximum temperature of 23 degrees F in 1920; lowest daily minimum temperature of 10 degrees F in 1954; highest daily minimum temperature of 59 degrees F in 1963; record precipitation of 1.00 inches in 1934 and record snowfall of 3.4 inches in 1920. There have been four measurable snowfalls on this date since 1948. Maximum snow depth has been 10 inches in 1975; the worst windchill conditions were -25 to -30 degrees F readings in 1920.

Average dew point for April 2nd is 28 degrees F, with a maximum of 61 degrees F and a minimum of -8 degrees F.

All-time state records for April 2nd:

Scanning the state climatic data base: the all-time high for this date is 83 degrees F at Beardsley (Big Stone County) in 1928; the all-time low is -21 degrees F at Tower (St Louis County) in 1975.

Words of the Week: Thirl and tirl

Both of these words are Scottish in origin, initially meaning to whirl, rotate, or spin, such as in a dance. Among Scottish meteorologists these terms, thirl (pronounced thurl) and tirl (pronounced turl), refer to a fresh, strong breeze. I suppose this is based on observations of the wind causing leaves to spin about across the ground. It is certainly not based on the wind causing people to spin about uncontrollably, which is called a gale! We have certainly experienced a good deal of strong wind in March, one of the windiest in recent memory.

Outlook:

Chances for rain, mixed precipitation, or snow (up north) right through the weekend and into early next week statewide. Another chance for precipitation later in the week as well. It will continue to be windy and warmer than normal in most areas.

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From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Apr 9, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Trends in evaporation data

Staff of the National Climatic Data Center released a paper last year which documented their study of time trends in evaporation data from the United States and the former Soviet Union. An examination of 45 years worth of daily pan evaporation measurements during the northern hemisphere growing season showed a decreasing trend in most areas. This fits well with the trends of increased cloudiness, frequency of precipitation and reduced diurnal temperature range in the northern hemisphere found by other authors. These features of the climate would tend to reduce evaporation rates since they suggest limited solar radiation and water vapor deficits, both of which help drive the evaporation process.

Granted this study only documents trends in evaporation from the land, rather than the oceans. Nevertheless, the downward trend does not support the idea that greenhouse forcing produces an enhanced hydrologic cycle. It does help explain an observed increase in surface runoff in parts of the northern hemisphere, though land use changes may have more to do with this.

Topic: Perceptions of freak weather and acts of God

There is a fascinating article in the current Weather Magazine from the Royal Meteorological Society about public perceptions of unusual weather and the court system. The article is by John Tyrrell of University College, Cork, Ireland.

He argues rather effectively that the use of the term "normal" by the weather forecaster has narrowed the public expectations for what the range of weather might be for any particular location and time of year. Tyrrell points to evidence of this perception in the widespread use of the term "freak weather" to describe anything that departs from the expected normal. Most often tornadoes, heavy rainfall, strong winds, hail, lightning, and even flooding are referred to as freak weather events or episodes. Though the frequencies for these events are better understood and documented than ever before, a large fraction of the public remain ignorant about the probabilities.

A distinction is drawn between freak weather and acts of God, the latter being a legal term used as an argument to constitute a defense against the rule of absolute liability. The premise of this distinction is that freakish weather does not always lead to damage, injury, or loss. The criteria to argue for an act of God defense include: (1) an event produced by natural causes or a process of nature, beyond human intervention; (2) clear, direct evidence for cause and effect; and (3) reference to circumstances that no human foresight can provide against and of which human prudence is not bound to recognize the possibility. The act of God defence has historically been based on the unpredictability of many weather events. However in recent decades with improvements in weather services and analysis of climate extremes, the courts have tended to accept the act of God defense with less frequency.

Indeed, the insurance industry has modified their products in recent years to include more all-risk policies without act of God exclusions. However, there are some geographic areas where specific exclusions apply to insurance policies, such as flood prone areas, and some companies require policy holders to meet action requirements relating to building codes.

The implication of this article is that all those with a duty of care (liability burden) that is likely to be affected by the weather need to become more educated and have their expectations finely tuned to the realities of the climate regime. The need for God as a defense in liability cases will likely continue to diminish as insurance companies continue to adapt and offer more products that consider the probabilities of a variety of weather events and episodes for specific geographic areas.

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Answer: Yes, some heavy snowfall amounts were reported Monday night and Tuesday morning from a number of northeastern Minnesota communities: Two Harbors nearly 12 inches, Duluth 11.5 inches, Grand Marais 10 inches, Silver Bay 10 inches, Finland 11 inches, and Wolf Ridge Nature Center 10 inches.

This is not especially unusual for the month of April. Some historically large April snowfalls have included: 18 inches at Meadowlands (St Louis County) on April 4, 1968; 20 inches at Grand Meadow (Mower County) on April 8-9, 1973; and 15 inches at Isabella (Lake County) on April 23-24, 1968. The greatest single snowfall in the month of April was 28 inches at Pigeon River Bridge (Cook County) on April 4-5, 1933. Even the larger metropolitan areas in the state have recorded pretty substantial April snowfalls. Some of these are listed below:

Greatest April snowfalls in three Minnesota's largest cities, amount of snowfall in inches and date(s) recorded:

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In April of 1950 Duluth recorded 32 inches of snowfall, while in April of 1983, the Twin Cities recorded nearly 23 inches of snow.

Twin Cities Almanac for April 9th:

The average MSP high temperature for this date is 51 degrees F (plus or minus 11 degrees standard deviation), while the average low is 32 degrees F (plus or minus 7 degrees standard deviation).

MSP Local Records for April 9th:

MSP weather records for this date include: highest daily

maximum temperature of 81 degrees F in 1930; lowest daily maximum temperature of 29 degrees F in 1973; lowest daily minimum temperature of 15 degrees F in 1997; highest daily minimum temperature of 53 degrees F in 1945; record precipitation of 0.75 inches in 1919 and record snowfall of 5.5 inches in 1894. There have been nine measurable snowfalls on this date since 1948. Maximum snow depth has been 4 inches in 1980; the worst windchill conditions were -10 to -15 degrees F readings in 1909.

Average dew point for April 9th is 27 degrees F, with a maximum of 58 degrees F and a minimum of 7 degrees F.

All-time state records for April 9th:

Scanning the state climatic data base: the all-time high for this date is 91 degrees F at Redwood Falls (Redwood County) in 1977; the all-time low is -5 degrees F at Tower (St Louis County) in 1997.

Words of the Week: Woolpack or Cauliflower Cloud

These terms are old ones used to refer to some types of cloud formations, namely cirrocumulus (high cumulus) and altocumulus (mid level cumulus). These types of clouds seen in abundance may have a fleecy appearance and look like an airborne flock of sheep or lambs. Seen in isolation, one of these clouds may have the appearance of a head of cauliflower. These terms were first used by 19th century British meteorologists Abercromby and Scott who contributed to the first International Cloud Atlas published in 1896. These cloud forms are more frequent during the spring months in Minnesota when it is fun to observe the wide variety of cloud formations.

Those readers wishing to learn more about clouds can consult two educational web sites which catalog the different cloud types:

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Outlook:

A period of cloudy, windy and rainy weather is in store for much of the state this weekend, especially southern counties. The unsettled conditions should prevail into next week as well, as another low pressure system approaches on Tuesday and Wednesday. Temperatures will continue to trend above normal, continuing a more rapid advance of spring. Rainfall will be abundant in the southern counties.

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From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Apr 9, 1999

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Topic: Trends in evaporation data

Staff of the National Climatic Data Center released a paper last year which documented their study of time trends in evaporation data from the United States and the former Soviet Union. An examination of 45 years worth of daily pan evaporation measurements during the northern hemisphere growing season showed a decreasing trend in most areas. This fits well with the trends of increased cloudiness, frequency of precipitation and reduced diurnal temperature range in the northern hemisphere found by other authors. These features of the climate would tend to reduce evaporation rates since they suggest limited solar radiation and water vapor deficits, both of which help drive the evaporation process.

Granted this study only documents trends in evaporation from the land, rather than the oceans. Nevertheless, the downward trend does not support the idea that greenhouse forcing produces an enhanced hydrologic cycle. It does help explain an observed increase in surface runoff in parts of the northern hemisphere, though land use changes may have more to do with this.

Topic: Perceptions of freak weather and acts of God

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He argues rather effectively that the use of the term "normal" by the weather forecaster has narrowed the public expectations for what the range of weather might be for any particular location and time of year. Tyrrell points to evidence of this perception in the widespread use of the term "freak weather" to describe anything that departs from the expected normal. Most often tornadoes, heavy rainfall, strong winds, hail, lightning, and even flooding are referred to as freak weather events or episodes. Though the frequencies for these events are better understood and documented than ever before, a large fraction of the public remain ignorant about the probabilities.

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To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Apr 16, 1999

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Topic: Our tax dollars at work

Having just past the tax filing deadline, we might pause and contemplate one of the great benefits from our tax dollars, the National Weather Service. Professor Ed Hopkins from the University of Wisconsin in Madison has calculated that each U.S. citizen contributes \$2.40 to the National Weather Service annual budget. For little more than the cost of a Sunday newspaper edition, we get the best weather service in the world, providing us with forecasts, observations, climate and weather research, advisories, outlooks, and the always important severe weather watches and warnings, 24 hours each day of the year. This security blanket is (in my humble opinion) greatly under-appreciated by the American public.

Topic: Weather related economic losses on a rising trend

The Worldwatch Institute and the insurance company Munich Re have recently calculated that the weather of 1998 brought over \$89 billion in economic losses worldwide, the highest ever annual total, far exceeding the total estimate of \$55 billion for the entire decade of the 1980s. Some of the costliest weather-related disasters of 1998 included Hurricane Mitch in Central America, flooding of the Yangtze River in China, flooding of the Ganges River in Bangladesh, the January ice storm in Canada and the New England states, drought related forest fires in Siberia, cyclones striking India, and floods in Turkey, Argentina and Paraguay.

It is argued by some that deforestation may have played a role in exacerbating the erosion and flood damages in Central America, China and Bangladesh. This is because of the loss of protective vegetative cover which normally intercepts much of the rainfall, reducing the amount of runoff and soil displacement, especially in sloping landscapes. Though further studies are needed to confirm the magnitude of this effect, the Chinese government is convinced and has initiated a \$2 billion reforestation project in the Yangtze watershed.

Speaking of weather disasters, Sydney, Australia recorded its worst weather disaster in perhaps 30 years on Wednesday night of this week (April 14) when a violent hailstorm crossed over the city, dropping wind-driven hailstones the size of cricket balls. Damages were estimated in the range of \$400 million. Most slate and tile roofs were damaged and many windows broken. Emergency repairs were required on over 5000 homes. Thousands of motorists filed for insurance claims on their vehicles. It was also reported that 20 aircraft at the Sydney Airport were damaged.

The unexpected storm took place within minutes of the staff changeover at the Bureau of Meteorology forecast office, and the

lone forecaster on the night shift had to handle the warning and emergency activation procedures for the city. He must have been under a little bit of stress!

MPR listener question: What is the latest date for a below zero temperature reading during the spring in Minnesota? Is it very common to have such readings during April?

Answer: The latest date I could find in the Minnesota records is April 19, 1897 at Tower, MN (St Louis County) when the minimum temperature dropped to -3 degrees F (there was also an inch of snow cover at the time). It is quite uncommon to have below zero temperatures in Minnesota during April, except for the far north central counties where such temperatures occur in 20 to 30 percent of the years.

Twin Cities Almanac for April 16th:

The average MSP high temperature for this date is 57 degrees F (plus or minus 12 degrees standard deviation), while the average low is 37 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for April 16th:

MSP weather records for this date include: highest daily maximum temperature of 88 degrees F in 1964; lowest daily maximum temperature of 32 degrees F in 1910 and 1953; lowest daily minimum temperature of 20 degrees F in 1907; highest daily minimum temperature of 65 degrees F in 1976; record precipitation of 0.78 inches in 1916 and record snowfall of 5.0 inches in 1961. There have been five measurable snowfalls on this date since 1948. Maximum snow depth has been 7 inches in 1983; the worst windchill conditions were -15 to -20 degrees F readings in 1907.

Average dew point for April 16th is 32 degrees F, with a maximum of 98 degrees F and a minimum of 8 degrees F.

All-time state records for April 16th:

Scanning the state climatic data base: the all-time high for this date is 89 degrees F in southwestern Minnesota at Canby, Windom, and Luverne in 1964; the all-time low is 0 degrees F at Gunflint Lake (Cook County) in 1983 (17 inches of snow still on the ground).

Words of the Week: Interception and interceptometer

These words are taken from the disciplines of agricultural and forest meteorology. Interception refers to the manner by which trees, brush, and crop canopies prevent all precipitation from reaching the soil. The amount of precipitation interception among these species varies from 40 to 100 percent depending on the rate that it is falling, the wind conditions, and the size and shape of the vegetative canopy. Interception helps prevent soil erosion by reducing both the amount of moisture and the kinetic energy which reaches the soil surface.

The interceptometer is the old name given to a rain gage or collection device that is placed underneath the vegetative canopy and allowed

to catch the drip from the leaves and stems, or the throughfall which is not intercepted. This catch is compared to that of a rain gage left in an unshielded open setting in order to estimate the amount of rainfall being intercepted.

Outlook:

Chance of mixed precipitation continuing in eastern sections of MN into Saturday, then looking dry for Sunday and Monday in most places. Even in the absence of precipitation, clouds will likely be abundant and temperatures will be cooler than normal for much of the coming week, though a warming trend looks probable by Thursday. Chance of shower activity and thunderstorms developing for late Tuesday through Thursday as a large storm system tracks across the central plains.

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Topic: Volcanoes

On Monday morning, Shishaldin Volcano in the eastern Aleutian Islands off Alaska erupted, producing an ash and steam plume that quickly rose to an altitude of between 40,000 and 60,000 feet within an hour before drifting south on northerly upper air winds over the Pacific Ocean. This volcano is located on Unimak Island to the west of Cold Bay. A volcanic ash warning was in effect for Unimak Island and aviation alerts were posted for high flying aircraft in the vicinity of the Aleutians. The National Weather Service Forecast Office in Anchorage has posted several impressive satellite images of the eruption at

<http://www.alaska.net/~nwsfoanc/volcano.html>.

Shishaldin was the 14th detected volcanic eruption so far in 1999. The Volcanic Ash Advisory Centers form a worldwide network to monitor volcanic activity and release information to the public. Their web site is...

<http://www.alaska.net/~aawu/vaac.html>

In addition, the University of North Dakota operates a web site which lists characteristics of the most recent volcanic eruptions around the world. This site can be found at....

http://volcano.und.nodak.edu/vwdocs/current_volcs/current.html

Topic: Remarkable swing in temperatures on this date in 1980

One of the most remarkable drops in temperature occurred on this date in 1980. Hawley, in Clay County east of the Fargo-Moorhead area, had recorded an all-time high April temperature of 101 degrees F on April 22nd. However, winds shifted around to the north and brought in a cold Canadian air mass dropping the temperature to 30 degrees F on the morning of April 23rd. This 71 degree F change in temperature over a 24 hour period is one of the largest in the Minnesota historical records. The month of April that year saw the onset of a spring drought in the Red River Valley.

MPR listener question: Though we have not seen a great deal of sunshine yet this month, is this the time of year when the Ultraviolet Index (UVI) forecast becomes important?

Answer: We usually see UVI values in the moderate range (4-5) during the first half of May. So, it is still a bit early to be concerned. The American Cancer Society recommendations indicate that at values of 4 or greater a sunblock lotion or spray of 15+ is a good idea, along with wearing sunglasses.

Web sites where you can obtain the daily UVI forecast from the National Weather Service include...

http://www.cpc.ncep.noaa.gov/index_frame.html
(NOAA Climate Prediction Center)

<http://www.weather.com/health/uvindex.html>
(Cable Weather Channel)

Twin Cities Almanac for April 23rd:

The average MSP high temperature for this date is 61 degrees F (plus or minus 11 degrees standard deviation), while the average low is 40 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for April 23rd:

MSP weather records for this date include: highest daily maximum temperature of 86 degrees F in 1990; lowest daily maximum temperature of 35 degrees F in 1910; lowest daily minimum temperature of 19 degrees F in 1910; highest daily minimum temperature of 65 degrees F in 1925; record precipitation of 0.87 inches in 1948 and 1968; and record snowfall of 1.6 inches in 1988. There have been three measurable snowfalls on this date since 1948. Maximum snow depth has been 2 inches in 1963; the worst windchill conditions were -20 to -25 degrees F readings in 1910.

Average dew point for April 23rd is 34 degrees F, with a maximum of 65 degrees F and a minimum of 13 degrees F.

All-time state records for April 23rd:

Scanning the state climatic data base: the all-time high for this date is 93 degrees F at Winona in 1980; the all-time low is -1 degrees F at Grand Rapids (Itasca County) in 1918.

Words of the Week: PUFF and VAFTAD

These acronyms refer to models that are used by various meteorological services around the world to forecast the movement of volcanic ash plumes in the atmosphere. PUFF (short for ash puff), a real-time tracer model named by its developer H. Tanaka, uses atmospheric profile data including winds aloft, along with hypothetical particle size distributions of ash to forecast the plume trajectory, dispersion and settling rate of particles. The model forecast is updated and corrected using satellite observations of the ash plume, when it is large enough to detect.

VAFTAD stands for Volcanic Ash Forecast Transport and Dispersion Model and is used in conjunction with the numerical forecast models of the National Weather Service to predict the track and dispersion of ash plumes. The chief purpose of this model is to provide alerts for aircraft route forecasting since ash plumes can present a severe hazard to high flying commercial aircraft. A number of historical cases document aircraft problems with turbulence and stalled engines when flying near or through ash plumes.

Outlook:

Less cloud, more sun, and a warming trend starting this weekend and the early part of next week. Temperatures will climb to above seasonal averages and the Minnesota landscape should more rapidly greenup. There will be a chance for shower activity again by the middle of next week, but an overall drier trend should prevail.

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Answer: We usually see UVI values in the moderate range (4-5)

during the first half of May. So, it is still a bit early to be concerned. The American Cancer Society recommendations indicate that at values of 4 or greater a sunblock lotion or spray of 15+ is a good idea, along with wearing sunglasses. Web sites where you can obtain the daily UVI forecast from the National Weather Service include...

http://www.cpc.ncep.noaa.gov/index_frame.html
(NOAA Climate Prediction Center)

<http://www.weather.com/health/uvindex.html>
(Cable Weather Channel)

Twin Cities Almanac for April 23rd:

The average MSP high temperature for this date is 61 degrees F (plus or minus 11 degrees standard deviation), while the average low is 40 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for April 23rd:

MSP weather records for this date include: highest daily maximum temperature of 86 degrees F in 1990; lowest daily maximum temperature of 35 degrees F in 1910; lowest daily minimum temperature of 19 degrees F in 1910; highest daily minimum temperature of 65 degrees F in 1925; record precipitation of 0.87 inches in 1948 and 1968; and record snowfall of 1.6 inches in 1988. There have been three measurable snowfalls on this date since 1948. Maximum snow depth has been 2 inches in 1963; the worst windchill conditions were -20 to -25 degrees F readings in 1910.

Average dew point for April 23rd is 34 degrees F, with a maximum of 65 degrees F and a minimum of 13 degrees F.

All-time state records for April 23rd:

Scanning the state climatic data base: the all-time high for this date is 93 degrees F at Winona in 1980; the all-time low is -1 degrees F at Grand Rapids (Itasca County) in 1918.

Words of the Week: PUFF and VAFTAD

These acronyms refer to models that are used by various meteorological services around the world to forecast the movement of volcanic ash plumes in the atmosphere. PUFF (short for ash puff), a real-time tracer model named by its developer H. Tanaka, uses atmospheric profile data including winds aloft, along with hypothetical particle size distributions of ash to forecast the plume trajectory, dispersion and settling rate of particles. The model forecast is updated and corrected using satellite observations of the ash plume, when it is large enough to detect.

VAFTAD stands for Volcanic Ash Forecast Transport and Dispersion Model and is used in conjunction with the numerical forecast models of the

National Weather Service to predict the track and dispersion of ash plumes. The chief purpose of this model is to provide alerts for aircraft route forecasting since ash plumes can present a severe hazard to high flying commercial aircraft. A number of historical cases document aircraft problems with turbulence and stalled engines when flying near or through ash plumes.

Outlook:

Less cloud, more sun, and a warming trend starting this weekend and the early part of next week. Temperatures will climb to above seasonal averages and the Minnesota landscape should more rapidly greenup. There will be a chance for shower activity again by the middle of next week, but an overall drier trend should prevail.

To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Apr 30, 1999

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Topic: Preliminary April Climate Summary

April brought frequent cloudiness and precipitation to the southern half of Minnesota, where most communities reported above normal precipitation. Some areas in south central and southeastern Minnesota received 7 to 8 inches, well over twice the historical average. Southern counties also reported measurable precipitation on nearly half the days in April. Conversely, northern areas were drier than average, especially in the northwest.

Temperatures for April in Minnesota started out above normal, were below normal by mid month, then finished the month well above historical averages. The mean temperature for the month ranged from 2 to 3 degrees above the historical average.

Topic: Record April Snows in the Rockies

Heavy snow fell over the central Rockies last Friday and Saturday. As of Friday morning, more than 2 feet of new snow had fallen at Lander, WY. By the end of the storm, late in the weekend, 51.7 inches of snow fell, setting a new record total snowfall for a single storm. The 28.6 inches set a 24 hour snowfall record and the 69.4 inches for the month was a monthly record. Other mountainous locations across Wyoming and Colorado also received on the order of 3 feet of snow. However, at lower elevations, such as at Denver, CO, only 8 inches fell.

Topic: What a difference 140 years can make!

This week in 1863, Francis Capen offered his services as a forecaster to President Abraham Lincoln. In his letter of introduction he presented himself as a practical meteorologist who could use the telegraphic weather reports established by Professor Henry of the Smithsonian Institute to forecast the weather one to two days ahead. Capen thought that such forecasts would save many lives and millions of dollars for the Union Army campaign in the Civil War. On April 25th, he sent the president a written forecast for the last week of April, stating that there would be no rain in the Washington D.C. area before the 30th. Lincoln rebuffed Capen's proposal in a letter written on April 28th which stated: "It seems to me Mr. Capen knows nothing about the weather, in advance. He told me three days ago that it would not rain again till the 30th....it is raining now and has been for ten hours....I cannot spare any more time for Mr. Capen." (footnote: it wasn't until 1870 that the Congress established a federal weather service under the Army Signal Corps).

In contrast to President Lincoln's skeptical view of the practicality of forecasting the weather, a story carried by the Reuter's news service this week said that wine growers in southwestern France were suing their national weather service (Meteo France) for failing to predict hail storms which devastated thousands of acres of vines and fruit trees recently. They assert that with proper warning, they would have taken some precautionary measures to protect the young vines and trees. Officials at Meteo France say that they did indeed issue a forecast which gave the risk of severe storms a grade level "B" on an A to C scale. I believe that in the United States, federal law prohibits private citizens from suing the National Weather Service for a "bad" forecast, although they can be taken to court for negligence if they fail to issue a mandated forecast product such as a severe thunderstorm warning. I don't know that the laws are different in France. Recently meteorologists at the Weather Channel in Atlanta, GA were taken to court in a lawsuit filed by the relatives of Florida fishermen who died in a storm off the Keys. Their contention was that the storm was not forecasted by the Weather Channel, the source of weather information used by the two men before they went fishing. In a March 18th ruling, U.S. District Judge James Paine stated that the relatives of the fishermen were seeking an expansion in the expectations and scope of responsibilities for weather forecasters that was untenable in light of the indeterminate reliability of all forecasts.

MPR listener question: You have often spoken of the official Twin Cities climate record which dates from 1891. How many of the all-time daily temperature and precipitation records that were set in the first decade of the National Weather Service operation in the Twin Cities (1891-1900) have survived the 20th century?

Answer: This is a great question and one I have never thought about. It fits well with the MPR All Things Considered tribute to life in Minnesota at the turn of the century.

Checking the daily climate records for MSP I found the following: There are still 40 daily maximum temperature records dating to the 1891-1900 period; there are also 40 daily minimum temperature records dating to this period; there are 34 daily precipitation records associated with this decade and 16 daily snowfall records.

Some months show an extraordinary frequency of all-time records carried over from the 1891-1900 period. There are still 10 daily maximum temperature records for January which date from this decade, and 9 for the month of September. There are 8 daily minimum temperature records for February dating from 1891-1900, and 7 daily minimum temperature records for November. Precipitation records appear to be more evenly distributed, except for the month of April, which shows 6 daily snowfall records from this decade.

If daily climate records were evenly distributed across decades, the decade of 1891-1900 would show fewer records for temperature (perhaps in the range of 32-33). It is somewhat unexpected that we should see such a relatively high frequency of temperature records in the first decade of National Weather Service observations

in the Twin Cities area.

Twin Cities Almanac for April 30th:

The average MSP high temperature for this date is 62 degrees F (plus or minus 13 degrees standard deviation), while the average low is 43 degrees F (plus or minus 9 degrees standard deviation).

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Average dew point for April 30th is 37 degrees F, with a maximum of 61 degrees F and a minimum of 11 degrees F.

All-time state records for April 30th:

Scanning the state climatic data base: the all-time high for this date is 96 degrees F at Maple Plain (Hennepin County) in 1934 and at Winona in 1952; the all-time low is 8 degrees F at Cook (St Louis County) in 1966.

Words of the Week: Robinson anemometer

This instrument is more commonly known today as the cup anemometer, used for measuring wind speed. It was invented by Irish physicist John Thomas Romney Robinson in 1846. He used a vertical shaft, with horizontally mounted spindles at the top, each end capped with a hemispheric cup to catch the wind. The spindles and cups rotated on the vertical shaft and caused a gear with 16 contact points to turn. The number of complete turns was proportional to the mean wind speed. His invention quickly became popular in the scientific community and was adopted as the standard for wind speed measurements in America and several European countries. The mechanical nature of the instrument required frequent calibration and maintenance intervals. Versions of this instrument are still popular today.

Outlook:

Warming trend will accelerate during the first week of May, with many 70 and 80 degree daytime temperatures. Chance of showers and thunderstorms late Sunday, then Monday and Tuesday as well. Another chance for thundershowers towards the end of the week and into the Mother's Day weekend. It will be on the windy side in western counties and precipitation will probably be greater in southern Minnesota than in the north.

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To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, May 7, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Tornado Outbreaks

Today, May 7th marks the 159th anniversary of the one of the most lethal tornadoes in United States history. In 1840, a tornado up to 1 mile wide swept up the Mississippi River southwest of Natchez, MS, leveling the forests along both river banks. The town of Natchez was destroyed, and parts of Vidalia, Louisiana (across the river) were also damaged. The death toll was at least 317, most of which were people caught in flatboats and steamboats on the river. A piece of a steamboat window was found 30 miles away. Some speculate that there were many slaves killed in the fields, but not reported to authorities.

The tornado outbreak on Monday, May 3rd was one of the largest and most destructive in United States history. The National Weather Service confirmed 76 tornadoes in a five state area (OK, TX, KS, NE, and SD). Especially hard hit were Oklahoma and Kansas, where over 40 fatalities were reported. An F5 tornado passed through the southwestern suburbs of Oklahoma City, while two other highly destructive F4 tornadoes occurred near Dover and Crescent, cities which are both north of Oklahoma City. These tornadoes occurred primarily from 3:30 to 11:00 pm and were accompanied by numerous reports of large hail, frequent lightning strikes and strong straight line winds.

These tornadoes developed from several large thunderstorm supercells and underneath a strong upper level jet stream with a great deal of wind shear (change in direction with altitude). The frequency, size, and intensity of this tornado outbreak exceeded that of the March 29, 1998 outbreak in southern MN (14 tornadoes), but shared many characteristics: The path orientation was SW to NE; the longest continuous path of the most intense tornado was over 60 miles; the time of the most intense tornadic activity was between 5:00 pm and 7 pm; a strong jet stream was present overhead; and the passage of the tornadoes was followed by additional rainfall and hail. The tornado outbreak of May 3rd, being later in the spring, was fueled by longer afternoon convection since daylength is about two hours longer on this date than it is on March 29th.

The May 3rd tornado outbreak was highly monitored by staff of NOAA's National Severe Storms Laboratory, located nearby in Norman, OK. Detection and measurement by highly sophisticated research radar systems, automated measurement systems on the ground, and video and satellite imagery will allow scientists to study this outbreak of severe weather in greater detail than most. This may be a piece of silver lining in this story of destruction.

MPR listener question: The outbreak of 76 tornadoes in five states on Monday (May 3rd) has to rank as one of the largest in United States history. How does it stack up to other historically significant tornado outbreaks?

Answer: According to Thomas Grazulis who published the most recent book on tornado history, the following outbreaks exceeded that of

May 3rd:

Dates	Number of tornadoes	Number of deaths
Apr 3-4, 1974	148	315
Sep 19-23, 1967	111	5
May 26-29, 1973	99	22
Nov 21-23, 1992	95	26
May 18-19, 1995	80	4

However, further reports on May 4-5 for the same large scale weather system that produced the storms on May 3rd accounted for an additional 31 tornadoes, bringing the total over three days to 107, ranking third on this list above.

Twin Cities Almanac for May 7th:

The average MSP high temperature for this date is 65 degrees F (plus or minus 12 degrees standard deviation), while the average low is 45 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for May 7th:

MSP weather records for this date include: highest daily maximum temperature of 92 degrees F in 1963; lowest daily maximum temperature of 38 degrees F in 1907; lowest daily minimum temperature of 31 degrees F in 1906, 1907, and 1931; highest daily minimum temperature of 68 degrees F in 1896; record precipitation of 1.31 inches in 1933; and record snowfall of just a Trace in 1907, 1938, and 1946.

Average dew point for May 7th is 37 degrees F, with a maximum of 68 degrees F and a minimum of 15 degrees F.

All-time state records for May 7th:

Scanning the state climatic data base: the all-time high for this date is 94 degrees F at Canby (Yellow Medicine County) in 1916; the all-time low is 13 degrees F at Hallock (Kittson County) in 1907.

Words of the Week: Tessellated clouds

Taken from the Latin word tessellatus, meaning to form as a mosaic from smaller squares or oblong shapes. These types of clouds are typically stratocumulus or cirro-cumulus layers which look like a patchwork in the sky, sometimes even a checkerboard. There were some present in the Twin Cities area on Tuesday of this week. Sometimes these cloud forms appear as a warm front approaches.

Community Salute: New Ulm, MN

New Ulm, located in eastern Brown County along the Minnesota River, is one of the oldest climate stations in the southern part of the state. Charles Roos began daily climate observations from his home in 1864, less than 50 feet from the Minnesota River. He nailed his thermometer to a pillar on the north side of his house so it would not be in the direct sunlight. He reported for the Smithsonian Institution until the 1870s, then he reported to the U.S. Army Signal Corps. He was a regular observer until 1877. His many reports and notes include comments on the prairie fires of 1864, many severe thunderstorms, and the impact of 12 inches of rainfall in June 1867.

The New Ulm climate record has provided valuable data for the study of the Minnesota River watershed and for the development of agriculture in the region.

Their climate record continues today with Lonnie Spaeth, who has been observer since 1984. Some of the extreme values in the climate record include: 111 degrees F on July 14, 1936; -39 degrees F on January 25, 1904; and 7.37 inches of rainfall on July 15, 1916.

Outlook:

Looks like a wetter pattern is settling in for the state during the first half of May. Some respite from the showers should occur over the weekend, perhaps on Mother's Day, but it may be brief as another low pressure system will bring a chance for showers for the beginning of next week. Temperatures will be highly affected by frequent cloud cover, but should average above normal for the coming period.

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Topic: Minnesota's Shortest Climate Record

Perhaps the shortest climate record for any place in Minnesota comes from Excel, a township in Marshall County of the Red River Valley area. The old Army Signal Corps had established a climate station in Marshall County at Argyle in 1887, with Dr. J.J. Stone as the observer. However his daily record keeping stopped in November of 1888. Some years later, pioneer settler H.H. Cavanagh became a volunteer observer in Excel, starting in January of 1894. He was provided a thermometer, a cotton region instrument shelter, and a standard rain gage by Mr. E.A. Beals, the chief of the Weather Bureau in Minneapolis.

Mr. Cavanagh kept daily records of temperature and precipitation, but only until May of that year, when the record stops. He very routinely filled in the remarks section of his climate report with a variety of observations including: multiple nights with spectacular northern lights displays in January and February, one of which was described in great deal with a drawing that showed a bright white light overhead and streaks of red light radiating off in all directions(*); ice 32 inches thick on Thief River; three February blizzards and one March blizzard; one case of frostbite in an improperly dressed neighbor who hunted prairie chickens all day; the return of migrating birds in March; notes on poplar, willow, and box elder trees leafing out in April; and seeding of wheat and barley crops by May 4th.

Mr. Cavanagh filed only 5 months worth of reports, recording temperatures as low as -44 degrees F in January of 1894, and snowfall during the winter of 22 inches. He appears to have been a conscientious observer and it is a mystery why his tenure was so short-lived. Later, daily climate observations were resumed in Marshall County at Argyle by Mr. Allen Boyce in 1896. The Argyle record accounts for most of the climate history of the county.

(*) footnote on Mr. Cavanagh's observations of northern lights: Mr Edward Beals of the Minneapolis Weather Bureau Office notes spectacular northern lights displays on Feb. 22-23, 1894, bright white archs, with red, green and purple streamers, moving at times "light heavy curtains and other times like merry dancers."

Topic: The Urban Environment

On Tuesday of this week (May 11), the Pioneer Press carried an article reporting on a NASA and EPA sponsored study which showed a higher frequency of cloud cover over sprawling urban areas such as Atlanta, GA. The cloud cover actually helps diminish the formation of smog, keeping the air of the city cleaner.

Cloud cover over urban areas is enhanced by the higher particulate and aerosol content of the atmosphere, providing more condensation nuclei for cloud droplets to form.

There are several other climate effects attributed to urbanization: higher frequency of fog (due to low wind speeds and more condensation nuclei); lower annual snowfall (due to warmer air, more precipitation falls as rain); lower wind speed (due to greater surface friction in urban areas); greater surface runoff (due to larger areas of paved surfaces); fewer heating degree days related to residential and commercial energy use (due to greater heat storage); and warmer mean annual temperatures (due to the urban heat island).

The study of Atlanta found that some daytime temperatures differed by as much as 13 degrees F between downtown and outlying areas. A similar study for the Twin Cities metropolitan area, done by Paul Todhunter in 1989 found a difference of nearly 4 degrees F in the mean annual temperature of the downtown area versus the suburbs.

Twin Cities Almanac for May 14th:

The average MSP high temperature for this date is 67 degrees F (plus or minus 11 degrees standard deviation), while the average low is 47 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for May 14th:

MSP weather records for this date include: highest daily maximum temperature of 95 degrees F in 1932; lowest daily maximum temperature of 38 degrees F in 1907; lowest daily minimum temperature of 32 degrees F in 1907; highest daily minimum temperature of 66 degrees F in 1894; record precipitation of 1.28 inches in 1916; and traces of snowfall in 1907 and 1927.

Average dew point for May 14th is 44 degrees F, with a maximum of 67 degrees F and a minimum of 19 degrees F.

All-time state records for May 14th:

Scanning the state climatic data base: the all-time high for this date is 99 degrees F at Milan (Chippewa County) and Redwood Falls (Redwood County) in 1932; the all-time low is 18 degrees F at Virginia (St Louis County) in 1945.

Words of the Week: Keras-meltem and Karpooz-meltem

The eastern Mediterranean is famous for many climate characteristics well documented by the ancient Greeks and Romans. One of these climate characteristics is the etesian (periodic) wind of the summer months. This is a moderate to strong northerly wind which blows from mid May to mid October, peaking during July and August. The winds stir up the Aegean and Ionian Seas so much that many still refer to this time as "the season of large boats" because travel becomes too dangerous in smaller craft.

When the winds first start during the increasing daylength up to

the summer solstice, they are modest (10-20 mph) and intermittent, usually occurring in the early part of the day, then diminishing in the afternoon and evening. These are called the keras-meltem by the Turkish people because they occur when the cherries (keras) are ripening and being picked. After the summer solstice, the northerly winds become stronger and more persistent, sometimes blowing all day at 25 to 35 mph. These winds are called the karpooz-meltem by the Turkish people because they occur when watermelons (karpooz) are being harvested.

Outlook:

Continued wetter than normal conditions for May appear to be in the cards. Chances for showers and thunderstorms over the weekend and well into next week, especially in southern areas of the state. A warming trend will be evident by the middle of the week, with temperatures climbing into the 70s and 80s.

To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, May 14, 1999

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Topic: Minnesota's Shortest Climate Record

Perhaps the shortest climate record for any place in Minnesota comes from Excel, a township in Marshall County of the Red River Valley area. The old Army Signal Corps had established a climate station in Marshall County at Argyle in 1887, with Dr. J.J. Stone as the observer. However his daily record keeping stopped in November of 1888. Some years later, pioneer settler H.H. Cavanagh became a volunteer observer in Excel, starting in January of 1894. He was provided a thermometer, a cotton region instrument shelter, and a standard rain gage by Mr. E.A. Beals, the chief of the Weather Bureau in Minneapolis.

Mr. Cavanagh kept daily records of temperature and precipitation, but only until May of that year, when the record stops. He very routinely filled in the remarks section of his climate report with a variety of observations including: multiple nights with spectacular northern lights displays in January and February, one of which was described in great deal with a drawing that showed a bright white light overhead and streaks of red light radiating off in all directions(*); ice 32 inches thick on Thief River; three February blizzards and one March blizzard; one case of frostbite in an improperly dressed neighbor who hunted prairie chickens all day; the return of migrating birds in March; notes on poplar, willow, and box elder trees leafing out in April; and seeding of wheat and barley crops by May 4th.

Mr. Cavanagh filed only 5 months worth of reports, recording temperatures as low as -44 degrees F in January of 1894, and snowfall during the winter of 22 inches. He appears to have been a conscientious observer and it is a mystery why his tenure was so short-lived. Later, daily climate observations were resumed in Marshall County at Argyle by Mr. Allen Boyce in 1896. The Argyle record accounts for most of the climate history of the county.

(* footnote on Mr. Cavanagh's observations of northern lights: Mr Edward Beals of the Minneapolis Weather Bureau Office notes spectacular northern lights displays on Feb. 22-23, 1894, bright white archs, with red, green and purple streamers, moving at times "light heavy curtains and other times like merry dancers."

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To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, May 21, 1999

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Topic: A Cloudy May

Preliminary data suggest that the first half of May was one of the cloudiest ever in the Twin Cities. Dave Ruschy who manages the St Paul Climatological Observatory on the University of Minnesota campus reports that the average daily solar radiation from the 1st through the 17th was the lowest ever, dating back to 1963. In addition, over the same period average daily cloud cover was between 6 and 7 tenths, with 3 days reported as mostly clear skies, 8 days reported as overcast or mostly cloudy, and 6 days reported as partly cloudy. The cloud cover caused the overnight minimum temperatures to be above normal on most dates (12 out of the first 17 days), while daytime highs were above normal about a third of the days.

MPR listener question: Earlier this month, I heard that some communities reported measurable rainfall on eight consecutive days? Isn't this unusual? What is the record for most consecutive days with measurable rainfall?

Answer: Indeed, eight consecutive days with rainfall is quite unusual. Most years produce at least one period of 4 consecutive days with rainfall. It is 5 or more consecutive days with rainfall that starts to become an unusual streak of wet weather in our type of climate. The record number of consecutive days with measurable rainfall in the Twin Cities is 10, occurring from June 18-27, 1951. Statewide the record is 14 consecutive days with measurable rainfall at Faribault, June 5-18, 1967.

Topic: Hay Cutting Time

Many of the alfalfa fields across the state came through the winter in good shape and are ready to be cut. Current growth stages vary from early bud to first flower and stand about 24 to 30 inches in height. Quality is estimated to be quite good. The problem is finding a dry period to do the first cutting. It would appear that showers and thunderstorms will become more widely scattered later this weekend, but the early part of next week may bring several dry days, with lower dewpoints and more sunshine.

Twin Cities Almanac for May 21st:

The average MSP high temperature for this date is 71 degrees F (plus or minus 10 degrees standard deviation), while the average low is 50 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for May 21st:

MSP weather records for this date include: highest daily maximum

temperature of 92 degrees F in 1964; lowest daily maximum temperature of 46 degrees F in 1915; lowest daily minimum temperature of 34 degrees F in 1979; highest daily minimum temperature of 71 degrees F in 1921; record precipitation of 3.16 inches in 1906; and a traces of snowfall in 1931.

Average dew point for May 21st is 47 degrees F, with a maximum of 69 degrees F and a minimum of 22 degrees F.

All-time state records for May 21st:

Scanning the state climatic data base: the all-time high for this date is 100 degrees F at Thief River Falls (Pennington County) in 1964; the all-time low is 19 degrees F at Baudette (Lake of the Woods County) in 1924 and tied at Tower (St Louis County) in 1997.

Words of the Week: Clear, Scattered, Broken, and Overcast

These are the common terms used in aviation meteorology to refer to sky conditions. They are based on the percentage of sky obscured by clouds. The list below shows the criteria used.....

CLEAR.....less than 10 percent of the sky covered by clouds
SCATTERED....10 to 50 percent of the sky covered by clouds
BROKEN.....60 to 90 percent of the sky covered by clouds
OVERCAST.....greater than 90 percent of the sky covered by clouds

Community Notes: Climate of Lake County

Lake County in northeastern Minnesota probably has one of the most variable climates of any region of the state. Encompassing the waterways of the Boundary Waters Canoe Area, the highlands of the Superior National Forest and the rocky shoreline of Lake Superior, the environment of this county is hard to quantify in any general terms, because of the numerous microclimates. A composite of various dated climate records from Winton (since 1913, Wales (since 1943), Two Harbors (since 1894) and Isabella (since 1925) have been used to examine the historical variations of climate in the county. More recently a climate station has been established at Wolf Ridge Environmental Learning Center near Finland.

An early climate record from the mid 19th century Smithsonian network exists for the Beaver Bay area. Two frontier settlers named Henry Wieland and Thomas Clark II recorded daily climate observations near Beaver Bay and along the Beaver River Valley from 1858 to 1875. Their records are being entered into a computer database by the Minnesota State Climatology Office. Their attempts at developing agriculture in the region are documented in some of the records. It was their hope to raise vegetable and fruit crops for the developing timber and mining industries. The soils were judged to be rich in nutrients and the initial growing seasons of 1859 and 1860 were quite warm, with some temperatures reaching the 90s inland from the lakeshore. The soils however proved to be too heavy and wet, promoting root and fungal diseases. The early growing seasons proved to be an aberration, and the climate demonstrated a preference for being cool with frequent frosts and a very short growing season, some

less than 80 days long.

In the 140 years since Wieland and Clark settled there, Lake County has seen little if any benefit from local agriculture, but the economy has greatly benefitted from the three Ts: timber, taconite, and tourism.

Outlook:

Some chance for widely scattered showers later on Sunday and perhaps into Monday, then drier. Cooling trend for much of next week with temperatures averaging a few degrees below normal.

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From: Mark Seeley
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To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, May 28, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: MPCA Pollution Standard Index for the Twin Cities

The Minnesota Pollution Control Agency maintains a web site where they provide information on the daily Pollution Standard Index (PSI) for the Twin Cities. This index ranges from 0 to 500 and is based on measurements of particulates, carbon monoxide, ozone, and sulfur dioxide. The pollutant with the highest measurement of the day is used to determine the PSI. There are not health implications for values below 100, while values approaching 400 to 500 imply some serious health concerns for the elderly or for those with respiratory or heart problems.

The PSI for this week has been under 50 as recent strong winds and rainfall have kept the atmosphere rather "clean." The address for the MPCA web site is.....

<http://blue.pca.state.mn.us/pca/psi.shtml>

Or for those wishing to obtain the daily PSI by voice message, telephone 651-297-1630.

Topic: Weather Forecasting for Air Strikes over Yugoslavia and Kosovo

Air Force meteorologists continue to struggle to come up with accurate 24 to 72 hour forecasts for the NATO bombing campaign in the Balkans. This area is very difficult to forecast in the spring because of the shifting winds over the Adriatic Sea. Wind shifts can produce bursts of rain or lightning, or rapidly dissipate overnight fog. Forecasts should improve because as summer approaches winds become less variable in direction and the longer daylength works against the persistence of fog.

The Air Force forecasters carry a substantial burden in that their advice helps dictate bombing targets, mission tactics, launch times, air routes, and flight altitudes. Head winds can increase fuel consumption and flight times, frequent lightning strikes limit inflight refueling from tanker planes, while turbulence and ice build up on aircraft endanger the pilots and crew. To date, NATO has expressed great satisfaction with the amount and accuracy of the forecasts provided by the Air Force meteorologists.

MPR listener question: As the Memorial Weekend approaches I keep telling our expected visitors from Florida to bring warm clothes because the Minnesota weather can produce just about anything in late May. In fact, historically, haven't we even recorded some snowfall this late in the spring?

Answer: Minnesota's climate history shows that even late May has brought some wintry weather. Some of the latest May snows in the state have been:

- May 20, 1892 Morris, MN received 1 inch of snowfall
 - May 20-21, 1971 Virginia, Pine River, and Grand Rapids received between 4 and 8 inches of snowfall
 - May 25, 1970 Big Falls recorded 2 inches of snowfall
 - May 27-28, 1947 Big Falls, International Falls, Orr, and Spring Grove all reported 2 to 4 inches of snowfall
 - May 27-28, 1965 International Falls, Duluth and Caribou all reported about 1 inch of snowfall
 - May 31, 1897 Tower reported 1 inch of snowfall
- And believe it or not, June 1, 1946 Gull Lake, Willmar, Park Rapids, Babbitt, and even St Paul's Holman Field reported a trace of snowfall

However, temperatures look to be in the 70s and 80s this Memorial Weekend, though there will be chances for showers and thunderstorms by Sunday and Monday, especially in the north. But, no snowfall is in the forecast!

Twin Cities Almanac for May 28th:

The average MSP high temperature for this date is 73 degrees F (plus or minus 10 degrees standard deviation), while the average low is 53 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for May 28th:

MSP weather records for this date include: highest daily maximum temperature of 98 degrees F in 1934; lowest daily maximum temperature of 46 degrees F in 1947; lowest daily minimum temperature of 36 degrees F in 1965; highest daily minimum temperature of 70 degrees F in 1969; record precipitation of 2.08 inches in 1899; and a traces of snowfall in 1965.

Average dew point for May 28th is 50 degrees F, with a maximum of 69 degrees F and a minimum of 22 degrees F.

All-time state records for May 28th:

Scanning the state climatic data base: the all-time high for this date is 106 degrees F at Beardsley (Big Stone County) in 1934; the all-time low is 18 degrees F at Hallock (Kittson County) in 1947.

Words of the Week: Stagnation area

In air pollution meteorology this refers to a region of the lower atmosphere (planetary boundary layer) near the surface where the following conditions persist for at least 4 days: wind speeds less than 17 mph (poor ventilation), no frontal passages (change in air mass), and no precipitation (washout). Under these conditions, fossil fuel emissions, particulates and other aerosols can build up in the atmosphere reducing the air quality.

Earlier this week, these conditions persisted over parts of Florida reducing the air quality significantly.

Outlook:

Generally warm for Memorial Weekend with temperatures in the 70s and 80s. Increasing cloudiness Sunday, with a chance for showers in northern counties. Chance for showers statewide on Monday with somewhat cooler temperatures. Seasonally warm most of next week with another chance for showers by Thursday and Friday.

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From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jun 4, 1999

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Topic: NOAA Weather Radio Web Site

With the increased popularity of NOAA Weather Radio, listeners and readers may be interested to know that the National Weather Service has a web site dedicated to this service. It lists about 480 transmitter locations across the nation and their respective broadcast areas and frequencies. Some locations even provide audio over the Internet, using the "real radio" software. The URL to access the web site is....

<http://www.nws.noaa.gov/nwr/nwrbro.htm>

Topic: Sampling of record climate reports for June, 1999

Tuesday, June 1st this week brought cool, cloudy weather around the state. A number of locations reported the coolest daytime maximum temperatures ever for June 1st. The list below shows some of the reported values.....

St Cloud 47 degrees F (tied with 1945)
Grand Marais 40 degrees F
Two Harbors 39 degrees F
Silver Bay 40 degrees F
Hibbing 47 degrees F
Aitkin 49 degrees F

Duluth reported a daytime high of 40 degrees F which was the 2nd coldest ever maximum temperature for June 1st (it was 37 F in 1945). Interestingly, the three stations along the northshore of Lake Superior all reported high temperature values that were very close to the surface water temperature of the big lake, 40 degrees F.

Minnesota was not the only state to report record-setting weather during the first week of June. Other reports from around the country included:

a record low of 37 degrees F on June 2nd at Brookings, OR
a record cool daytime high on June 2nd at Thermal, CA of 83 degrees F
record rainfall at the Los Angeles Civic Center on June 2nd of 0.58 in.

Record-setting weather reports from around the nation are available each day on the Internet at a web site maintained by the University of California, Davis. This can be found at the following address.....

<http://www-atm.ucdavis.edu/~wxauto/fos/sxus/index.html>

MPR listener question: Tuesday of this week seemed more like March than June. It was so cold, I wondered what has been the coldest month of June in Minnesota and what was it like?

Answer: On a statewide basis, the coldest June was in 1969, when the average temperature was less than 59 degrees F (the statewide average temperature for June is about 64 degrees F). In 1969, the month started off with snow up north and high temperatures just in the 40s F. Both 1915 and 1945 produced very cold June temperatures as well, averaging around 59 degrees F.

Since June is a month of long days and high sun elevation, cool Junes are dominated by abundant and persistent cloud cover, which holds the daily maximum temperatures down. In 1915, 1945, and 1969 overcast or partly cloudy skies dominated the weather, along with a higher than normal frequency of fog. Average percent possible sunshine in June is 60 to 65 percent, but in those years it was more like 40 to 45 percent.

Twin Cities Almanac for June 4th:

The average MSP high temperature for this date is 76 degrees F (plus or minus 8 degrees standard deviation), while the average low is 56 degrees F (plus or minus 7 degrees standard deviation).

MSP Local Records for June 4th:

MSP weather records for this date include: highest daily maximum temperature of 96 degrees F in 1968; lowest daily maximum temperature of 56 degrees F in 1935; lowest daily minimum temperature of 38 degrees F in 1990 and 1998; highest daily minimum temperature of 70 degrees F in 1934; and record rainfall of 1.80 inches in 1984.

Average dew point for June 4th is 51 degrees F, with a maximum of 75 degrees F and a minimum of 30 degrees F.

All-time state records for June 4th:

Scanning the state climatic data base: the all-time high for this date is 100 degrees F at Lambertton (Redwood County) in 1968; the all-time low is 21 degrees F at Bigfork (Itasca County) in 1964 and at Remer (Cass County) in 1985.

Words of the Week: Hurricane and Typhoon Seasons

Severe tropical cyclones (wind speeds greater than 74 mph) are called hurricanes in the central and eastern Pacific, Gulf of Mexico and north Atlantic Oceans, typhoons in the western Pacific and Indian Oceans, and willy-willies off the west coast of Australia. The portion of the year having the highest relative frequency of these types of storms is called the hurricane or typhoon season. For the north Atlantic and Gulf of Mexico region this season is June 1 to November 30, while for the eastern Pacific it is May 15 to November 30. In the southwestern Pacific and Indian Oceans the typhoon season runs from November to April, while in the northwestern Pacific it runs from April to October. The typhoon season for Hong Kong is July through September.

Currently Typhoon Maggie is tracking through the Philippine Sea in the northwestern Pacific, but is not presently a threat to make landfall soon.

Outlook:

Chance of showers and thunderstorms Saturday and Sunday, especially in northern counties, where showers may linger into Monday morning as well. Higher dewpoints and much warmer temperatures are in store for the coming week. Many areas will record daytime highs in the 80s and overnight lows in the 60s. Chances for convective thunderstorms will increase by Wednesday and Thursday.

To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jun 4, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: NOAA Weather Radio Web Site

With the increased popularity of NOAA Weather Radio, listeners and readers may be interested to know that the National Weather Service has a web site dedicated to this service. It lists about 480 transmitter locations across the nation and their respective broadcast areas and frequencies. Some locations even provide audio over the Internet, using the "real radio" software. The URL to access the web site is....

<http://www.nws.noaa.gov/nwr/nwrbro.htm>

Topic: Sampling of record climate reports for June, 1999

Tuesday, June 1st this week brought cool, cloudy weather around the state. A number of locations reported the coolest daytime maximum temperatures ever for June 1st. The list below shows some of the reported values.....

St Cloud 47 degrees F (tied with 1945)
Grand Marais 40 degrees F
Two Harbors 39 degrees F
Silver Bay 40 degrees F
Hibbing 47 degrees F
Aitkin 49 degrees F

Duluth reported a daytime high of 40 degrees F which was the 2nd coldest ever maximum temperature for June 1st (it was 37 F in 1945). Interestingly, the three stations along the northshore of Lake Superior all reported high temperature values that were very close to the surface water temperature of the big lake, 40 degrees F.

Minnesota was not the only state to report record-setting weather during the first week of June. Other reports from around the country included:

a record low of 37 degrees F on June 2nd at Brookings, OR
a record cool daytime high on June 2nd at Thermal, CA of 83 degrees F
record rainfall at the Los Angeles Civic Center on June 2nd of 0.58 in.

Record-setting weather reports from around the nation are available each day on the Internet at a web site maintained by the University of California, Davis. This can be found at the following address.....

<http://www-atm.ucdavis.edu/~wxauto/fos/sxus/index.html>

MPR listener question: Tuesday of this week seemed more like March than June. It was so cold, I wondered what has been the coldest month of June in Minnesota and what was it like?

Answer: On a statewide basis, the coldest June was in 1969, when the average temperature was less than 59 degrees F (the statewide average temperature for June is about 64 degrees F). In 1969, the month started off with snow up north and high temperatures just in the 40s F. Both 1915 and 1945 produced very cold June temperatures as well, averaging around 59 degrees F.

Since June is a month of long days and high sun elevation, cool Junes are dominated by abundant and persistent cloud cover, which holds the daily maximum temperatures down. In 1915, 1945, and 1969 overcast or partly cloudy skies dominated the weather, along with a higher than normal frequency of fog. Average percent possible sunshine in June is 60 to 65 percent, but in those years it was more like 40 to 45 percent.

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of Mexico region this season is June 1 to November 30, while for the eastern Pacific it is May 15 to November 30. In the southwestern Pacific and Indian Oceans the typhoon season runs from November to April, while in the northwestern Pacific it runs from April to October. The typhoon season for Hong Kong is July through September.

Currently Typhoon Maggie is tracking through the Philippine Sea in the northwestern Pacific, but is not presently a threat to make landfall soon.

Outlook:

Chance of showers and thunderstorms Saturday and Sunday, especially in northern counties, where showers may linger into Monday morning as well. Higher dewpoints and much warmer temperatures are in store for the coming week. Many areas will record daytime highs in the 80s and overnight lows in the 60s. Chances for convective thunderstorms will increase by Wednesday and Thursday.

To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jun 11, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Hail Climatology in Minnesota

Hail was reported from many Minnesota counties this past week, ranging in size from 0.5 inches to 3.0 inches in diameter. Most crops are small and can recover from hail damage at this time.

Hail is common in many midwestern states. In Minnesota the hail season runs primarily from March through November, peaking in July in terms of the frequency of events. A typical year produces 11 to 13 days with hail across the state. The areas of the state with the highest average annual frequency are counties in west-central, southwestern and parts of southeastern Minnesota, which record from 2 to 4 days with hail, primarily during the growing season. Hail losses filed with insurance companies typically exceed 100 claims per year.

The most common time of occurrence for hailstorms is between 3 pm and 8 pm, in correspondence with the peak times of day for thunderstorms and tornadoes. Hailstorms are often associated with stationary fronts over northern Iowa or southern Minnesota.

A hail pad is sometimes used to measure the distribution of sizes and shapes regarding hailstones. This is composed of a piece of styrofoam board, covered with a secured sheet of aluminum foil and placed in an exposed area when thunderstorms are predicted. The falling hailstones leave a measurable impression in the tin foil so that size and shape can be determined after the storm without having to go out and collect the stones.

The Skywarn spotter training program of the National Weather Service uses food, sports, and money analogies to define the size of hailstones. Spotters may report actual measured diameters of hailstones or make estimates using the analogies in the table below....

Hail Diameter Size	Description
1/4 in.	Pea size
1/2 in.	Marble size
3/4 in. (severe criteria)	Dime size
7/8 in.	Nickel size
1 in.	Quarter size

1 1/4 in.	Half Dollar size
1 1/2 in.	Walnut or Ping Pong Ball size
1 3/4 in.	Golf Ball size
2 in.	Hen egg size
2 1/2 in.	Tennis ball size
2 3/4 in.	Baseball size
3 in.	Teacup size
4 in.	Grapefruit size
4 1/2 in.	Softball size

MPR listener question: There were numerous reports of hail around the state this week. What is the largest hailstone to ever fall in Minnesota?

Answer: The largest hailstone reported in the state climate records is one with a 12 inch circumference recorded near Detroit Lakes (Becker County) on July 4, 1966. There may have been even larger ones that have gone unreported. Incidentally, hailstones of 3/4 inch diameter or larger are one of the criteria used by the National Weather Service to issue a severe thunderstorm warning.

Topic: Editorial comments on the philosophy of science

Dr. David Miller a philosopher at the University of Warwick, U.K. recently wrote the "science compass" column in Science magazine (vol 284, page 1625, June 4, 1999) taking some pokes at the sometimes arrogant attitudes of scientists. In my opinion he does drive home some significant points:

-observation, precision measurements, experimentation, logic and hypothesis testing with statistics lead scientists to conclusions that are probable, but not certain. In nearly all scientific questions a realm of uncertainty still exists.

-we, as scientists are often too harsh and critical of colleagues who make interesting but false conjectures. The need to be right, or alternatively, the paralyzing fear of being wrong can distort judgement and stifle creative thinking.

-scientists need to show more readiness to admit ignorance when confronted with questions and issues yet to be settled or tested. Ignorance is no more shameful than poverty or disease. Saying, "I don't know" is the simple answer, while saying why you don't know is more challenging and complex.

-hand in glove with the admission of ignorance is a tempering of unrealistic public expectation that scientists have all the answers. We don't. This is well recognized in the field of meteorology and the public has a history of being forgiving and understanding on this point. It is perhaps not the case in many other fields of science, especially medicine.

Dr. Miller points out that science above all is a method of

critical thinking which attempts to prove hypotheses, often by assigning a probability of their likelihood. Whether or not this approach to understanding the world reveals truth, it is a healthy and correct posture to be skeptical rather than to blindly accept scientific conclusions.

Twin Cities Almanac for June 11th:

The average MSP high temperature for this date is 76 degrees F (plus or minus 9 degrees standard deviation), while the average low is 57 degrees F (plus or minus 7 degrees standard deviation).

MSP Local Records for June 11th:

MSP weather records for this date include: highest daily maximum temperature of 96 degrees F in 1956; lowest daily maximum temperature of 57 degrees F in 1903; lowest daily minimum temperature of 40 degrees F in 1903; highest daily minimum temperature of 74 degrees F in 1956; and record rainfall of 2.58 inches in 1975.

Average dew point for June 11th is 54 degrees F, with a maximum of 71 degrees F and a minimum of 31 degrees F.

All-time state records for June 11th:

Scanning the state climatic data base: the all-time high for this date is 102 degrees F at Fairmont (Martin County) in 1933; the all-time low is 25 degrees F at Pokegama Dam (Itasca County) in 1903.

Words of the Week: Renegade showers

This is how meteorologists often refer to isolated thunderstorms and showers that have broken away from a major complex of thunderstorms or a large frontal system. Often times these clouds escape from the main air flow aloft and may linger over areas of the landscape already saturated by the earlier passage of strong thunderstorms. They typically only effect small areas ranging up to less than 100 square miles. The use of the Spanish term renegade connotes a hostile deserter from the main band of active weather.

Outlook:

Some widely scattered showers possible early Saturday, especially southern counties, then a drying trend should begin. Partly cloudy skies for the balance of the weekend with a cooler and less humid pattern. Temperatures next week will average a few degrees cooler than normal. Chance of rainfall increases towards the end of the week.

To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jun 18, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Automated Surface Observing Systems

With the modernization of the National Weather Service in the past several years, many airports have been equipped with Automated Surface Observing Systems (ASOS) for the purpose of providing weather forecasters and aviation services with current real-time environmental data. These systems monitor the weather continuously providing measurements of temperature, dewpoint, precipitation type and amount, barometric pressure, cloud ceiling, visibility, and wind direction and wind speed.

Nearly 900 ASOS systems have been deployed by the National Weather Service and these now serve as the primary source of surface weather data throughout the United States. Whenever you hear weather conditions reported on the radio, or access weather information on the Internet, it is likely coming from an ASOS array transmitted through the National Weather Service.

Though ASOS has proven to be a successful data network in many respects, it is not entirely problem-free. Some noted exceptions are listed below:

- the anemometer and wind vane, both mechanical devices, are subject to icing up in freezing drizzle, freezing rain or snow. Under these conditions they report false readings or no readings at all. New improved ice-free wind sensors are expected to be deployed in the next year or two.

- cloud ceiling, cloud height and extent of cloud cover are valid for elevations up to 12,000 ft. For clouds above that altitude, ASOS reports are augmented by satellite observations and pilot reports.

- heated tipping bucket rain gages often give false readings or no readings during the winter, when precipitation is often of the frozen type (sleet, ice pellets, snow). At many of these airport sites, the precipitation is augmented by manual readings taken elsewhere on the airport grounds. In addition, a new improved precipitation type sensor is expected to be deployed in the next year or two to better differentiate between light drizzle, rain, ice pellets and hail.

- in areas where long term climate records have been kept, many of the ASOS measurements are augmented with manual measurements to insure that the integrity of the climate record is preserved for study of future trends.

More information about ASOS is available at the National Weather Service Modernization web site:

<http://tgs5.nws.noaa.gov/modernize/asostech.html>

or the ASOS users web site:

<http://tgs5.nws.noaa.gov/asos/index.html>

MPR listener question: I heard you describe the coldest June in the historical records statewide on a recent Morning Edition program. What has been the wettest and driest month of June statewide and what were the rainfall totals?

Answer: The average rainfall statewide in June of 1910 was only 1.5 inches, the driest ever. Grand Meadow in southeastern Minnesota reported just two days with measurable rainfall and a monthly total of 0.05 inches, while Rochester reported only a trace of rainfall for the entire month. Four years later, June rainfall averaged over 8 inches statewide, making 1914 the wettest. Grand Meadow and Winona in southeastern Minnesota received over 14 inches of rainfall during June of that year.

Twin Cities Almanac for June 18th:

The average MSP high temperature for this date is 78 degrees F (plus or minus 9 degrees standard deviation), while the average low is 59 degrees F (plus or minus 6 degrees standard deviation).

MSP Local Records for June 18th:

MSP weather records for this date include: highest daily maximum temperature of 98 degrees F in 1953; lowest daily maximum temperature of 56 degrees F in 1935; lowest daily minimum temperature of 46 degrees F in 1950; highest daily minimum temperature of 74 degrees F in 1931; and record rainfall of 1.14 inches in 1956.

Average dew point for June 18th is 55 degrees F, with a maximum of 76 degrees F and a minimum of 39 degrees F.

All-time state records for June 18th:

Scanning the state climatic data base: the all-time high for this date is 106 degrees F at Beardsley (Big Stone County) in 1933; the all-time low is 27 degrees F at Angus (Polk County) in 1912.

Words of the Week: Mesoscale Convective System (MCS)

This expression, often used by the National Weather Service, refers to a cluster of thunderstorms which is larger in scale than any individual cumulonimbus cloud, but smaller in scale than a frontal system. These systems appear on satellite imagery as circular or linear cloud forms with very bright tops (indicating cold air). Often times severe weather including, hail, damaging winds, heavy rainfall and tornadoes are associated with an MCS. We have already recorded a number of these over the state this June. Many have produced hail, ranging in size from 0.5 to 3.0 inches in diameter.

Outlook:

Temperatures are expected to average above normal next week with near normal rainfall. Showers and thunderstorms are more probable in southern counties than up north.

To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jun 18, 1999

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Answer: The average rainfall statewide in June of 1910 was only 1.5 inches, the driest ever. Grand Meadow in southeastern Minnesota reported just two days with measurable rainfall and a monthly total of 0.05 inches, while Rochester reported only a trace of rainfall for the entire month. Four years later, June rainfall averaged over 8 inches statewide, making 1914 the wettest. Grand Meadow and Winona in southeastern Minnesota received over 14 inches of rainfall during June of that year.

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Average dew point for June 18th is 55 degrees F, with a maximum of 76 degrees F and a minimum of 39 degrees F.

All-time state records for June 18th:

Scanning the state climatic data base: the all-time high for this date is 106 degrees F at Beardsley (Big Stone County) in 1933; the all-time low is 27 degrees F at Angus (Polk County) in 1912.

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This expression, often used by the National Weather Service, refers to a cluster of thunderstorms which is larger in scale than any individual cumulonimbus cloud, but smaller in scale than a frontal

system. These systems appear on satellite imagery as circular or linear cloud forms with very bright tops (indicating cold air). Often times severe weather including, hail, damaging winds, heavy rainfall and tornadoes are associated with an MCS. We have already recorded a number of these over the state this June. Many have produced hail, ranging in size from 0.5 to 3.0 inches in diameter.

Outlook:

Temperatures are expected to average above normal next week with near normal rainfall. Showers and thunderstorms are more probable in southern counties than up north.

To: Bob Potter, Jim Bickal, and John Bischoff
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jun 25, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Climate Data in Design, Planning and Risk Applications

A recent paper in the Bulletin of the American Meteorological Society highlights the growing utilization of climate data in various economic sectors. Those working in agriculture, water management, and energy related commercial enterprises account for nearly 60 percent of the users.

Traditional uses include the examination of weather risk associated with the design and planning of various construction projects, and increasingly, an assessment of the uncertainty in cash flow and earnings from operations that are vulnerable to weather events and episodes. Climate data services provide managers with a means to assess the probability of extreme events, climate trends, changes in seasonal climate variability patterns, current monitoring networks and examination of proposed regulatory guidelines related to the environment. It is expected that there will continue to be increased utilization of climate data services as many companies expand into marketing products abroad.

Topic: A Wet Season Indeed

For much of Minnesota, April through June rainfall totals rank as some of the highest ever historically, especially in south-central counties. For nearly half of Minnesota's counties the total rainfall reported since April 1st ranks higher than 80 percent of all years historically. Many communities report between 15 and 20 inches of rainfall for the three months. For historical comparison, the decade of the 1990s has produced three of the wettest springs in Minnesota history, 1991, 1993, and 1999.

The saturated soil conditions have produced large volumes of runoff through tiles lines and drainage ditches. Consequently, many rivers, including the Minnesota, the Mississippi, the St Croix, and the Red River of the North continue to run at higher than normal flows for this time of year. The DNR Division of Waters reports that some current flows exceed 75 percent of all previous years for this late in June. For fishermen and boaters, weekly updates on stream flows around the state are available from the DNR web site at.....

http://climate.umn.edu/doc/dnrdow/stream_flow_weekly.htm

MPR listener question: I work a flexible weekly schedule and usually try to take a weekday off in order to play golf. No matter what day I pick it always seems to rain. Which days of the week have seen the

lowest frequency of rainfall so far this year?

Answer: The lowest frequency of measurable rainfall in the Twin Cities area has occurred on Mondays and Fridays so far this year, each showing eight occurrences. The highest frequency has been on Tuesdays and Wednesdays with 13 occurrences.

Twin Cities Almanac for June 25th:

The average MSP high temperature for this date is 81 degrees F (plus or minus 8 degrees standard deviation), while the average low is 61 degrees F (plus or minus 6 degrees standard deviation).

MSP Local Records for June 25th:

MSP weather records for this date include: highest daily maximum temperature of 98 degrees F in 1934; lowest daily maximum temperature of 63 degrees F in 1968; lowest daily minimum temperature of 46 degrees F in 1957; highest daily minimum temperature of 75 degrees F in 1901; and record rainfall of 2.88 inches in 1978.

Average dew point for June 25th is 57 degrees F, with a maximum of 75 degrees F and a minimum of 39 degrees F.

All-time state records for June 25th:

Scanning the state climatic data base: the all-time high for this date is 109 degrees F at Beardsley (Big Stone County) in 1933; the all-time low is 27 degrees F at Wannaska (Roseau County) in 1982.

Words of the Week: Heliotropic plants

Some plants exhibit a character known as heliotropism, taken from the Latin root words helio for sun and tropos meaning to turn. The daily orientation of these plants actually changes with the position of the sun in the sky. For this reason these plants are called "sun trackers." Agronomic crops like sunflowers and some species of cotton are heliotropic, facing east to greet the sun in the morning, and west to say goodbye to the setting sun in the evening. It has been estimated that the sunflower receives up to 40 percent more sunlight on its leaves than it would if it were in a fixed orientation all day. Some desert plants exhibit heliotropic behavior but only during the winter months when the daylength is shorter and the sun's elevation angle is lower.

Outlook:

Continued chance for showers and thunderstorms into the weekend with lows in the 60s and highs mostly in the 80s and 90s. There will be lower dewpoints by Monday but chances for showers and thunderstorms will continue until midweek.

Wednesday and Thursday should be relatively dry with cooler temperatures, then a warm humid period is in store for the early part of the July 4th weekend.

To: Bob Potter, Jim Bickal, John Bischoff, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jul 2, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Preliminary June Climate Summary

Some rather wild swings in temperature during the month seemed to balance out as most communities reported an average June temperature that was only 1 degree F either side of normal. There were quite noticeable differences in sleeping comfort as well, with some sultry evening dewpoints in the 70s and some brisk early morning sweatshirt-type dewpoints in the 40s. Some record and near record low temperatures were reported on the mornings of the 14th - 16th.

For the most part, rainfall ranged from 3 to 6 inches around the state. Rainfall deficiencies were most common in parts of the Arrowhead, while elsewhere they were highly localized. There were dozens of reports of hail during the month and wind gusts in excess of 50 mph, but no widespread crop damage occurred. In many areas, the abundant rainfall kept rivers running quite high.

Topic: Extremes of comfort on July 4th

Unlike many national holidays when citizens may choose to be either indoors or out, celebration of the July 4th holiday invariably requires an outdoor venue for observing displays of fireworks. Yet, the climate on July 4th, despite falling in the middle of summer, can present some rather challenging conditions. Perhaps the two most uncomfortable July 4th holidays in the Twin Cities were in 1949 and 1977. Oppressively hot, with temperatures in the 90s to near 100 degrees F and sultry (dewpoints in the mid 70s), these celebrations took place despite a heat index of 105 to 112 degrees F. Many people observed fireworks while bathing or swimming in the lakes of the Twin Cities. Conversely, 1967 and 1972 saw the two coldest July 4th holidays of this century, with temperatures in the 50s and 60s F and dewpoints in the 40s. In fact there were overnight frosts in northern Minnesota counties, so perhaps fireworks were set off around some roaring campfires.

MPR listener question: The recent climate outlook suggests that Minnesota will be drier than normal for July, but after just having recorded one of the wettest springs, I don't believe it. How often does a dry July follow a wet spring?

Answer: Good question, but I am sure there is some variation among communities around the state. I will use the Twin Cities climate record to answer the question. With over 13 inches of rainfall, 1999 ranks among the 25 wettest April-June periods in

the MSP records since 1891. Of those 25 wet springs, only six were followed by significantly drier than normal Julys. So, the climate predictors are definitely betting against the historical statistics. Perhaps the biggest change from wet to dry occurred in 1975 when over 17 inches of rainfall was measured for April, May, and June, but July produced only 0.58 inches. Incidentally, the driest July on record in Minnesota was in 1936 when the Twin Cities received only 0.11 inches. Even the statewide average July rainfall that year was less than 3/4 inches, and some communities only reported a trace.

Twin Cities Almanac for July 2nd:

The average MSP high temperature for this date is 81 degrees F (plus or minus 7 degrees standard deviation), while the average low is 62 degrees F (plus or minus 6 degrees standard deviation).

MSP Local Records for July 2nd:

MSP weather records for this date include: highest daily maximum temperature of 96 degrees F in 1911; lowest daily maximum temperature of 60 degrees F in 1892; lowest daily minimum temperature of 49 degrees F in 1924; highest daily minimum temperature of 73 degrees F in 1897, 1921, 1966, and 1975; and record rainfall of 2.18 inches in 1992.

Average dew point for July 2nd is 59 degrees F, with a maximum of 75 degrees F and a minimum of 41 degrees F.

All-time state records for July 2nd:

Scanning the state climatic data base: the all-time high for this date is 105 degrees F at Winona (Winona County) in 1911; the all-time low is 28 degrees F at Tower (St Louis County) in 1980.

Word of the Week: Sukhoveis

This is a Russian word (pronounced sue-koo-vay) for the hot, dry winds that sometimes blow during their growing season. In the absence of sufficient soil moisture, these winds can rapidly lead to drought conditions and drastically reduce crop yields, up to 30 to 40 percent. Like the Corn Belt in America, the most critical time for poor weather to occur in Russia is in the month of July when most crops are blooming or heading out. The sukoveis brings temperatures of 80 and 90 degrees F, humidities less than 20 percent and winds from 10 to 20 mph, all of which last for several days. This causes rapid dessication of most plants. The agriculturally productive area of the Caspian plains is sometimes buffered from the effects of the sukoveis by the water available from the Volga River flood plain.

Outlook:

Chance of showers Saturday statewide, but especially in the north. A warming trend will be evident by Sunday as most places will see above normal temperatures. Chance for showers in the north on Monday, but a mostly sunny and warm first full week of July appears to be in the works. Dewpoints will be on the rise by July 4th, reaching the mid to high 60s. Only widely scattered showers and thunderstorms are seen later in the week.

To: Perry Finelli, Jim Bickal, John Bischoff, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jul 9, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Summarizing A Stormy July 4th Holiday

This past July 4th holiday weekend was certainly a record breaker. Among the many weather records and impacts that occurred, some of the most notable were:

-Record high dewpoint temperatures on July 3rd and 4th elevated the Heat Index to the 100 to 110 degree F range. Some of these record high dewpoint values included....

MSP 77 Fergus Falls 81 Aitkin 81 Morris 79 St Paul 80
Appleton 81 Montevideo 79 Pipestone 79 Jackson 79
Alexandria 77 Hutchinson 79 New Ulm 81 St Cloud 77
Red Wing 81 Cambridge 79 Owatonna 77 Faribault 77

-The Heat Index at MSP on July 4th of 107 degrees F was the 2nd highest ever, topped only by 112 F on July 4th, 1949. Obviously energy and beverage consumption were way up as people tried to stay cool and hydrated in these oppressive conditions.

-Record warm minimum temperatures were set across southern areas of the state on both the 4th and the 5th. Some of the record warm minimum temperatures on the 4th included....

St Cloud 77 F St Paul 80 F La Crosse (WI) 80 F
MSP 80 F Rochester 74 F (tied rec) Redwood Falls 78 F (tied rec)

Record warm minimum temperatures on July 5th included....

Winona 78 F Hutchinson 78 F Rosemount 77 F Canby 77 F
Waseca 76 F Olivia 77 F Albert Lea 76 F (tied rec)
Brainerd 75 F Lamberton 79 F Red Wing 78 F Faribault 78 F

-Record setting rainfall in parts of Itasca, St Louis, Lake, and Cook counties in northeastern Minnesota. Rainfall amounts there ranged from 3 to over 8 inches and created flashflood conditions which closed many roads.

-A rainy 4th of July weekend statewide kept many rivers flowing near flood stage around the state. For some watersheds this is very late into the summer to have such high flow conditions prevail, especially so in the Red River and its tributaries.

-Heavy wind damage occurred in the Fargo-Moorhead area and in the Superior National Forest, as straight line winds were estimated to be 80 mph or greater. There was structural damage to buildings, in addition to downed powerlines, and hundreds of thousands of felled trees, especially in the Boundary Waters

Canoe Area. Even in southern Minnesota, strong winds of 15 to 25 mph distorted some of the fireworks display patterns.

Topic: Similarities of Stormy July 4th Holidays

Before there are too many speculations about climate change and the most recent July 4th storm damage in northern Minnesota, an examination of past weather events and episodes is warranted. The most recent 4th of July storminess is not without precedence.

Stormy July 4th holidays were reported across Minnesota in earlier years, especially in 1902, 1949, 1977, and 1986. Comparing 1999 with the older climate data and other historical records from these years reveals some common weather characteristics:

-All showed very high dewpoint values, mostly in the 70s F, indicating high levels of water vapor in the atmosphere and relatively high Heat Index values. Maximum Heat Index Values:
1902 95 F 1949 112 F 1977 104 F 1986 99 F 1999 107 F

(Though the Heat Index was not used by the National Weather Service in 1902 or 1949, NWS forecasters nevertheless referred to these two incidences as a "heat wave.")

-All were characterized by an unstable atmospheric conditions which eventually produced strong thunderstorms that moved across the state from west to east. Heavy rainfall amounts of 3 inches or more and some hail were reported in many areas.

-Straight line wind damages occurred in central and northern Minnesota counties as trees were blown down and buildings were damaged.

-The areas of heavy rainfall, hail and damaging winds were typically in central or northern Minnesota counties perhaps associated with an area of strong upper level winds. The displacement of these damage areas was generally oriented west to east, but varied in size.

In light of the historical evidence it would be difficult to argue that the most recent July 4th storms were entirely unique meteorologically, even though the area affected, especially the BWCA, was large and perhaps previously untouched by such storms.

MPR listener question: I saw that both the Twin Cities and La Crosse, WI reported a low temperature of 80 degrees F on July 4th. Aren't minimum temperature values of 80 degrees F or higher a rare occurrence in this region?

Answer: Yes, indeed. In the La Crosse, WI record I can only find 5 days with a minimum temperature of 80 degrees F or higher this century. The Twin Cities climate record is longer

and more complete and shows a total of 19 days with minimum temperatures of 80 degrees F or warmer since 1891. The most recent previous occurrence was August 22, 1968. Incidentally in the Twin Cities record 13 of the 19 days with minimum temperatures so high occurred in July, the highest being 86 degrees F on July 13, 1936.

Twin Cities Almanac for July 9th:

The average MSP high temperature for this date is 83 degrees F (plus or minus 7 degrees standard deviation), while the average low is 63 degrees F (plus or minus 6 degrees standard deviation).

MSP Local Records for July 9th:

MSP weather records for this date include: highest daily maximum temperature of 99 degrees F in 1976; lowest daily maximum temperature of 68 degrees F in 1945; lowest daily minimum temperature of 48 degrees F in 1895; highest daily minimum temperature of 82 degrees F in 1936; and record rainfall of 1.43 inches in 1932.

Average dew point for July 9th is 60 degrees F, with a maximum of 75 degrees F and a minimum of 42 degrees F.

All-time state records for July 9th:

Scanning the state climatic data base: the all-time high for this date is 110 degrees F at Beardsley (Big Stone County) in 1936; the all-time low is 32 degrees F at Tower (St Louis County) in 1977.

Words of the Week: Heat Index

The National Weather Service provides public advisories and warnings when the combination of temperature and humidity becomes high enough to pose a health risk. The Heat Index is used somewhat interchangeably with the term Comfort Index, or Temperature-Humidity Index to evaluate the combined effects of temperature and humidity on the body's ability to cool itself. An air temperature of 85 degrees F with a relative humidity of 60 percent feels the same as a temperature of 90 degrees F with a humidity of 30 percent according to the Heat Index. For nighttime values of 80 F or above and daytime values 105 F or more the National Weather Service usually issues a heat advisory. These conditions can cause fatigue, heat cramps, sunstroke or heat exhaustion in some people. Recently some deaths in the northeastern United States were blamed on a persistent heat wave that produced Heat Index Values of 105 to 115 F.

Outlook:

A somewhat cool start to the weekend with overnight lows

in the 40s and 50s and daytime highs mostly in the 70s. Warming on Sunday and early next week, but temperatures will remain near normal for the most part. Chances for widely scattered showers, especially in the north on Tuesday, but otherwise mostly dry.

To: Bob Potter, Jim Bickal, John Bischoff, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jul 16, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Unnoticed July Cold

Following the record and near record-setting dewpoints, Heat Index values, and warm minimum temperatures of early July, few noticed the record setting cold in northern Minnesota which occurred on July 8th and 9th. Easterly winds off Lake Superior, persistent low level cloud cover, and a wet landscape as a result of the July 4th weekend storms combined to produce record cold daytime maximum temperatures in many north-central and northeastern Minnesota communities. Those climate stations which set new record cold maximum temperatures on July 8th are shown below.....

International Falls 57 F Hibbing 58 F Roseau 61 F
Grand Rapids 58 F Warroad 60 F (tied 1928) Brimson 55 F
Babbitt 55 F Embarrass 56 F Grand Portage 62 F
Little Fork 58 F Floodwood 57 F Remer 62 F
Bruno 63 F Sandy Lake Dam 61 F

Those setting record cold maximum temperatures on July 9th were....

Hibbing 64 F Grand Rapids 66 F Bruno 63 F
Pokegama Dam 67 F (tied 1928)

Overnight minimum temperatures in the 50s F are certainly a welcome comfort in the summertime. But, daytime high temperatures in the 50s F are generally uncomfortable (especially for outdoor recreation) and quite rare for inland locations. Though Duluth has recorded over 40 July days this century when daytime highs were in the 50s F, inland communities like Grand Rapids and Babbitt have recorded only 10-12 such occurrences.

Topic: July Fogs on Hudson Bay

During the peak summer months, 70 degree F temperatures are recorded in far northern Manitoba along the Churchill River to the shores of western Hudson Bay. Dewpoints rarely get very high, but even values in the 40s and 50s (low by Minnesota standards for summer) F are sufficient to bring fog to the area. The major cause of this is the cold water of Hudson Bay which keeps temperatures over the water in the 30s and 40s. This causes rapid condensation of the water vapor given up by the land surface as evaporation or plant transpiration during the daytime. Fog is often evident in summer satellite images of Hudson Bay, and appears as a darker layer of stratoform clouds. In addition, summertime satellite images often show ice floes scattered about western and northern sections of the bay, even in July. The unfrozen or thawed period for the waters of Hudson Bay (at 55 to 60 degrees north latitude) is a short season

indeed.

MPR listener question: What is the average number of days with thunderstorms in Minnesota and how does this number compare with other states?

Answer: The average number of days with thunderstorms each year varies across Minnesota, from about 30 days in northern counties to over 40 days for those counties along the Iowa border. This is considerably more than west coast states and the northeastern states, but less than most southern states. The state with the largest number of annual thunderstorm days is Florida, where some central counties record 100 days with thunderstorms each year. This features is the result of convergence of the sea breezes coming off both the east and west coasts, which induces lift in the warm, humid air and development of cumulonimbus clouds. The second highest frequency of thunderstorm days is found in the Rocky Mountain Front Range through portions of Wyoming, Colorado, and New Mexico. In this region, topography plays an important role and helps produce 60-70 days with thunderstorms each year.

Twin Cities Almanac for July 16th:

The average MSP high temperature for this date is 84 degrees F (plus or minus 7 degrees standard deviation), while the average low is 64 degrees F (plus or minus 6 degrees standard deviation).

MSP Local Records for July 16th:

MSP weather records for this date include: highest daily maximum temperature of 102 degrees F in 1926; lowest daily maximum temperature of 66 degrees F in 1900; lowest daily minimum temperature of 51 degrees F in 1911 and 1958; highest daily minimum temperature of 80 degrees F in 1931; and record rainfall of 1.28 inches in 1908.

Average dew point for July 16th is 61 degrees F, with a maximum of 76 degrees F and a minimum of 42 degrees F.

All-time state records for July 16th:

Scanning the state climatic data base: the all-time high for this date is 109 degrees F at Beardsley (Big Stone County) in 1931; the all-time low is 33 degrees F at Tower (St Louis County) in 1979.

Word of the Week: SIGMET

This is an acronym for significant meteorological observations used in aviation forecasting. When significant events are observed or forecast a SIGMET is issued to help pilots plan routes and anticipate conditions. A SIGMET might refer to thunderstorms, icing levels, severe clear air turbulence, volcanic smoke plumes, or other features which affect visibility or aircraft performance.

Outlook:

Cloudy and cooler conditions will settle in over the weekend.

There will be a chance for scattered showers and thunderstorms both Saturday and Sunday, then drier on Monday and Tuesday.

Temperatures for much of next week should average cooler than normal, with a chance for showers to return to the state by Wednesday and Thursday.

To: Bob Potter, Jim Bickal, John Bischoff, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jul 23, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Remembering July 23, 1987

Most long-time residents of the Twin Cities area can recall this date because it marked the worst flashflood in the area this century. Between 8 pm and midnight, MSP airport recorded a total of 9.15 inches of rainfall (another 0.85 inches fell after 12 am making a storm total of 10 inches). Quite obviously that amount of rainfall in less than 6 hours produced flooding on a grand scale, closing many sections of the Interstate system, flooding thousands of basements, and even blowing off manhole covers on major streets with storm sewer drainage underneath them.

The magnitude of this rainfall challenged all the statistical records kept by Minnesota climatologists: a new daily rainfall record for the month of July by nearly 3 inches; a new daily rainfall record for any day of the year by nearly 2 inches; three consecutive hours of rainfall rates that were equivalent to the 100 year return period calculation; a storm total rainfall that exceeded the 100 year maximum expected 10 day total; and a new monthly rainfall total (17.9 inches) which exceeded the previous record for any month of the year by 6 inches. Among all single day weather events recorded in Minnesota during the 20th century, this one would have to rank among the most unusual.

Topic: Wettest Decade of the 20th Century

An examination of precipitation data suggests that the decade of the 1990s is likely to go down as the wettest of the 20th century in Minnesota. In fact, on a statewide basis, five years in the present decade are ranked in the wettest 25 percent of the past 105 years. Further, 1999 is on a pace to be ranked among the wettest as well. Only one year from this decade, 1992, shows annual precipitation that ranks in the lower 50 percent of the century-old distribution.

It is no wonder that shallow aquifers and lake levels which were so low following the 1988 drought have recovered so rapidly, or that plant diseases have been so prolific, or that soil erosion and sediment loss along the major watersheds remains such a concern. Who knows, if this trend will carry over into the 21st century.

Question from Bob Potter (Host of MPR's Morning Edition):
Tuesday's (July 20th) maximum and minimum temperatures reported

from MSP airport were 72 degrees F and 68 degrees F. Is that an unusually narrow range for July?

Answer: Indeed, it is. The average daily temperature range in the Twin Cities during July is 20 to 22 degrees F (taken as difference between high and low). The 4 degrees F spread in temperature on Tuesday tied the historical record for the smallest daily temperature range during July. There have only been two other July days since 1891 with a range as narrow: July 17, 1913 with a high of 70 F and a low of 66 F; and July 30, 1956 with a high of 63 F and a low of 59 F.

Incidentally the record largest daily range in July temperature for MSP is 37 degrees F, which occurred twice: July 11, 1895 with a high of 87 F and a low of 50 F; and July 31, 1960 with a high of 86 F and a low of 49 F.

Away from the Twin Cities area, daily temperatures in July have varied even more. Tower, in St Louis County recorded a high of 86 degrees F and a low of just 35 degrees F on July 9, 1981, marking a 51 degree swing in temperature. Along the northshore of Lake Superior, the daily temperature range can be very narrow indeed when there is low overcast and winds are off the lake. Two examples are: July 12, 1986, when Grand Marais reported a maximum temperature of 51 degrees F and a minimum temperature of 50 degrees F, and July 30, 1989 when Grand Marais reported a maximum of 60 degrees F and a minimum of 59 degrees F. Both days were dominated by low overcast skies and northeasterly winds off Lake Superior.

Twin Cities Almanac for July 23rd:

The average MSP high temperature for this date is 84 degrees F (plus or minus 7 degrees standard deviation), while the average low is 64 degrees F (plus or minus 6 degrees standard deviation).

MSP Local Records for July 23rd:

MSP weather records for this date include: highest daily maximum temperature of 105 degrees F in 1934; lowest daily maximum temperature of 67 degrees F in 1962; lowest daily minimum temperature of 50 degrees F in 1978; highest daily minimum temperature of 80 degrees F in 1934; and record rainfall of 9.15 inches in 1987.

Average dew point for July 23rd is 60 degrees F, with a maximum of 79 degrees F and a minimum of 43 degrees F.

All-time state records for July 23rd:

Scanning the state climatic data base: the all-time high for this date is 108 degrees F at Milan (Chippewa County) in 1934; the all-time low is 32 degrees F at Pine River Dam (Crow Wing County) in 1925.

Word of the Week: Ac

Most people who see or hear these letters spoken in the summer immediately think of air conditioning. However, meteorologists (who think differently from normal people) readily associate these letters with the international observation code for altocumulus clouds. These are common summertime clouds which form in the middle layers of the atmosphere. They are puffy, rounded masses, some with considerable vertical development. They typically form between 6500 ft and 25,000 ft. They indicate moderate instability and turbulence in the middle layers of the atmosphere, but they are not associated with severe weather.

Outlook:

Warm and humid conditions appear to be in store until at least Monday. Dewpoints will be in the 70s many places, falling into the 60s early next week. Temperatures will generally remain above normal. Chance of widely scattered thunderstorms over the weekend, and again by Wednesday and Friday of next week.

To: Bob Potter, Jim Bickal, John Bischoff, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Jul 30, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: High Dewpoints in July

The recent hot and humid weather has produced a good deal of discomfort and caused some health risk due to fatigue, dehydration, and heat exhaustion. The combination of temperature and humidity is used by the National Weather Service to derive a value known as the Heat Index (HI). The HI, sometimes also called the apparent temperature, is used as a guideline to advise people when to limit their exposure times in order to minimize health risks. Daytime HI values of 105 or greater warrant an advisory, while nighttime values of 80 or greater usually call for an advisory to be issued as well.

Further, most people find that the dewpoint is a good indicator of the comfort level imposed by the combination of temperature and atmospheric moisture. The dewpoint is a measure of the amount of water vapor in the air (expressed as the temperature at which the water vapor would begin to condense into droplets) and most people express some level of discomfort when it reaches 70 degrees F or greater. An examination of the climate records shows that excessive HI values and/or dewpoint values of 70 degrees F or higher are most frequent in July, but do not occur every July. Some of the most uncomfortable Julys in the Twin Cities climate record are listed in the table below:

A Sampling of the Most Uncomfortable Julys Since 1945 (Based on Dewpoints and Heat Index Values)

Year	No. of HRS with Dewpoints of 70 degrees F or greater	Range of Heat Index Values
1949	223	98 - 112
1987	207	98 - 104
1955	207	98 - 113
1957	193	99 - 114
1977	159	100 - 108
1983	156	102 - 110
1995	108	98 - 116
1968	104	99 - 102

(note these data represent the period from 1945 to present because dewpoint measurements were scarce in the first half of the 20th century)

MPR listener question: Do all tornadoes form aloft and then

descend down to the Earth's surface?

Answer: People have the impression that this is the case because the typical tornado is usually first detected as a funnel cloud aloft or a rotating wind field at the middle levels of the atmosphere. However, recent research at the National Severe Storms Laboratory in Oklahoma suggests that some tornadoes form from the ground up. A convergence of winds at the surface starts the formation of a vortex which builds and elongates vertically. The Doppler radar systems have a difficult time detecting these types of tornadoes until they are fully developed because their field of view is directed more aloft by the elevation angle of the radar beam. For example at a distance of 100 miles, a radar beam cannot detect anything in the lowest mile of the atmosphere, therefore a tornado forming at the surface may go undetected. The researchers at NSSL are continuing to model and study these types of tornadoes which may escape early radar detection. In the meantime, the storm spotter networks around the country remain an essential element of the National Weather Service storm warning system and provide a method of detecting and reporting tornadoes regardless of how they form.

Twin Cities Almanac for July 30th:

The average MSP high temperature for this date is 82 degrees F (plus or minus 7 degrees standard deviation), while the average low is 63 degrees F (plus or minus 6 degrees standard deviation).

MSP Local Records for July 30th:

MSP weather records for this date include: highest daily maximum temperature of 100 degrees F in 1933; lowest daily maximum temperature of 63 degrees F in 1956; lowest daily minimum temperature of 50 degrees F in 1971; highest daily minimum temperature of 78 degrees F in 1933 and 1955; and record rainfall of 1.37 inches in 1956.

Average dew point for July 30th is 60 degrees F, with a maximum of 77 degrees F and a minimum of 42 degrees F.

All-time state records for July 30th:

Scanning the state climatic data base: the all-time high for this date is 107 degrees F at Milan (Chippewa County) in 1933; the all-time low is 31 degrees F at Virginia (St Louis County) in 1964.

Words of the Week: The Ozone Season

During the warm season in North America, stronger sunlight and heat combine to convert industrial and transportation emissions into smog (ground-level ozone). This is particularly true for major metropolitan areas. The Environmental Protection Agency

(EPA) and others have monitoring sites in over 1300 locations, covering more than 70 metropolitan areas and 30 states. National Weather Service forecast models along with data from these monitoring sites are used to produce daily ozone forecasts during the "ozone season", defined for North America as May 10 to September 30 for most places, except in California where it extends to October 31. The season is defined based on the historical frequency of ozone levels (sometimes called the Air Quality Index) that may be unhealthy.

Daily ozone forecast maps and health risks for major cities in the United States can be found on the Internet at the EPA's Office of Air and Radiation web site:

<http://www.epa.gov/airnow/>

Additional information about ozone and health risks can be found on the Internet at the National Oceanic and Atmospheric Administration Public Affairs Office web site:

<http://www.publicaffairs.noaa.gov/grounders/ozo1.html>

Outlook:

The outlook favors temperatures to be above normal for the first full week of August. There will also be daily chances for widely scattered showers and thunderstorms.

To: Bob Potter, Jim Bickal, John Bischoff, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Aug 6, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Memorable Climate Features of July 1999

The weather of July 1999 will be remembered for a number of reasons: flooding with record rainfalls in northeastern and southeastern counties; record cold daytime temperatures in northern cities on the 8th and 9th; some record high temperatures during the last ten days of the month; record high dewpoints on numerous days; and record Heat Index Values on the 29th and 30th across southern Minnesota. Some of the specific records set included:

13.37 inches of rainfall at Hibbing (St Louis County) set a new record for July and exceeded the highest value for any month in the station history.

14.65 inches of rainfall at Preston (Fillmore County) set a new record for July and exceeded the highest value for any month in the station history.

In addition all of the following were new July rainfall records:

10.72 inches at Marcell Forestry Station (Itasca County), 10.82 inches Pokegama Dam (Itasca County), 9.13 inches at Brimson (St Louis County), 9.37 inches at Floodwood (St Louis County), 10.07 inches at Bruno (Pine County), and 12.68 inches at Grand Meadow (Mower County).

As a result of the above rainfalls, some rivers exceeded flood stage for a period during the month.

The following tied or set new high temperature records during July -

July 24th, 94 F at Grand Marais.

July 25th, 97 F at La Crosse (WI), 99 F at MSP Airport, 96 F at Red Wing, 95 F at Lambertson.

July 29th, 98 F at La Crosse (WI), 98 F at MSP Airport.

July 30th, 98 F at Lambertson, 98 F at Faribault, 98 F at Red Wing, 100 F at La Crosse (WI), 97 F at Waseca.

Record cold daytime high temperatures were recorded at Hibbing on the 8th (58 F) and the 9th (64 F), at Grand Rapids on the

8th (58 F) and 9th (66 F), and at Bruno on the 8th (63 F) and 9th (63 F) as low clouds and fog persisted over both days.

On the 20th, the Twin Cities reported the lowest ever daytime temperature range (4 F) in July, with a high of 72 degrees F and a low of 68 degrees F.

The Twin Cities set new high dewpoint records on the following dates in July -

July 3 77 F dewpoint tied the record highest
July 4th 79 F dewpoint, new record high
July 22nd 80 F dewpoint, new record high
July 25th 78 F dewpoint, new record high
July 30th 81 F dewpoint, new record high (highest ever measured)

The Heat Index reached a high of 123 degrees F on July 29th at Faribault, MN, setting a new record.

Lastly, in the Twin Cities area, July 1999 will rank as one of the most uncomfortable in the historical record based on the frequency of high dewpoints and range in Heat Index Values, as noted in the table below (revised since last week):

A Sampling of the Twin Cities Most Uncomfortable Julys Since 1945 (Based on Dewpoints and Heat Index Values)

Year	No. of HRS with Dewpoints of 70 degrees F or greater	Range of Heat Index Values
1949	223	98 - 112
1987	207	98 - 104
1955	207	98 - 113
1999	205	98 - 115
1957	193	99 - 114
1977	159	100 - 108
1983	156	102 - 110
1995	108	98 - 116
1968	104	99 - 102

(note these data represent the period from 1945 to present because dewpoint measurements were scarce in the first half of the 20th century)

MPR listener question: Earlier this year, the outlook for the Atlantic Hurricane Season (June through November) favored a greater than normal number of tropical storms and hurricanes, however little if any activity has occurred. Do you think this prediction was wrong?

Answer: It is too early to judge whether or not this prediction was wrong. There was one tropical storm (Arlene) in June and a tropical depression in early July, but it has been quiet in recent weeks. During the average North Atlantic Hurricane Season

there are 9 named storms and 6 hurricanes, 2 of which are major. This year the corresponding predictions were for 14, 9, and 4 primarily based on a La Nina effect (cold phase of the equatorial Pacific Ocean). This prediction may yet prove accurate as the peak frequency for tropical storms and hurricanes in the North Atlantic is found in the months of August, September, and October.

Twin Cities Almanac for August 6th:

The average MSP high temperature for this date is 83 degrees F (plus or minus 7 degrees standard deviation), while the average low is 62 degrees F (plus or minus 5 degrees standard deviation).

MSP Local Records for August 6th:

MSP weather records for this date include: highest daily maximum temperature of 97 degrees F in 1916; lowest daily maximum temperature of 66 degrees F in 1903 and 1991; lowest daily minimum temperature of 48 degrees F in 1977; highest daily minimum temperature of 76 degrees F in 1916; and record rainfall of 1.67 inches in 1995.

Average dew point for August 6th is 61 degrees F, with a maximum of 76 degrees F and a minimum of 41 degrees F.

All-time state records for August 6th:

Scanning the state climatic data base: the all-time high for this date is 106 degrees F at Canby (Yellow Medicine County) in 1937; the all-time low is 28 degrees F at Tower (St Louis County) in 1976.

Word of the Week: Sundowning

This is a term used to describe the reaction of some people (usually the elderly who suffer from forms of dementia) to the loss of sunlight in the late afternoon or evening. In some cases the loss of light triggers an agitated or confused state, or sometimes anxious and restless behaviors. There are a variety of explanations being offered for this but I am not aware of any consensus opinion. Like those who suffer from Seasonal Affective Disorder, some who suffer from sundowning are helped by photo therapy and being in rooms with bright lights.

Outlook:

Low pressure will bring a chance of widely scattered showers to the state on Saturday and early Sunday. Temperatures will average a few degrees cooler than normal most of the upcoming week. There will be another chance for showers statewide by next Thursday and Friday.

To: Bob Potter, Jim Bickal, John Bischoff, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Aug 13, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Air Stagnation Climatology

Many air pollution episodes in the United States are related to stagnating (stationary) high pressure systems which linger over areas for up to 4 days or longer. These high pressure systems are often characterized by low surface wind speeds, and inversion layers which tend to hold pollutants in the lower atmosphere and minimize their dispersal. Under such conditions some health risks can develop, especially for people with respiratory problems.

Wang and Angell recently did a study of air stagnation for the National Oceanic and Atmospheric Administration's Air Resources Laboratory. They found that the Dakotas and Minnesota suffer from fewer air stagnation episodes than just about anywhere else in the country. Western and southern states tend to show the highest frequency of air stagnation episodes. Some of these states are California, Nevada, New Mexico, Arizona, Texas, Georgia, Louisiana, and Mississippi, where 20 to 40 air stagnation days occur on average each year. Conversely, the Dakotas and Minnesota record an average of less than 10 days. The north-central states tend to benefit from more frequent air mass changes and stronger pressure gradients, both of which help prevent air stagnation.

For Minnesota, the highest frequency of air stagnation during the summer months is found in August. 1998 brought a record number of air stagnation days to Minnesota when 12 were recorded, several of which were in the month of August.

MPR listener question: What were the warmest and coldest months of August in Minnesota history?

Answer: Using a statewide average temperature, 1900 ranks as the warmest August with a mean temperature of 73.3 degrees F, while 1977 ranks as the coldest with a mean temperature of 61.9 degrees F. Interestingly, both of these months were very wet, but distinctly different in temperature. August of 1900 was dominated by warm, moist southerly air flow. New Ulm reported temperatures of 90 degrees F or higher on the first 11 days of the month, and 22 days of 90 F plus temperatures for the entire month. Dewpoints were very high, with several overnight lows in the 70s. Alexandria reported an all-time record monthly precipitation of 16.52 inches. August of 1977 was dominated by cool Canadian air which produced numerous frosts. There were ground frosts even in southern Minnesota counties on the 18th, and Tower (St Louis County) dipped to 22 degrees F on the morning of the 24th.

Twin Cities Almanac for August 13th:

The average MSP high temperature for this date is 81 degrees F (plus or minus 7 degrees standard deviation), while the average low is 61 degrees F (plus or minus 5 degrees standard deviation).

MSP Local Records for August 13th:

MSP weather records for this date include: highest daily maximum temperature of 95 degrees F in 1965 and 1978; lowest daily maximum temperature of 63 degrees F in 1951; lowest daily minimum temperature of 48 degrees F in 1924 and 1997; highest daily minimum temperature of 75 degrees F in 1985 and numerous earlier years; and record rainfall of 2.03 inches in 1957.

Average dew point for August 13th is 60 degrees F, with a maximum of 75 degrees F and a minimum of 38 degrees F.

All-time state records for August 13th:

Scanning the state climatic data base: the all-time high for this date is 108 degrees F at Beardsley (Big Stone County) in 1965; the all-time low is 26 degrees F at Bigfork (Itasca County) in 1964 and at Embarrass (St Louis County) in 1997.

Word of the Week: WAFS

This term is an acronym for the World Area Forecast System, a worldwide satellite communications system sponsored by the World Meteorological Organization and the International Civil Aviation Organization. Its purpose is to provide critical weather analyses and products to national meteorological services, aviation authorities and airline operators. Gridded wind, pressure, and temperature fields are available from observational data, as are various upper air observations and satellite images.

Outlook:

A warming trend is expected during the third full week of August, with some widely scattered showers and thunderstorms, especially in the west and north.

To: Bob Potter, Jim Bickal, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Aug 20, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Another Wet Year

The 1999 growing season has indeed been a wet one for most of the state. There are still dry pockets in southwestern Minnesota, but the majority of the state is much wetter than normal, with higher than normal rivers and streams and surplus soil moisture. This year is further enhancing the reputation of the 1990s as the wettest decade of the century.

Some remarkable rainfall totals for the period from April 1st to August 16th include....

Location	Total Rainfall	Departure from Normal
Itasca State Park	23.33	+9.22
Grand Rapids	24.40	+9.47
Leech Lake Dam	24.02	+9.26
Pokegama Dam	26.51	+11.60
Hibbing	29.85*	+14.93
Brainerd	24.78	+9.51
U of MN St Paul	23.00	+6.86
Mankato	26.76	+10.33
Grand Meadow	32.80*	+15.89
Preston	31.09	+14.21
Rosemount	26.00	+9.81
Rushford	28.50	+11.67

* already exceeds the annual average precipitation

Nearly all of the above values are record setting for the 4.5 month period based on the local climatological records. In general, the north-central, northeastern, and southeastern counties are recording one of the wettest summers this century. These 1999 precipitation amounts are compatible with recent findings in a soon to be published EPA report that shows the number of rainy days and total precipitation are higher by as much as 20 percent over what they were earlier this century in Minnesota. This trend helps explain why lake levels have risen so high in recent years in many places around the state, and why so much concern is being expressed over erosion, pollution runoff and sediment loading in many Minnesota watersheds.

MPR listener question: Are frosts very common in northern Minnesota counties during August, or are they rare?

Answer: In far northern Minnesota counties away from Lake

Superior, August frosts are fairly common, with a frequency of once every 3 to 4 years. In some notably cold locations like Tower and Embarrass, August frosts occur in 2 out of every 3 years. The table below summarizes the coldest temperatures and earliest dates of frost for some northern Minnesota communities:

Location	Coldest August Temp (degrees F)	Earliest Date of Frost (32 F or colder)
Intern. Falls	27	8/22/1958
Itasca State Park	26	8/13/1964
Roseau	23	8/3/1971
Cloquet	28	8/1/1920
Virginia	29	8/12/1964
Big Falls	25	8/13/1964
Hibbing	29	8/14/1964
Crookston	31	8/13/1964
Baudette	28	8/20/1950
Brainerd	29	8/6/1977
Tower*	22	8/1/1995
Embarrass*	26	8/11/1997

*both locations have reported frosts in July

Twin Cities Almanac for August 20th:

The average MSP high temperature for this date is 80 degrees F (plus or minus 7 degrees standard deviation), while the average low is 60 degrees F (plus or minus 5 degrees standard deviation).

MSP Local Records for August 20th:

MSP weather records for this date include: highest daily maximum temperature of 97 degrees F in 1972; lowest daily maximum temperature of 62 degrees F in 1966; lowest daily minimum temperature of 40 degrees F in 1950; highest daily minimum temperature of 74 degrees F in 1959 and numerous earlier years; and record rainfall of 2.23 inches in 1891.

Average dew point for August 20th is 58 degrees F, with a maximum of 78 degrees F and a minimum of 33 degrees F.

All-time state records for August 20th:

Scanning the state climatic data base: the all-time high for this date is 105 degrees F at Campbell (Wilkin County) in 1976; the all-time low is 28 degrees F at Big Falls (Koochiching County) in 1934.

Words of the Week: Sand Auger

This term is used to refer to a dust devil or dust whirl which occurs in Death Valley, CA. It usually happens on calm, hot afternoons with clear skies when surface heating is at a maximum. A strong surface level rotating wind up to 300 ft

in height may develop and be strong enough to actually auger a hole in the dry layer of surface sand.

Outlook:

Generally a dry weekend for most places, with a chance for showers early Saturday in the south. Temperatures and humidity will be near normal elsewhere. Increasing cloudiness statewide by Sunday night with a chance for showers and thunderstorms continuing into Monday, especially in the north. Temperatures should remain near normal for most of next week, but increase by Thursday and Friday. There will also be a notable increase in humidity towards the end of the week with some possible showers and thunderstorms by Friday.

To: Bob Potter, Jim Bickal, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Aug 27, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Advances in Cloud Seeding

Cloud seeding, sometimes called weather modification research, has been conducted since the late 1940s. Numerous experiments were conducted using dry ice and silver iodide to provide more cloud condensation nuclei. However, most results were inconclusive because of the great variability in cloud life cycles and the precipitation process. This makes it difficult to quantify the effectiveness of cloud seeding.

Recently, researchers in the arid regions of northern Mexico and South Africa have claimed more conclusive results using salts like potassium chloride and sodium chloride (released by burning flares on aircraft wings). These salts provide larger and more efficient condensation nuclei which allow water droplets to reach a critical size more rapidly. The scientists have been studying over a hundred seeded and unseeded storms and are convinced that the seeded clouds yielded up to 30 percent more precipitation.

As a result of this research there may be a resurgence of interest in cloud seeding operations for various arid regions which rely on building up water supplies for irrigation or power generation during excessively dry periods.

MPR listener question: You have mentioned that the 1990s will be remembered as the wettest decade of the 20th century in Minnesota. How do the various decades rank in terms of average annual precipitation? Is there a positive upward trend?

Answer: Good question. The table below summarizes the decadal averages of annual precipitation aggregated for all reporting stations Minnesota.

Period	Decadal Ave Precipitation (inches)
1900-1909	27.83
1910-1919	24.73
1920-1929	23.27
1930-1939	22.52
1940-1949	26.82
1950-1959	25.96
1960-1969	26.35
1970-1979	26.71
1980-1989	26.74
1990-1999*	29.01

The 1990-1999 value is extrapolated using precipitation through July of 1999 and normal values for the balance of the year. This extrapolation would place 1999 in the top ten wettest of the century (along with 1991, 1993, 1995, and 1998).

There has been an increase in mean annual aggregate precipitation across the state each decade since the 1950s but I am not sure if this is statistically significant. Note that the first decade of the 20th century was the second wettest.

Twin Cities Almanac for August 27th:

The average MSP high temperature for this date is 79 degrees F (plus or minus 9 degrees standard deviation), while the average low is 60 degrees F (plus or minus 7 degrees standard deviation).

MSP Local Records for August 27th:

MSP weather records for this date include: highest daily maximum temperature of 99 degrees F in 1926; lowest daily maximum temperature of 60 degrees F in 1914; lowest daily minimum temperature of 44 degrees F in 1967, 1971, and 1986; highest daily minimum temperature of 76 degrees F in 1973; and record rainfall of 2.80 inches in 1978.

Average dew point for August 27th is 60 degrees F, with a maximum of 75 degrees F and a minimum of 34 degrees F.

All-time state records for August 27th:

Scanning the state climatic data base: the all-time high for this date is 103 degrees F at Pipestone, Luverne and Tracy in 1973; all-time low is 22 degrees F at Tower (St Louis County) in 1986.

Words of the Week: Streamlines

This word refers to the pattern of air flow or wind moving horizontally at a given level in the atmosphere. The lines on a weather map will run parallel to the wind direction, but they may form different patterns depending on which vertical level is being examined. For example the surface stream lines may look quite different from those depicted at the 500 mb level (say 18,000 ft aloft). The streamlines aloft earlier this week over Minnesota ran northwest to southeast.

Outlook:

Looks like a dry weekend with somewhat cooler than normal temperatures. A warming trend should start next week, with a return of 80 F plus daytime temperatures. There will be a chance for showers and thunderstorms on Wednesday, but it should be a generally dry week.

To: Bob Potter, Jim Bickal, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Sep 3, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: Natural Disasters or Our Vulnerability, Which is Changing?

A recent study printed in the Bulletin of the American Meteorological Society examined the trends in natural weather disasters and their societal impacts (economic losses and fatalities) in the United States.

The study revealed that though there are upward trends in impacts, there are not similar upward trends in the frequency of all the weather events and extremes which cause them. This leads to the conclusion that increased losses are primarily due to increased vulnerability arising from a number of societal changes, including growing populations in high risk coastal areas and large cities, more property subject to damages, and lifestyle changes which increase exposure.

Specifically the study showed no significant increase in hurricane frequency or intensity; no significant increase in the frequency of drought; no significant increase in the frequency of heat waves or cold waves; no significant national trends in the frequency of severe thunderstorms, hail, or tornadoes (though some regional trends such as an increase in the high plains are significant); increased winter storm damage in the northeastern states, but decreases in the midwestern states; and increased losses and fatalities from floods, with possible but not yet proven increased frequency in heavy rain events.

Estimated mean annual economic losses in the United States from extreme weather events and episodes for the period of 1986-1995.

Event	Mean Annual Estimated Losses in 1995 dollars
Floods	\$2.4 billion
Hurricanes	\$6.2 billion
Winter Storms	>\$1.0 billion (est)
Tornadoes	\$2.9 billion
Hail	\$2.3 billion (est)

More on the societal impacts of weather can be found at the following University Corporation for Atmospheric Research web site...

<http://www.dir.ucar.edu/esig/socasp/weather1>

MPR listener question: Do you think that the fall colors will come early this year?

Answer: Perhaps. Former State Climatologist Earl Kuehnast developed a system to predict the onset and peak of fall colors based on the frequency of overnight temperatures in the 30s F. His method showed that during September and October when trees are responding to a more rapidly decreasing daylength, three overnight low temperatures in the 30s F were sufficient to initiate leaf color change in maples, aspen and birch. Seven to ten nights of such temperatures were usually associated with peak fall color. This system is not foolproof but works in general. Since the outlook for September favors below normal temperatures over much of the state, I suspect colors will change a bit earlier than normal perhaps.

Twin Cities Almanac for September 3rd:

The average MSP high temperature for this date is 77 degrees F (plus or minus 9 degrees standard deviation), while the average low is 57 degrees F (plus or minus 7 degrees standard deviation).

MSP Local Records for September 3rd:

MSP weather records for this date include: highest daily maximum temperature of 97 degrees F in 1925; lowest daily maximum temperature of 58 degrees F in 1934; lowest daily minimum temperature of 32 degrees F in 1974; highest daily minimum temperature of 73 degrees F in 1960; and record rainfall of 0.84 inches in 1986.

Average dew point for September 3rd is 55 degrees F, with a maximum of 74 degrees F and a minimum of 31 degrees F.

All-time state records for September 3rd:

Scanning the state climatic data base: the all-time high for this date is 103 degrees F at New Ulm (Brown County) in 1925; the all-time low is 20 degrees F at Tower (St Louis County) in 1997.

Words of the Week: Secondary air pollutant

This category of atmospheric pollutant refers to a substance or contaminant in the air which results from a chemical reaction between other constituents that are present. An example is photochemical smog which results from a mixture of sunlight, automobile exhaust (nitrous oxides) and various volatile organic compounds. This type of smog often forms in valleys or areas with poor ventilation climatology.

Outlook:

Warmer than normal temperatures are expected during the first full week of September. Precipitation should be near normal.

To: Perry Finelli, Jim Bickal, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Sep 10, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of MPR's web site (<http://news.mpr.org>).

Topic: A Minnesota Earthquake

On September 3, 1917 at 3:30 pm in the afternoon a rare earthquake occurred in north central Minnesota, along the Crow Wing River Valley from Staples to Brainerd. It was felt across an area 150 to 200 miles in diameter. It was reported by a number of weather observers in the area, but it was relatively mild and did little damage.

Earthquakes are exceedingly rare in Minnesota, but somewhat common in other midwestern states. Small earthquakes (of magnitude 2-3 on the Richter scale) have already occurred earlier this year in Illinois and Missouri. The New Madrid seismic zone located in southeastern Missouri is the source region for most midwestern earthquakes. In 1895 a 6.8 magnitude earthquake near Charleston, MO sent shock waves into southeastern Minnesota counties.

The USGS (Geological Survey) maintains a web site with current and historical earthquake information. It can be found at...

<http://quake.wr.usgs.gov>

Topic: Meteorological Time Keeping

For thousands of years, human civilization measured time by the position of the sun in the sky. Local noon was a convenient reference, marking the time when the sun would be overhead. Locations just several miles apart could have different local times. When more rapid long distance transportation and communications were made feasible by the railroads and telegraph (primarily after the Civil War in America), travel sometimes meant that a person's local time kept constantly changing. To reduce the large number of locally observed times, the railroad companies pushed for a simplified and standardized time keeping scheme. As a result, civil time zones were established across the U.S. and Canada in 1883 to standardize time keeping. The concept of international time zones was officially adopted in November 1884 at the International Meridian Conference in Washington, D.C.. Because The Old Royal Observatory in Greenwich, England had instituted the best early astronomical time determinations, the meridian of longitude passing through this observatory became the Prime Meridian (0 degrees longitude) and serves as the world-wide standard for time keeping.

Many people who browse Internet weather sites or watch the Weather Channel on cable television have asked about the time designation

for weather forecast analysis and products. It is always given as UTC (for Universal Time Coordinated System) or "Z" time (for Zulu or Greenwich Prime Meridian, 0 degrees longitude). While still on Daylights Savings Time, we subtract 5 hours from the Z or UTC time designated on a forecast product to determine our local time. When we go back to Standard Time at the end of October, we must then subtract 6 hours from the Z or UTC time designation on forecast products.

MPR listener question: It was awfully chilly in the Twin Cities on Thursday, September 9th, with daytime temperatures in the 50s F and brisk winds. Rochester tied a record cold daytime high temperature reading with only 60 degrees F. How often does the temperature not reach even 60 degrees F this time of year?

Answer: It is somewhat rare, but perhaps not as rare as you think. The last time the Twin Cities daytime high did not reach 60 degrees F during the first ten days this month was September 6, 1965 when the high only reached 57 degrees F. The Twin Cities climate record since 1891 shows that for the period September 1 through September 10 only 28 times has the daytime high not reached 60 F. This represents a frequency of about 2.5 percent of the daily climate records for this ten day period. Incidentally the coldest daytime high for the first ten days of September was on this date in 1918 when the maximum temperature was only 49 degrees F in the Twin Cities.

Twin Cities Almanac for September 10th:

The average MSP high temperature for this date is 74 degrees F (plus or minus 10 degrees standard deviation), while the average low is 54 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for September 10th:

MSP weather records for this date include: highest daily maximum temperature of 104 degrees F in 1931; lowest daily maximum temperature of 49 degrees F in 1918; lowest daily minimum temperature of 37 degrees F in 1917; highest daily minimum temperature of 75 degrees F in 1931; and record rainfall of 2.08 inches in 1913.

Average dew point for September 10th is 53 degrees F, with a maximum of 73 degrees F and a minimum of 25 degrees F.

All-time state records for September 10th:

Scanning the state climatic data base: the all-time high for this date is 106 degrees F at New Ulm (Brown County), Morris (Stevens County), and St Cloud (Sherburne County) in 1931; the all-time low is 17 degrees F at Roseau (Roseau County) in 1917.

Words of the Week: Dumbbell or Dumbbelling

Some MPR listeners think that this refers to the long pause (or dead airwaves) so evident when Bob Potter stumps me with a question. However, these terms are occasionally used by forecasters as verbs when describing the behavior of a low pressure system. Sometimes a low pressure system splits into two circulating lobes that are close to each other. They behave in the large scale weather pattern as a single system, but they actually appear on satellite imagery as two distinct rotating cloud masses. Such a system occurred on Thursday of this week in southern Ontario. Dumbbelling then refers to the shape of the pressure pattern (like a weight room dumbbell) rather than the character of the forecaster.

Outlook:

Cooler than normal temperatures will be evident for this weekend and much of next week, with a warming trend by the end of the week. Chance for showers in southern sections on Saturday and statewide into Sunday, Monday, and possibly early Tuesday. Generally fair weather, but cool by mid week with a warming trend. Some overnight lows in the 30s in northern sections of the state through Tuesday should help accelerate the fall leaf color change.

To: Bob Potter, Jim Bickal, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Sep 17, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Invitation to readers of WeatherTalk and MPR listeners

The University of Minnesota Department of Soil, Water, and Climate will host the 7th Annual Kuehnast Lecture in Climatology on Friday, September 24th at 3:30 pm on the St Paul Campus in Room 335 Borlaug Hall. The public is cordially invited to attend this lecture. The speaker this year is Dr. John Norman from the University of Wisconsin-Madison. He will talk about estimating evapotranspiration (crop water use) from both ground-based measurements and satellite observations. Dr. Norman is highly regarded professionally and well known for his research in agricultural meteorology.

Topic: Assessing the costs and benefits of the 1997-98 El Nino

A recent article by Stan Changnon in the Bulletin of the American Meteorological Society provides an assessment of the losses and benefits in the United States attributed to the weather generated by the El Nino Episode of 1997-1998. Having been described as one of the strongest El Nino events of the 20th century and equated with the 1982-1983 episode which caused billions of dollars in losses, the most recent El Nino was logically perceived to have nothing but negative consequences and impacts on the United States. Changnon dismisses this idea.

Using a wide variety of data sources he finds that weather related losses associated with the 1997-1998 El Nino total between \$4.2 and \$4.5 billion dollars. This is derived primarily from: (1) property losses of \$2.8 billion (mostly from insured and uninsured properties in California and the southeastern states); (2) agricultural losses estimated at \$650-\$700 million; (3) federal government relief payments on 18 declared disasters totaling \$400 million; (4) losses in the tourist industry of \$180-\$200 million; (5) state assistance programs providing \$125 million; and (6) lost sales in snow removal equipment of \$60-\$80 million.

On the other hand, he finds that benefits derived from the recent El Nino episode total between \$19.6 and \$19.9 billion, including 850 lives saved from the lack of severe winter storms and lack of hurricanes making landfall in 1998. This estimate of benefits includes the following: (1) reduction of average losses from spring snowmelt flooding and landfall

of Atlantic hurricanes saving \$6.9 billion; (2) reduced heating costs in the northern states saving \$6.7 billion; (3) increased sales of merchandise, homes, and other goods totaling \$5.6 billion; (4) income from increased construction and related employment totaling \$450-\$500 million; (5) lower costs for snow and ice removal from streets and highways saving \$350-\$400 million; and (6) reduced operating costs to airlines and the trucking industry saving \$160-\$175 million.

Some of Changnon's conclusions about the lessons learned from this analysis include: (1) that scientists and government officials should consider both the good and bad impacts of El Nino related climate forecasts; (2) whether or not to attribute specific weather events to El Nino episodes requires study and analysis and usually cannot be stated with much confidence while the event is happening; and (3) though nearly all weather events and episodes produce positive and negative effects, most media tend to focus on the negative, while less is known about the positive effects.

MPR listener question: It has been so cold this week, I was wondering how often we see snow in September in Minnesota?

Answer: Certainly, it is rare, but it occurs with greater frequency in the far northern counties. During the 20th century, 25 years show that at least a trace of snow has been observed at International Falls during September, a frequency of 1 in 4 years. Comparatively, in the Twin Cities, a trace or more of snowfall during September has been observed in only 7 years since 1900: 1908, 1916, 1927, 1945, 1951, 1961, and 1985. Perhaps the most unusual September snowfall occurred on the 26th in 1945 when 1 to 2 inches fell across southern Minnesota from New Ulm to Faribault. September snowfalls are very short-lived because of the warmer ground temperatures during the month. None have remained on the ground for more than a day or two.

Twin Cities Almanac for September 17th:

The average MSP high temperature for this date is 72 degrees F (plus or minus 10 degrees standard deviation), while the average low is 52 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for September 17th:

MSP weather records for this date include: highest daily maximum temperature of 96 degrees F in 1895; lowest daily maximum temperature of 47 degrees F in 1918; lowest daily minimum temperature of 34 degrees F in 1943; highest daily minimum temperature of 75 degrees F in 1948; and record rainfall of 1.70 inches in 1942.

Average dew point for September 17th is 51 degrees F, with a maximum of 71 degrees F and a minimum of 31 degrees F.

All-time state records for September 17th:

Scanning the state climatic data base: the all-time high for this date is 105 degrees F at Milan (Chippewa County) in 1895; the all-time low is 18 degrees F at Cook (St Louis County) in 1959.

Word of the Week: MOS

This is an acronym for Model Output Statistics, a tool used by meteorologists to make local forecasts. It refers specifically to a statistical method of relating the output parameters of a numerical weather prediction model (usually scaled for the entire United States or northern hemisphere) to local weather elements such as temperature and humidity. Using the historical relationship between climate records of a given location and past forecasts, the numerical model values are adjusted for local scale effects or biases. The National Weather Service provides forecasters with updated MOS data every three hours which they can use to revise forecasts throughout the day and night if warranted.

Outlook:

The magnitude and path of Hurricane Floyd off the east coast is likely to modify the amplitude of the high pressure ridge building over the midwest. This means that temperatures will warm significantly over the weekend, with daytime highs returning to the 70s F in many places on Saturday. There will be a chance for showers late Saturday in the central and northern counties and Sunday statewide. Temperatures will begin to dip again to below normal values on Sunday and last into mid week, with some overnight lows in the 30s to low 40s. A warming trend is expected by Wednesday and should linger into the following weekend when there will be a chance for rain. It is expected to be mostly a dry week as well, with generally light winds.

To: Bob Potter, Jim Bickal, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Sep 24, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: Cold fronts take hold in the fall

Now that the fall season has officially started we will be seeing and feeling stronger cold fronts as they move across Minnesota. Typically in the fall, the contrasts between air masses of polar origin and those of tropical origin become sharper, the pressure gradients get stronger, and the cold fronts which are produced by advancing low pressure systems are much more notable as they are typically swept in by strong northwesterly winds. This pattern is first observed in the higher latitudes of the northern hemisphere beginning in September, and then gradually develops with greater frequency in lower latitudes through October and November. Parts of Canada have already seen the effects of stronger cold fronts earlier this week as Winnipeg, Manitoba reported a nearly 35 degree F temperature drop with a frontal passage on Tuesday and Wednesday. 24-hour drops in temperature of this magnitude are not uncommon in the fall. On September 30, 1972 a cold front dropped the temperature at Fergus Falls, MN from 77 degrees F to 26 degrees F in less than 24 hours.

Topic: Record low temperatures on Tuesday, September 21, 1999

A cool, dry Canadian high pressure system brought some record low temperatures to the state on Tuesday morning of this week. Many locations touched or fell below the freezing mark for a number of hours between 2 am and 8 am that morning. Some of the record lows included:

NORTHERN MINNESOTA:

Embarrass 20 F
Eveleth 24 F
Ely 28 F
Orr 28 F

CENTRAL MINNESOTA:

Bruno 24 F
Cambridge 28 F
Aitkin 28 F (tied record low)
Benson 30 F

SOUTHERN MINNESOTA:

Waseca 28 F

Worthington 28 F
Windom 25 F
Lamberton 29 F
Marshall 33 F (ground frost in surrounding areas)
New Ulm 30 F (tied record low)

IOWA:

Spencer 28 F
Mason City 29 F
Cedar Rapids 33 F
and Ottumwa 36 F

MPR listener question: In comparing my home barometer with the current local atmospheric pressure reported on the cable Weather Channel, NOAA weather radio, or my favorite Internet web sites, I sometimes get confused by the units of pressure measurements. How do you convert millibars to inches of mercury, and vice versa?

Answer: Use the factor of 33.86 to convert atmospheric pressure given in millibars to the equivalent in inches of mercury. Divide the number of millibars by 33.86 to get inches. Conversely, if you have atmospheric pressure in inches on your home barometer, multiply by 33.86 to get millibars. Millibars, sometimes called hectopascals, is the standard measurement unit applied by government meteorological services around the world and is commonly used on the Internet.

Twin Cities Almanac for September 24th:

The average MSP high temperature for this date is 67 degrees F (plus or minus 9 degrees standard deviation), while the average low is 47 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for September 24th:

MSP weather records for this date include: highest daily maximum temperature of 89 degrees F in 1935; lowest daily maximum temperature of 42 degrees F in 1942; lowest daily minimum temperature of 30 degrees F in 1942; highest daily minimum temperature of 71 degrees F in 1892; and record rainfall of 1.06 inches in 1934.

Average dew point for September 24th is 45 degrees F, with a maximum of 73 degrees F and a minimum of 23 degrees F.

All-time state records for September 24th:

Scanning the state climatic data base: the all-time high for this date is 94 degrees F at New Ulm (Brown County) and Beardsley (Big Stone County) in 1935; the all-time low is 19 degrees F at Tower (St Louis County) in 1976.

Words of the Week: Station Model

In the meteorological community this refers to a specific set of symbols and a pattern for using them to show the state of the weather at each observing station plotted on the map. The symbols and numbers used typically represent air temperature, dewpoint, pressure, sky cover, wind speed and direction, and character of the weather (snowing, raining, fog, dust, etc). More on the station model and interpreting data presented in this form can be found at the Unisys Weather web site:

<http://weather.unisys.com/surface/details.html>

Outlook:

Increasing cloudiness with a chance of precipitation later on Saturday and into Sunday. Somewhat strong southerly winds will be blowing. Temperatures will decline somewhat from Saturday to Monday, but remain near normal for much of next week, with another chance for showers by Tuesday and Wednesday.

To: Bob Potter, Jim Bickal, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Oct 1, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: Cold air building at high latitudes

The outlook for October favored cooler than normal temperatures for Minnesota and the western Great Lakes region. This seems to be already in evidence if you look at what has been happening across the northern hemisphere.

A strong northwesterly jet stream is allowing air from high latitudes to intrude down into North America. Earlier this week, low temperature records were set at many locations in Washington, Idaho, Nevada, Colorado, and northern California. In addition parts of interior Alaska reported the first subzero temperatures of the fall season on Wednesday morning. Some Canadian stations have reported temperatures in the teens and twenties this week, while locations in central and the northeastern Russian Federation have reported the seasons first snowfalls, particularly in the mountains around Lake Baykal. All of this suggests that the mid latitude mixing of polar air is taking place relatively early this year. This may mean some significant October snows for the state of Minnesota.

Topic: Keeping up with fall colors

The USDA Forest Service hosts a web site where you can find the latest updates on fall colors across the country, including links to tour information, places to stay, a photo gallery, tips for tree identification, and a variety of other information. Their web site can be found at.....

<http://www.fs.fed.us/news/fall.shtml>

Additionally the North Central Forestry Experiment Station field office, affiliated with the University of Minnesota St Paul campus hosts a web site which explains how and why leaves change colors in the fall. They also have tips on planting trees and information on using living snow fences for snow control. Their web site can be found at....

<http://willow.ncfes.umn.edu/>

MPR listener question: What is the average amount of winter snowfall in the Twin Cities. One neighbor says it is about 45 inches, while another says it is 55 inches. Also, I read

where one local meteorologist (Bruce Watson, I believe) thinks that we'll get 70 inches of snowfall this winter. How often do we get that much or more?

Answer: The official "normal" for winter season snowfall in the Twin Cities is just short of 57 inches. This is taken from the current period of record, 1961-1990 for calculating normals used by the National Weather Service and others. The longer term averages, naturally, show different totals: For the past 50 years the average is 53.3 inches, for this century the average is 46.6 inches, and for the entire period of record (all the way back to 1884) the average is 45.5 inches. This suggests that Twin Cities residents today have been experiencing greater seasonal abundance of snow in general than those generation of the past.

In answer to part two, a seasonal total of 70 inches of snowfall or more is somewhat rare for the Twin Cities, having occurred only 12 times in the past 115 years. I might add that six of the past 18 winters have exceeded 70 inches of snowfall however. The extremes have ranged from about 15 inches to 98 inches.

A complete listing of the monthly snowfall record for the Twin Cities is available at the Minnesota Climate Working Group web site.....

<http://www.climate.umn.edu/doc/historical.htm>

Twin Cities Almanac for October 1st:

The average MSP high temperature for this date is 67 degrees F (plus or minus 10 degrees standard deviation), while the average low is 46 degrees F (plus or minus 7 degrees standard deviation).

MSP Local Records for October 1st:

MSP weather records for this date include: highest daily maximum temperature of 87 degrees F in 1897; lowest daily maximum temperature of 45 degrees F in 1974; lowest daily minimum temperature of 24 degrees F in 1974; highest daily minimum temperature of 61 degrees F in 1971; and record rainfall of 0.63 inches in 1907.

Average dew point for October 1st is 43 degrees F, with a maximum of 66 degrees F and a minimum of 20 degrees F.

All-time state records for October 1st:

Scanning the state climatic data base: the all-time high for this date is 93 degrees F at Madison (Lac Qui Parle County) in 1963 and at Browns Valley (Traverse County) in 1976; the all-time low is 16 degrees F at Mora (Kanabec County) in 1984.

Word of the Week: EMWIN

This is a National Weather Service acronym for the Emergency Managers Weather Information Network. Developed in cooperation with FEMA (Federal Emergency Management Agency), EMWIN uses a variety of sources of data which are transmitted from the geostationary satellites (GOES 8 and GOES 10) to federal, state, and local emergency management offices which have satellite receiving dishes. A number of the information products are also available on the Internet, including severe weather warnings, hurricane warnings, flood warnings, air pollution statements, specialized forecasts, seismic activity, iceberg reports, and various advisories. Many can be found at the the following web site....

<http://iwin.nws.noaa.gov/iwin/graphicsversion/rbigmain.html>

Outlook:

Quite cool for the weekend and much of next week. Chance of showers, even snow showers Saturday, then mostly dry Sunday and Monday. Shower activity may return to the north on Tuesday and spread statewide by Wednesday. Temperatures will average 10 degrees F or more colder than normal, with somewhat blustery winds. Some moderation in temperatures by Wednesday and Thursday with a warming trend toward next weekend.

To: Bob Potter, Jim Bickal, Julie Siple

Topic: October Continues to Set Record Cold Temperatures:

Earlier this month on the 3rd, Embarrass reported a record low temperature of 9 degrees F. This is the earliest ever fall reading of a single digit temperature in Minnesota. In addition, Tower, MN reported a record low of 14 degrees F on October 3rd. This past Wednesday, October 6th also brought record cold to many northern Minnesota communities. The following were morning lows reported on October 6th and their ranking in each station's climate record.....

Location	Minimum Temp on Oct 6th	Historical Ranking
International Falls	18 F	new record
Orr	18 F	new record
Eveleth	18 F	new record
Ely	19 F	new record
Aitkin	19 F	tied record of 1976
Bigfork	21 F	new record
Hibbing	21 F	new record
Grand Rapids	21 F	3rd coldest
Cook	21 F	2nd coldest
Crane Lake	23 F	new record
Roseau	23 F	2nd coldest
Bemidji	23 F	3rd coldest

Topic: Twin Cities Climate and Outdoor Baseball

The proposal to build a new outdoor baseball park for the Twins has prompted a number of MPR listeners to ask me about the probability for inclement weather during the early and latter parts of the season. They are particularly concerned about playing baseball outdoors in April and October, especially late October when a highly successful team might be hosting a World Series. There are, of course, many definitions of inclement weather, some relating to the ability of the players to perform, and some relating to the comfort of the fans attending a game.

Baseball attendance is usually diminished when temperatures are less than 50 degrees F, though there have been numerous occasions when players have still competed during such conditions. Based on the Twin Cities climatology (1891-1999), in April, the probability of having temperatures less than 50 degrees F is 32 percent. That is about one third of the time such temperatures can be expected. In October, the probability is only 21 percent, or about one out of five. So from a temperature standpoint, the comfort of baseball fans may be more affected in April than in October.

From the perspective of an umpiring crew, a game may be postponed or cancelled because of rain, but it is almost invariably

cancelled if it is snowing. Twin Cities climatology once again shows that it has snowed measurably in 84 of the past 108 Aprils, roughly 78 percent of the time. It has snowed measurably in 37 of the past 108 Octobers, roughly 34 percent of the time. This can be misleading with respect to baseball, since a snowfall which occurs either before or after the 2 or 3 hours occupied by the game itself, may make little difference on whether or not the game is played. In addition, a team usually only plays about half of the games in any particular month in their home park. Nevertheless, one could expect that on occasion April or October games would be snowed out. In fact, though uncommon, there have been days in both months when the temperature has never risen above the mid 20s F and it has snowed persistently.

Coping with the risks of inclement weather is a given for all baseball operations. The extremes of the weather possibilities are probably of greater magnitude for the Twins than any other Major League Club. There are, however, far more important factors to consider in examining the potential economic success of a new outdoor ball park.

MPR listener question: Having snow during the first few days of October was rather frightening. What is the record snowfall for October in the Twin Cities?

Answer: The most snowfall in October for the Twin Cities is the 8.2 inches which fell on October 31, 1991 during the onset of the famous Halloween Blizzard. However, the most days with snowfall during the month of October occurred in 1925 when measurable snowfall was recorded on 5 different days.

Almanac Segment:

Twin Cities Almanac for October 8th:

The average MSP high temperature for this date is 61 degrees F (plus or minus 10 degrees standard deviation), while the average low is 42 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for October 8th:

MSP weather records for this date include: highest daily maximum temperature of 84 degrees F in 1966; lowest daily maximum temperature of 42 degrees F in 1925 and 1977; lowest daily minimum temperature of 27 degrees F in 1989; highest daily minimum temperature of 69 degrees F in 1997; record rainfall of 1.43 inches in 1970; and record snowfall of 0.3 inches in 1959.

Average dew point for October 8th is 41 degrees F, with a maximum of 68 degrees F and a minimum of 20 degrees F.

All-time state records for October 8th:

Scanning the state climatic data base: the all-time high for this date is 90 degrees F at Montevideo (Chippewa County) in 1980; the all-time low is 11 degrees F at Roseau (Roseau County) and Hallock (Kittson County) in 1917.

Words of the Week: Wind profiler

This is a three beam Doppler Radar system aimed vertically to measure atmospheric winds at different altitudes over a station. These data provide forecasters with an atmospheric profile of wind so they can detect where wind shear (sharp changes in direction or speed) is occurring and the altitude of maximum wind speeds. This information aids in forecasting for aviation. There is a wind profiler system located at Wood Lake, MN west of the Twin Cities area.

Forecast for October 9-15:

Dry period coming up, with plenty of sunshine and seasonable temperatures. Good time to tackle the remaining fall chores. Becoming windy on Tuesday and Wednesday, with a chance for precipitation. Another chance for precipitation as we approach next weekend.

To: Bob Potter, Jim Bickal, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Oct 15, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: An El Nino Relative in the Indian Ocean

A recent article in Science News Magazine (Sept 25, 1999) highlighted the results of two independent studies of the Indian Ocean which showed some behavior similar to El Nino in the Pacific Ocean. It was found that on occasion, abnormally warm surface waters are driven by easterly winds and pile up along the east coast of Africa. This is the reverse of the usual pattern which shows warmer waters in the eastern Indian Ocean near Indonesia. In the past 40 years (including 1997) there have been six episodes of this unusual pattern in Indian Ocean temperature when the warm waters off the east African coast fueled greater convection and storminess bringing heavy rains and spawning epidemics in Kenya and other African countries. These episodes appear to occur independently of El Nino in the Pacific, but share similar physical characteristics such as shifts in water temperature, wind patterns and sea level. Meteorologists and climatologists hope to utilize monitoring and measurement of the Indian Ocean temperatures to better forecast climate anomalies in the surrounding countries. More on this study and others can be found at the Science News web site:

<http://www.sciencenews.org>

Topic: Composting

Many homeowners around the state compost leaves in the fall. My university home, the Department of Soil, Water, and Climate has developed recommendations for composting and mulching of organic yard wastes, including leaves. Carl Rosen and Tom Halbach among others have published a guide to composting and mulching which is available from county extension offices. Some of the important points about composting:

Large plastic bags, barrels, wire cages or wooden frames will all work well for composting.

Shredded leaves will decompose faster than whole leaves.
(Basically, smaller breaks down faster than larger)

Key ingredients include: organic waste (leaves, grass clippings, plant residues from gardens), proper aeration (stirring or mixing occasionally), moisture (periodically water the compost pile),

and nitrogen (either from manure, blood meal, or fertilizer).

Depending on the amount of material, composting may take from 6 months to a year or more before you have a usable mulch.

Weather is certainly a factor in governing the speed of the composting process. Leaves placed in a compost pile early this fall will be subject to more decomposition before winter freeze up. During the winter months in Minnesota, compost piles are usually frozen and little biological activity occurs. Thus, if you would like to use the mulched material by next summer or fall, start composting now and don't wait for the last leaf to fall.

MPR listener question: I have heard you speak about intense rainfall amounts of 2.5 to 3.0 inches per hour having a return period of only once in 100 years. But, what about snowfall rates? What are the extreme hourly rates of snowfall?

Answer: Good question, and hard to answer. There is a scarcity of data concerning hourly snowfall rates. Some of the National Weather Service airport locations have kept hourly records in recent decades. Most snowfalls are gentle and with gradual accumulations. For 90 percent of the snow storms in the United States, it is estimated that the accumulation rate is less than 0.5 inches per hour. Extreme rates in Minnesota have ranged from 1.5 to 2.0 inches per hour and these are quite rare. Notably the famous Halloween Blizzard of 1991 produced rates like this, as did the heavy snowfalls of January 1982 and the Armistice Day Blizzard of 1940. Some meteorologists claim lake-effect hourly snowfall rates of 5 to 7 inches per hour around the Great Lakes, but these measurements may be a combination of falling and drifting (blowing) snow. Even higher rates, up to 18 inches per hour have been suggested as possible in mountainous areas of the west.

Twin Cities Almanac for October 15th:

The average MSP high temperature for this date is 62 degrees F (plus or minus 11 degrees standard deviation), while the average low is 42 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for October 15th:

MSP weather records for this date include: highest daily maximum temperature of 85 degrees F in 1947 and 1968; lowest daily maximum temperature of 40 degrees F in 1943; lowest daily minimum temperature of 26 degrees F in 1974; highest daily minimum temperature of 66 degrees F in 1968; record rainfall of 1.24 inches in 1966; and record snowfall of 0.3 inches in 1992. There have been two measurable snowfalls on this date since 1948.

Average dew point for October 15th is 41 degrees F, with a maximum of 69 degrees F and a minimum of 13 degrees F.

All-time state records for October 15th:

Scanning the state climatic data base: the all-time high for this date is 93 degrees F at Madison (Lac Qui Parle County) in 1958; the all-time low is 9 degrees F at Hallock (Kittson County) in 1919.

Words of the Week: Operational Weather Limits

Most commonly this refers to the limiting values of cloud ceiling, visibility and winds which allow for safe operation of aircraft, particularly in takeoff and landing. They are typically different for daytime and nighttime operations and are also tailored to the specific airport environments, which account for navigational aids and types of aircraft used. There are also operational weather limits for other endeavors such as snowplowing, well drilling, shipping, painting, and just about any other outdoor activity you can think of.

Outlook:

A cold period is in store for most of Minnesota during the third week of October. Temperatures will average 10 degrees F or more cooler than normal with a chance for showers, and even some snow showers up north over the weekend and into early Monday. Some moderation in temperature will occur next week, but it will likely remain several degrees colder than normal until late in the week, when a warming trend should carry us into the weekend of the 23rd.

To: Bob Potter, Jim Bickal, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Oct 22, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: Polar News

Three separate stories about polar research activities have been highlighted this month and might be of interest to WeatherTalk readers and MPR listeners.....

The October Bulletin of the American Meteorological Society features a story about preservation of historical arctic meteorological data. From 1954 to 1990 the former Soviet Union operated 21 drifting meteorological stations on the ice covered Arctic Ocean. These stations routinely took upper air observations using balloon launched radiosondes. The data were stored in bound volumes of handwritten tables at the Arctic and Antarctic Research Institute in St Petersburg. Thanks to a joint effort of the United States and the Russian Federation through an Agreement for Protection of the Environment and Natural Resources, these data have been entered into a computer database and quality controlled for further study of trends and cycles in the structure of the atmosphere over the Arctic Ocean. This is the only long-term data set of its kind and should be of great value in gaining a better understanding of meteorological conditions in the vicinity of the North Pole. The 25,000 plus soundings are available at the National Snow and Ice Data Center in Boulder, CO (web site:<http://www-nsidc.colorado.edu/>).

Science News (web site: <http://www.sciencenews.org>) earlier this month featured a story about Lake Vostok in Antarctica. About three years ago, glaciologists discovered that beneath the Russian research station at Vostok is a lake roughly the size of Lake Ontario, only deeper. This subglacial lake is buried by 2 mile thick ice cover, but is thought to perhaps contain some ancient microbes or sediment structure that may provide evidence about the Earth's past climate. Plans are to map the lake dimensions using airborne radar and then drill for core samples at some time in the future if the technology can be developed so that drilling will not contaminate the lake.

Lastly, Bruce Smith, a science teacher from Appleton, WI has recently journeyed to Antarctica to spend the summer doing research at the McMurdo Station, a drill site for the Cape Roberts Project on the Ross Ice Shelf. He is a participant in the National Science Foundation TEA program (Teachers Experiencing

Antarctica or the Arctic (web site: <http://tea.rice.edu/index.html>). He will be analyzing cores from the sea bottom for microfossils. Perhaps more importantly for science teachers, he files journal reports on his web site (http://tea.rice.edu/tea_smithfrontpage.html) detailing the weather, providing images of the local environment, and suggesting activities for earth science teachers and their students. It might be interesting for students to track his progress each week using the web site. Soon Antarctica will be experiencing 24 hours of daylight as summer advances there.

Topic: Rapid Decline in Soil Temperatures

If you have been waiting for soil temperatures to drop in order to mulch the garden, tip the roses, fertilize or plant bulbs, the time to act is now. Average soil temperatures (4 inch depth) have dropped by 10 to 15 degrees F over the past week and are now in the low to mid 40s F. In addition, because of a lack of rainfall over the past month, some fall watering might be helpful to reduce stress on trees and shrubs and make sure they are adequately hydrated going into winter. Golf course superintendents should probably be thinking about covering greens for the winter during the last week of October or first week of November as the snow season may come early this year.

MPR listener question: Most of the Twin Cities record low temperatures in late October are in the teens. But, what is the record low windchill temperature for October and does it very often get below zero degrees F?

Answer: Checking the historical data back to 1891, the coldest windchill temperature for October in the Twin Cities is -15 degrees F on October 28, 1925. It appears that at least eleven Octobers in the past 108 years have produced windchill values below zero. Perhaps the worst case was in 1925, when windchill values below zero were recorded on four consecutive days (27th-30th). The most recent episode of October windchill temperature below zero in the Twin Cities was October 31, 1996 when it was -11 degrees F briefly during the morning hours.

Twin Cities Almanac for October 22nd:

The average MSP high temperature for this date is 56 degrees F (plus or minus 12 degrees standard deviation), while the average low is 39 degrees F (plus or minus 9 degrees standard deviation).

MSP Local Records for October 22nd:

MSP weather records for this date include: highest daily maximum temperature of 81 degrees F in 1992; lowest daily maximum temperature of 31 degrees F in 1936; lowest daily minimum temperature of 20 degrees F in 1936; highest daily minimum temperature of 60 degrees F in 1914; record rainfall of 0.69 inches in 1957; and record snowfall of 1.6 inches in 1925. There have been three measurable snowfalls on this date in the 20th

century, 1917, 1925, and 1938. The coldest windchill conditions on this date were -4 degrees F in 1917.

Average dew point for October 22nd is 38 degrees F, with a maximum of 57 degrees F and a minimum of 13 degrees F.

All-time state records for October 22nd:

Scanning the state climatic data base: the all-time high for this date is 87 degrees F at St Peter (Nicollet County) in 1947; the all-time low is 2 degrees F at Hallock (Kittson County) in 1936.

Words of the Week: Noctilucent clouds

These are rarely seen wavy, thin bluish or silvery clouds. They appear in shapes and patterns similar to cirrus clouds, but they are much higher, 45 to 55 miles above the Earth's surface in the mesosphere, where temperatures range below -100 degrees F. Most often seen at high latitudes just before sunrise or just after sunset, noctilucent clouds are thought to be composed of ice that is deposited on ejected volcanic debris or the dust particles from meteorites.

Outlook:

Becoming less windy over the weekend. Quite cold on Saturday morning, then climbing temperatures for the rest of the weekend. Mostly a dry week coming up, with near normal temperatures, then increasing cloudiness by Wednesday with a chance for rain or snow showers and colder temperatures.

To: Bob Potter, Jim Bickal, and Julie Siple
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Oct 29, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: Dry Air

Frequent grass fires, withholding burning permits, itchy skin, dry scalp and throat, static electricity shocks, cracked soils - these are all signs of dry weather and indeed we have had a prolonged spell of it this fall. The most obvious statistical signature of the dry spell is the lack of precipitation. The 0.27 inches of total precipitation reported at the MSP airport is tied for the 6th driest October (with 1975) of the past 108 years. Nearly a quarter of the climate observers around the state are reporting less than 0.5 inches of precipitation for the month so far. The absence of precipitation is not the only sign of dryness. The air itself is extremely dry, in fact record-setting for the month of October in terms of measured dewpoints and relative humidities.

Earlier this week on Monday (October 25) afternoon, a dry cold front passed across the state ushering in the driest air of the year. Between 2 pm and 7 pm strong wind gusts mixed very dry air aloft (up to 5000 ft) with already dry air at the surface. Dewpoints dropped over 20 degrees F and relative humidity fell by over 30 percent. The locations and conditions listed below probably represent the driest air observed this century in the month of October across Minnesota.

October 25th climate report, extreme values for the hours 2-7 pm

Location	Dewpoint F	Relative Humidity PCT	Peak Wind Gusts MPH
MSP	9	11	29
Univ of MN (St Paul)	9	11	31
Rosemount	4	9	28
Litchfield	0	8	31
St James	12	13	30
Faribault	0	7	29
St Cloud	10	12	29
New Ulm	8	12	31
Albert Lea	6	10	30
Jackson	8	10	29
Hutchinson	8	11	30
Little Falls	7	11	31
Princeton	-6	6	37

The previous record low relative humidity observed at the MSP airport during the month of October was 15 percent. October dewpoint values in the single digits and below zero have been observed in the past

(about 1 percent of the time at MSP) across Minnesota, but in much colder air. Temperatures on October 25th were generally in the 60s F, leading to the record setting low relative humidity values, that were roughly equivalent to those at Tucson, AZ on the same day.

Topic: Daylight Saving Time

Daylight Saving Time comes to an end this Sunday. Set your clock back one hour before going to bed Saturday night. Advancing the clock by one hour for the April through October period has been shown to improve our use of the evening hours for outdoor activity and also to reduce our home energy use (because of more daylight in the after dinner hours and before bedtime) during the Daylight Saving Time months.

Standard time zones in the United States were first proposed by the railroads in 1883 in order to help standardize their schedules. The International Prime Meridian Conference in Washington during 1884 helped establish the standard time zones (based on the 0 degree meridian at Greenwich, England) throughout the world. In 1918 Congress officially adopted the standard time zones proposed by the railroads, along with the summer usage of Daylight Saving Time to conserve energy resources. Daylight Saving Time was unpopular that year (people got up earlier and went to bed earlier than today), that it was repealed in 1919. Daylight Saving Time was again adopted by many states during World War II to save energy. The Uniform Time Act of 1966 established the use of Daylight Saving Time based on the last Sunday of April and last Sunday of October. It was amended in 1986 to start on the first Sunday of April.

Today, over 70 countries observe some form of Daylight Saving Time. Most equatorial countries do not, because the length of day varies so little throughout the year. Some MPR listeners have asked if the time change causes a problem among government weather services in reporting their data. Not really. The World Meteorological Organization mandates that all government weather services remain on international standard time (Universal Time) throughout the year. They do adjust some hourly reporting to accommodate the media, but their official data and reports are geared on a midnight to midnight calendar date using standard time.

More on Daylight Saving Time can be found at the following web site...

www.webexhibits.com/daylightsaving

MPR listener question: What are the averages and extremes of weather for Halloween in the Twin Cities?

Answer: The average max/min temperatures on Halloween are 51 and 35 degrees F, respectively. Precipitation occurs about one third of the time (35 of the past 108 years). A trace or more of snow has fallen on seven Halloweens this century, the largest being 8.2 inches during the onset of the Halloween Blizzard of 1991. The warmest Halloween was in 1950 when the afternoon temperature hit 83 degrees F. The coldest Halloweens were 1951 (with a hi/lo of 30 and 18 degrees F)

and 1996 (with a hi/lo of 32 and 16 degrees F). However the coldest feeling Halloweens were probably the ones with windchill values of 0 degrees F or colder: 1905 (-8 WC), 1911 (-7 WC), 1925 (0 WC), 1935 (-6 WC), and 1951 (-5 WC). All had brisk northwest winds. Average wind speed on the evening of Halloween is 10 mph, but has been as high as 34 mph.

Twin Cities Almanac for October 29th:

The average MSP high temperature for this date is 53 degrees F (plus or minus 11 degrees standard deviation), while the average low is 35 degrees F (plus or minus 9 degrees standard deviation).

MSP Local Records for October 29th:

MSP weather records for this date include: highest daily maximum temperature of 78 degrees F in 1922; lowest daily maximum temperature of 25 degrees F in 1925; lowest daily minimum temperature of 15 degrees F in 1925; highest daily minimum temperature of 56 degrees F in 1974; record rainfall of 1.01 inches in 1896; and record snowfall of 5.5 inches in 1905. There have been five measurable snowfalls on this date in the 20th century, 1905, 1913, 1929, 1955, and 1984. The coldest windchill conditions on this date were -12 degrees F in 1917.

Average dew point for October 29th is 35 degrees F, with a maximum of 64 degrees F and a minimum of 6 degrees F.

All-time state records for October 29th:

Scanning the state climatic data base: the all-time high for this date is 84 degrees F at Tracy (Lyon County) and Canby (Yellow Medicine County) in 1937; the all-time low is -3 degrees F at Campbell (Wilkin County) in 1919 and at Pipestone in 1925.

Words of the Week: Psychrometric Tables

These are tables used by meteorologists to determine measures of atmospheric water content (dewpoint, vapor pressure, or relative humidity) from the observed dry-bulb and wet-bulb temperature values taken with a psychrometer. Today's modern electronic instrumentation is often programmed to give these values. The term is composed of the Greek word "psychros" meaning cooling, and meter meaning to measure. The cooling power of the air is related to the water vapor content, the drier the air the more rapidly evaporation, or cooling will occur.

Outlook:

Chance of mixed showers Saturday and Sunday, especially up north. Somewhat cooler next week, with temperatures falling to below normal levels by mid-week. Possibility of more mixed showers by the end of the week.

To: Bob Potter, Jim Bickal, Julie Siple, and Eugene Cha
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Nov 5, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: Internet Weather Sparks Competitive Fires

A recent article this fall in the Economist Magazine highlighted the growing competition in weather forecasting services. In recent decades, many government funded weather services, especially in Europe, have been able to secure contracts for forecasting services with the media, the shipping industry, airlines, recreation and tourism businesses. These contracts supplement their funding from the government. However, the rapid development of Internet based worldwide-weather data and information has provided many private, commercial meteorological services with the basis to expand and explore new customers, including some who have relied on government services. Government weather services rightly claim that the infrastructure needed to acquire and process data for the meteorological community remains in their jurisdiction and is funded by their organizations. There would be no modern meteorological services for anyone without this infrastructure. So how can competition between commercial and government operated meteorological services be allowed in a healthy manner that is fair and respectful of the governments investment in infrastructure. This is the question placed before the World Meteorological Organization in Geneva, Switzerland. A great deal of potential revenue is at stake.

Topic: Different Perspectives of the Dry Fall

Though not uniform throughout the state, a significant dry weather pattern has persisted this fall in many areas. Some had a very dry month of October, with only a handful of measurable rainfalls. Still other areas recorded an even drier two month sequence of September and October. The table below summarizes these different ways of examining the dry spell. Ranks are relative to the most recent 100 years of data (except for Lamberton which dates from 1960).

Location Amount and Rank # of Oct days Amount and Rank
of Oct. Pre. with pre.(normal) of Sep-Oct pre

Crookston	.09 (5th driest)	4 (6)	4.10 (69th driest)
Grand Forks	.12 (5th driest)	2 (6)	2.67 (28th driest)
Artichoke Lake	.14 (5th driest)	1 (6)	2.40 (26th driest)
Sioux Falls	.37 (10th driest)	4 (6)	1.18 (4th driest)
Pipestone	.77 (30th driest)	4 (7)	2.12 (14th driest)
Canby	.69 (25th driest)	4 (6)	2.74 (25th driest)
Lamberton	.95 (13th driest)	4 (6)	1.62 (2nd driest)
Morris	.31 (19th driest)	2 (6)	2.86 (38th driest)

Montevideo	.47 (19th driest)	4 (6)	1.65 (10th driest)
Rochester	.92 (16th driest)	6 (8)	1.45 (6th driest)
Worthington	.74 (23rd driest)	5 (7)	1.15 (2nd driest)
MSP	.92 (25th driest)	6 (8)	2.11 (13th driest)

In addition to the above, other indications of dryness were exhibited by the following: record setting low relative humidity values were recorded during October (single digits in places); very high solar radiation (sunshine) which was about 25 to 30 percent more than normal was recorded in the Twin Cities area; and associated high evaporation rates were measured in a number of agricultural areas.

MPR listener question: Next Thursday is the 59th anniversary of the famous Armistice Day Blizzard in Minnesota (Nov 11, 1940), perhaps the most vivid weather memory for my generation. Even though the total snowfall accumulation in the Twin Cities was measured at 11.2 inches and has since been surpassed many times, I remember the rate of snowfall was extreme. What was the maximum rate of accumulation during that storm?

Answer: It is estimated that during the peak of the storm in the mid afternoon hours, the snowfall rate was 3 to 4 inches per hour with winds of 30 to 35 mph. This produced zero visibility and extremely dangerous conditions for those caught outside. Total precipitation from the storm was 2.52 inches which would have perhaps even exceeded the famous Halloween Blizzard of 1991 had it all fallen as snow. However, much of the precipitation fell as rain and sleet before afternoon temperatures plummeted into the teens.

Twin Cities Almanac for November 5th:

The average MSP high temperature for this date is 47 degrees F (plus or minus 10 degrees standard deviation), while the average low is 30 degrees F (plus or minus 8 degrees standard deviation).

MSP Local Records for November 5th:

MSP weather records for this date include: highest daily maximum temperature of 70 degrees F in 1975; lowest daily maximum temperature of 26 degrees F in 1935; lowest daily minimum temperature of 3 degrees F in 1951; highest daily minimum temperature of 48 degrees F in 1918; record rainfall of 0.93 inches in 1948; and record snowfall of 4.2 inches in 1959. There have been eleven measurable snowfalls on this date in the 20th century. Greatest snow depth on this date was 23 inches in 1991. The coldest windchill conditions were -16 degrees F in the evening of 1959.

Average dew point for November 5th is 29 degrees F, with a maximum of 55 degrees F and a minimum of 0 degrees F.

All-time state records for November 5th:

Scanning the state climatic data base: the all-time high for this date is 78 degrees F at Madison (Lac Qui Parle County) in 1975; the all-time low is -16 degrees F at Detroit Lakes (Becker County) in 1951.

Word of the Week: Gnomonists

Originally the Greek word gnomon meant an interpreter, judge or knowledgeable person. The center post of of a sundial is called a gnomon, because it casts a shadow to show what time it is. Thus gnomonists are people in the know who tell time and direction by reading the size and shapes of shadows. The shadow is not always cast upon a sundial. Historically other objects that cast shadows, such as rock formations (Stonehenge), buildings or monuments have been used as well. The space probe named Mars Surveyor carries a sundial of sorts. A gnomon has been added to a color target that is used to calibrate the landers camera. So when the space probe lands on Mars in 2002, an image will be transmitted back to Earth which, in effect, will convey what time it is on Mars.

Outlook:

Dry and warm weather appears to be in store for most of the coming week. Temperatures will average several degrees above normal under mostly sunny skies (an unusual feature for November which tends to be the cloudiest month). There is a chance for some widely scattered showers Tuesday and Wednesday of next week, with increasing winds by Thursday.

To: Bob Potter, Jim Bickal, Julie Siple, and Eugene Cha
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Nov 12, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: Warm start to November

Numerous record high maximum temperatures were recorded around the state this week. While dozens of record highs were reported on the 7th and the 9th, November 8th brought record high temperatures to virtually every Minnesota community, a very rare occurrence climatologically. In addition, a number of record warm overnight minimum temperatures were recorded. The high 70s and low 80s recorded on Monday, November 8th, were for many the highest temperatures every recorded so late into the fall. A rundown of all the record-setting weather of early November can be found at the web site of the Minnesota Climatology Working Group.....

<http://www.climate.umn.edu/doc/journal/nov99heat.htm>

Since nine of the first eleven days of November have been significantly warmer than normal, the first part of the month ranks as one of the warmest historically in the Twin Cities record. Dave Ruschy, of the Minnesota Climatology Working Group has provided the following table ranking the warmth of early November.....

Top Ten List

Warmest first eleven days of November since 1891 at MSP....

Year	Rank	Average Daily Temperature
1975	1	49.9 F
1964	2	49.5 F
1978	3	48.8 F
1893	4	48.4 F
1909	5	47.6 F
1999	6	46.5 F
1915	7	46.2 F
1922	8	46.0 F
1931	9	45.8 F
1956	10	45.5 F

Note, of these warm early Novembers, five later produced above normal snowfall for the month, and four recorded much colder than normal temperatures during the second half of the month.

Topic: Winter Weather Awareness Week

This week is Winter Weather Awareness Week, when the National

Weather Service encourages us to review and become familiar with the various watches, warnings and advisory statements that are issued for hazardous winter weather conditions. Web sites which host this information, including definition of terms and recommended actions, are the following.....

<http://tgsv5.nws.noaa.gov/om/winter/>
<http://www.crh.noaa.gov/fsd/windex.htm>

Topic: Legendary November Storms

As the nights grow longer, the contrast in temperature across the northern latitudes increases sharply. Low pressure and high pressure systems grow in strength and typically invade the Great Lakes region during November, bringing strong winds, heavy rain or snow, and sometimes dangerous windchill values. Some historically significant November storms were....

November 11, 1911 a strong cold front passed through the upper midwest, producing an F4 tornado near Janesville, WI, followed an hour later by blizzard conditions with windchills near zero.

November 9-10, 1913 a storm system, later named the "Freshwater Fury," produced strong gales on the Great Lakes, where 17 ships were sunk.

November 11, 1940 brought the famous Armistice Day Blizzard, with winds of 60 mph in Duluth, MN. Forty-nine people were killed in Minnesota, many of them hunters caught out in the open in zero visibility and -40 degree F windchills. Three freighters sank in Lake Michigan during the storm.

November 10, 1975 brought gale winds and high waves to Lake Superior where the Edmund Fitzgerald sank with all 29 men on board. Winds of 71 mph were recorded at Sault Ste Marie, MI.

November 15-16, 1996 brought a heavy ice storm to southern Minnesota and a blizzard to northwestern counties. Heavy snow (8-13 inches) and winds to 45 mph, with zero visibility occurred in the Red River Valley, while ice 1/2 inch thick coated trees and powerlines in southern counties. Some lost power for 5 days. Flights were cancelled at MSP airport.

And most recently, November 10-11, 1998 brought a winter storm to southern Minnesota and a blizzard for western and northern counties. Many communities reported wind gusts over 60 mph. Many all-time low barometric pressure readings were recorded, including a new state record low of 28.43 inches (typical of a hurricane) at Austin and Albert Lea. Seventy-seven mph winds were reported along the Lake Superior shoreline, with 20 foot waves, but ships had been warned and taken shelter.

MPR listener question: On Wednesday, November 10th, hail fell in the Twin Cities area. It was so abundant on Highway 212 in

Eden Prairie that the Minnesota Department of Transportation dispatched a snowplow and loader to remove it. How often does hail occur during November in the Twin Cities area?

Answer: Not very often. Data since 1945 show a frequency of less than 0.4 percent of November days when hail was reported in the Twin Cities area. This amounts to about six days in the last 50 years.

MPR listener question: Thursday, November 11th was the 59th anniversary of the famous Armistice Day Blizzard in Minnesota (1940), during which a number of hunters were killed or suffered frostbite. What were the windchill temperatures during that storm?

Answer: Based on some of the historical hourly data for November 11, 1940, windchill values ranged from -40 to -50 degrees F during the afternoon and evening as temperatures fell dramatically, by over 30 degrees F in some places. Wind gusts of 35 to 45 mph caused afternoon visibility to go to zero as well.

Twin Cities Almanac for November 12th:

The average MSP high temperature for this date is 41 degrees F (plus or minus 11 degrees standard deviation), while the average low is 27 degrees F (plus or minus 10 degrees standard deviation).

MSP Local Records for November 12th:

MSP weather records for this date include: highest daily maximum temperature of 62 degrees F in 1952; lowest daily maximum temperature of 11 degrees F in 1911 and 1940; lowest daily minimum temperature of -4 degrees F in 1966; highest daily minimum temperature of 44 degrees F in 1964; record rainfall of 0.90 inches in 1965; and record snowfall of 8.5 inches in 1940. There have been eleven measurable snowfalls on this date since 1891, most recently 0.2 inches in 1983. Greatest snow depth on this date was 16 inches in 1940. The coldest windchill conditions were -46 degrees F in 1911.

Average dew point for November 12th is 26 degrees F, with a maximum of 51 degrees F and a minimum of -9 degrees F.

All-time state records for November 12th:

Scanning the state climatic data base: the all-time high for this date is 71 degrees F at Winona in 1964; the all-time low is -26 degrees F at Tower (St Louis County) in 1995.

Word of the Week: Attery

This is taken from the old Anglo Saxon word 'atter' meaning poison or inflammation. The Scottish Meteorological Office will still occasionally use this term to describe a spell of stormy

weather, implying that it is like a poisonous, or inflamed condition of the atmosphere. Usually November brings "attery" weather to Minnesota, but there has been a conspicuous absence of it so far this month.

Outlook:

A chance of rain showers and/or snow in the north on Saturday night and Sunday. It will be mostly dry, warm and windy in the south over the weekend, with near record high temperatures Saturday. Cooler on Sunday, but temperatures will remain above seasonal averages. Stronger winds by Wednesday and Thursday with an increasing chance of precipitation towards next weekend, as cooler than normal temperatures settle in with possibly some snow.

To: Bob Potter, Jim Bickal, Julie Siple, and Eugene Cha
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Nov 19, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: Drought Monitoring

Drought has been a concern in the east-central and southeastern United States for much of 1999, and since September drought has developed in parts of the western Corn Belt states, including southern Minnesota. In cooperation with the National Weather Service and the USDA, the National Drought Mitigation Center of the University of Nebraska monitors drought on a weekly basis. Many different indices are used to monitor drought including percent of normal precipitation, the Standardized Precipitation Index, the Palmer Drought Index, Crop Moisture Index, Surface Water Supply Index, and the Reclamation Drought Index. Each has its strengths and weaknesses. A full description of drought monitoring methods is available at the web site of the National Drought Mitigation Center.....

<http://enso.unl.edu/monitor/monitor.html>

Drought can have devastating impact on the agricultural economy, as well as water supply and river navigation. The economic losses associated with the 1988 drought were estimated at nearly \$40 billion. Drought which begins in the fall season is typically less consequential than drought which begins in the winter, spring or summer. Winter drought can cause dessication of plants, and winter injury to pasture grasses, winter wheat and alfalfa. Spring drought can cause delayed crop planting and emergence and/or significant soil loss from wind erosion, while summer drought can stunt plants, cause drastically reduced crop yields, and very low river flows that present navigation problems. The current dry fall conditions can yet be mitigated in three ways: (1) by late fall precipitation which will be stored in the soil before it freezes up; (2) by heavy overwinter snow cover which will infiltrate into the dry soil layers with each thaw cycle of the late winter; or (3) by early spring precipitation which will recharge the depleted surface layers of the seedbed and perhaps bridge the dry layers of the rootzone with the more saturated layers of soil below. Thus, though the current lack of soil moisture in parts of Minnesota is of concern, there are still a number of ways that the soil could be recharged sufficiently for the year 2000 crop season.

MPR listener question: How often does the Twin Cities receive only a trace of snow or less during the month of November?

Also, how often does the month end with no snow cover?

Answer: According to the Twin Cities snowfall records from the past 115 years, there have only been three Novembers when only a trace or less of snowfall was measured: 1928 showed a trace, 1939 showed a trace, and 1963 shows no snowfall at all. Regarding the frequency that there is no snow cover in the Twin Cities area on the 30th of November, this is far more common, and has happened about 50 percent of the time historically.

Twin Cities Almanac for November 19th:

The average MSP high temperature for this date is 40 degrees F (plus or minus 11 degrees standard deviation), while the average low is 25 degrees F (plus or minus 11 degrees standard deviation).

MSP Local Records for November 19th:

MSP weather records for this date include: highest daily maximum temperature of 65 degrees F in 1930; lowest daily maximum temperature of 13 degrees F in 1894; lowest daily minimum temperature of -5 degrees F in 1932; highest daily minimum temperature of 48 degrees F in 1930; record rainfall of 1.0 inches in 1983; and record snowfall of 6.2 inches in 1981. There have been twelve measurable snowfalls on this date since 1891. The greatest snow depth on this date was 10 inches in 1957. The coldest windchill conditions were -43 degrees F in 1914.

Average dew point for November 19th is 25 degrees F, with a maximum of 52 degrees F and a minimum of -1 degrees F.

All-time state records for November 19th:

Scanning the state climatic data base: the all-time high for this date is 74 degrees F at Montevideo (Chippewa County) in 1897 and at Winona in 1953; the all-time low is -29 degrees F at Roseau in 1896.

Word of the Week: Sweevil

This is another term occasionally used by Scottish meteorologists to describe a gust of wind. It is derived partially from the Norwegian term *sweel*, which means to whirl around. A visiting Norwegian meteorologist may have very well passed this term on to the Scottish sometime in the past hundred years or so.

Outlook:

Perhaps the change to more stable winter conditions is finally on the horizon, with a precipitation-bearing low pressure system scheduled to pass over the state this weekend, followed by a much cooler air mass which will usher in below normal temperatures for Thanksgiving week.

To: Bob Potter, Jim Bickal, Julie Siple, and Eugene Cha
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Nov 26, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: Heating Degree Days and the Heating Season

There was an article in the Pioneer Press this week pointing out the recent increases in the per unit cost of natural gas, home heating oil, and electricity. This is an unfortunate coincidence with what will likely be a return to near normal winter temperature. Having just experienced the two mildest back-to-back winters of the 20th century in Minnesota, most Minnesotans were bracing for a return to higher residential and commercial heating costs anyway, but the inflation in unit costs for energy use will certainly enhance the shock to the budget.

The heating season for estimating energy use runs from July 1 to June 30, with most of the Heating Degree Days (accumulation of daily temperature values of less than 65 degrees F) occurring during the months of November through March. Taking the Twin Cities climate record as an example, the average Heating Degree Days (HDD) for a season is 7906. Six of the most recent ten winters have HDD values less than this, implying that we as consumers generally paid less for our energy use, particularly the past two years when HDD values were 12 to 13 percent less than the long term average. The most recent winters with above average heating needs based on HDD were those of 1995-96 and 1996-97 when values were 7 to 8 percent more than the long term average. Some extreme winters historically (1935-36, 1916-17, and 1903-1904) have produced HDD values as much as 15 percent more than average.

A return to near normal temperature conditions combined with higher per unit costs for energy implies that most Minnesotans might want to budget anywhere from 15 to 25 percent more for home heating during this coming winter.

MPR listener question: Despite the snowfall earlier this week, it has been so mild this month, I am wondering if this is one of the warmest Novembers in history.

Answer: Yes, indeed it is from almost any perspective. Though we are not yet to the end of the month, it is likely that this will be recorded as the warmest ever month of November in the Twin Cities climate record (1891-1999). The record warm November occurred in 1899, with an average temperature of 41.2 degrees F. So far this month, the average temperature is well over 42 degrees F.

Similarly, if we look at statewide temperature averages, it looks like this will be the warmest November in Minnesota history. The statewide average temperature so far is over 40 degrees F, and the old statewide record is 38.3 degrees F also from 1899. The warmth has been enhanced by the absence of snow cover around the state for most of the month, and by the record-setting daily temperatures on the 8th, 9th, 13th and 14th. This is only the 8th year in the historical record that temperatures have reached 80 degrees F or higher in Minnesota during the month of November. Windom, MN tied the all-time state high temperature record for November with 84 degrees F on the 13th.

Twin Cities Almanac for November 26th:

The average MSP high temperature for this date is 34 degrees F (plus or minus 10 degrees standard deviation), while the average low is 20 degrees F (plus or minus 10 degrees standard deviation).

MSP Local Records for November 26th:

MSP weather records for this date include: highest daily maximum temperature of 62 degrees F in 1914; lowest daily maximum temperature of 10 degrees F in 1898; lowest daily minimum temperature of -16 degrees F in 1977; highest daily minimum temperature of 39 degrees F in 1909; record rainfall of 1.76 inches in 1896; and record snowfall of 5.0 inches in 1970. There have been thirty-two measurable snowfalls on this date since 1891. The greatest snow depth on this date was 9 inches in 1983 and 1996. The coldest windchill conditions were -51 degrees F in 1930.

Average dew point for November 26th is 20 degrees F, with a maximum of 41 degrees F and a minimum of -22 degrees F.

All-time state records for November 26th:

Scanning the state climatic data base: the all-time high for this date is 67 degrees F at New Richland (Waseca County), Winnebago (Faribault County), and Windom (Nobles County) in 1914; the all-time low is -37 degrees F at Pokegama Dam (Itasca County) in 1903.

Words of the Week: Snawwreath and Snawbroo

These are terms Scottish meteorologists would have used in describing our weather earlier this week. Snaw is Scottish for snow. A snawwreath is the term for snowdrift, something which was visible in the Minnesota landscape on Tuesday of this week. Broo is a Scottish term used to refer to water for cooking. Thus, snawbroo is melting snow, a feature that was quite visible on Wednesday and Thursday this week.

Outlook:

Chance of snow in the northeast on Saturday and Sunday, with some

possible shower activity in the south on Saturday. Then dry until midweek, with an increasing chance for snow or perhaps rain showers by Wednesday through Sunday. It will be windier by then as well. Temperatures will average a few degrees above normal throughout the period, with skies generally cloudy.

To: Bob Potter, Jim Bickal, Julie Siple, and Eugene Cha
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Dec 3, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: Additional Features of the Warm 1999 November

Earlier this week, the National Weather Service reported that November of 1999 was the warmest ever, exceeding the mark set in 1899. This was true for most communities in the state of Minnesota, but it was equally applicable to a larger geographic area as well. Marquette, MI, Goodland and Topeka, KS, Sioux Falls, SD, Tulsa and Oklahoma City, OK all reported the warmest November as well. Fargo, ND reported the warmest November this century, while La Crosse, WI reported the second warmest.

Many stations tied or set records for dryness as well. Several western Minnesota communities reported only trace amounts of precipitation during November, including Crookston, Fergus Falls, Itasca State Park and Fargo-Moorhead. International Falls also reported only a trace, marking also the least amount of November snowfall for that community. The absence of snowfall, other than trace amounts also set a November record at Aberdeen, SD, Green Bay, WI, and Milwaukee, WI.

According to daily solar radiation records kept by the St Paul Campus of the University of Minnesota, November of 1999 was the sunniest ever, with values that were 27 percent higher than average. This broke the old record from 1986. In terms of percent possible sunshine, the National Weather Service in Chanhassen reported 67 percent for the month, the highest ever and also 27 percent higher than the historical average of 40 percent. Hand in hand with the high solar radiation and percent sunshine values, were an unusually few number of mostly cloudy days (7 compared to a historical average of 18) and some very low relative humidities, as low as the teens on the 8th and 9th in western counties.

Topic: Weather and Sports

At this point in the 1999 NFL football season weather has not been mentioned too often as a factor. Usually by now, heavy rain, strong wind, or snow storms have had a major impact on at least a few NFL games. But football is not the only sport affected by the weather. Nearly every sport is affected in some way.

Many studies have been conducted over the years to estimate the optimal temperature range for various sporting activities.

Quite often the optimal environmental conditions for athletes are not exactly comfortable for the spectators. This mostly relates to high activity sports where the athlete's body is generating excess heat. For sports like rowing, tennis, ping pong, and volleyball, a temperature range of 55 to 65 degrees F has been suggested as optimal. For the sports of soccer, football, rugby, squash and racketball a temperature range of 50 to 60 degrees F applies. In swimming competition water temperatures of 84 to 90 degrees F are considered optimal for performance in short races, while cooler water temperatures of 73 to 79 degrees F are desired for optimal performance in longer races like the 1500 meters. It is interesting that badminton tournament players prefer cooler temperatures of 40 to 50 degrees F, not so much for their comfort or performance, but because the dynamics of the shuttlecock are more stable under such conditions.

Though much research and attention has been given to the study of environmental conditions which are optimal for athletic performance, from a spectator point of view, some of the most memorable individual or team accomplishments were earmarked by a performance that withstood or overcame the harshest of environmental conditions. An example is the respect and appreciation shown to marathon runners or dog sled racers who often have to overcome the elements as well as their competitors.

MPR listener question: The absence of snow on the ground worries me. I invited my relatives from California for a white Christmas in Minnesota. What are the chances it will happen?

Answer: Well, despite the absence of snow, there is still a pretty good chance. Historically, in the Twin Cities area there is only a 46 percent occurrence of snow cover on December 1st, but this increases as the month progresses: the frequency of snow cover is 58 percent by December 5th; it is 66 percent by December 15th; and it is 80 percent by December 25th.

Twin Cities Almanac for December 3rd:

The average MSP high temperature for this date is 32 degrees F (plus or minus 11 degrees standard deviation), while the average low is 18 degrees F (plus or minus 13 degrees standard deviation).

MSP Local Records for December 3rd:

MSP weather records for this date include: highest daily maximum temperature of 62 degrees F in 1962; lowest daily maximum temperature of 6 degrees F in 1972; lowest daily minimum temperature of -19 degrees F in 1940; highest daily minimum temperature of 43 degrees F in 1962; record rainfall of 1.05 inches in 1953; and record snowfall of 5.9 inches in 1934. There

have been twenty-seven measurable snowfalls on this date since 1891. The greatest snow depth on this date was 17 inches in 1985 and 1991. The coldest windchill conditions were -40 degrees F in 1985.

Average dew point for December 3rd is 18 degrees F, with a maximum of 52 degrees F and a minimum of -19 degrees F.

All-time state records for December 3rd:

Scanning the state climatic data base: the all-time high for this date is 72 degrees F at Canby (Yellow Medicine County) in 1941; the all-time low is -38 degrees F at Itasca State Park in 1927.

Words of the Week: Comma Cloud

This term refers to the typical cloud pattern of a midlatitude cyclone (especially winter storms) when viewed in satellite images. The curvature of the cloud system is like that of a comma because of the counterclockwise rotation of winds that occurs with a strong low pressure system. Visually, a sharply curved cloud system, usually indicates a deep low pressure center and a strong storm. Real-time images of cloud systems over the entire Earth are available on the Internet through the Space Science and Engineering Center at the University of Wisconsin, Madison. Their URL is.....

<http://www.ssec.wisc.edu/data/>

Outlook:

Chance of snow or rain in southern and eastern sections of the state this weekend, mostly dry in the north. Temperatures will average above normal through the weekend and much of next week. Generally a cloudy period coming up, with increasing chances for precipitation, especially in the north Wednesday through Friday.

To: Perry Finelli, Jim Bickal, Julie Siple, and Eugene Cha
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Dec 10, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: Holiday Gifts for the Weather Enthusiast

The current edition of Weatherwise magazine includes a shopper's guide to holiday gifts for the weather enthusiast. Many are listed online (<http://www.weatherwise.org/tocs.html>).

Several hand-held anemometers, thermometers, hygrometers, and barometers are described, ranging in price from \$50 to \$200. One instrument, called a Skymate, can be used to take instant measurements of both temperature and wind speed, from which it will calculate a windchill factor and display it on the LCD. A home weather station for under \$300 is described, and some interesting weather books and calendars are listed.

There is also an interesting Canadian weather products site on the Internet which lists a very wide range of instruments, publications, software and gadgets for the keen weather observer. The web address is.....

<http://www.weathersense.com/>

A practical gift is to give someone a NOAA weather radio with the Specific Area Message Encoder (SAME) option so that they can be warned of any threatening weather when such messages are released by the National Weather Service. These radios cost about \$70 to \$80 and include battery backup power supplies. One local supplier is Radio Shack.

Topic: Temperature record broken in the Twin Cities

The average date for the minimum temperature in the Twin Cities area to fall below 20 degrees F is November 11th. To date, no minimum temperature below 20 degrees F has been recorded at the MSP airport this fall. The latest date this was ever recorded previously was December 3, 1899. In addition, yesterday, December 9th produced another new, but somewhat obscure temperature record for the Twin Cities. It represents the latest date in the fall without a maximum daily temperature of 32 degrees F or less. The record eclipsed was indeed an old one, dating back to December 8th, 1830. These are both measures of how mild the temperatures of the fall season have been in Minnesota.

Topic: Significant weather of 1999

A complete listing of the most significant weather events and episodes on a nationwide basis during 1999 is available from the National Weather Service Office of Meteorology web site....

<http://tgs5.nws.noaa.gov/om/images/99dis.gif>

Weather events which caused economic losses of a billion dollars or more included the January 21-22 tornadoes in Arkansas and Tennessee (\$1.3 billion), the May 3rd tornado outbreak in Oklahoma and Kansas (\$1.1 billion) and the passage of Hurricane Floyd from North Carolina north to Connecticut during September 13-17 (\$5.5 billion). The most lethal episode of weather in 1999 was the heat wave which persisted across several midwestern and eastern states from July 19-31 and caused 257 deaths.

Topic: Dry Spell and Absence of Snow Cover: Something to Sneeze About?

Recent findings by air pollution researchers at the California Institute of Technology suggest that small dust particles disturbed by traffic on roads and highways carry allergy-causing plant pollens and molds many miles. Small road dust particulates measuring just 10 micrometers or less (known as PM-10 particulates) often contain fragments of pollen or molds that can cause allergic reactions. Because they are so small they can be inhaled into the lungs and they can remain suspended in the air long enough to travel several miles, reaching homes and offices. These dusts may contribute significantly to the allergenic particulate load in the atmosphere, especially in winter when much of the vegetation in the landscape is absent or dormant.

Such a study makes one wonder about the increased incidence of allergic reactions this fall in Minnesota. The prolonged, mild weather, along with the absence of precipitation and snow cover are conducive to a greater abundance of road dusts and associated pollutants. However, there may be many other factors contributing as well.

MPR listener question: In the past 50 years how many times have we experienced a "brown Christmas" in the Twin Cities? Without any snow cover, I am worried that Christmas of 1999 may be one of them.

Answer: A "brown Christmas" is somewhat rare in the Twin Cities. If we define this condition as both the absence of snow cover and absence of snowfall on Christmas Day, then we find that this has occurred only nine times in the past 50 years (1949, 1958, 1965, 1967, 1977, 1979, 1986, 1988, and 1997). But don't forsake all hopes of using your skis, sleds, snowshoes, or snowmobile. Six

of the previous nine occurrences of a "brown Christmas" were followed by 20 or more inches of snowfall during the balance of winter, and 5 saw 33 or more inches of snow.

Twin Cities Almanac for December 10th:

The average MSP high temperature for this date is 27 degrees F (plus or minus 12 degrees standard deviation), while the average low is 12 degrees F (plus or minus 14 degrees standard deviation).

MSP Local Records for December 10th:

MSP weather records for this date include: highest daily maximum temperature of 54 degrees F in 1979; lowest daily maximum temperature of -3 degrees F in 1977; lowest daily minimum temperature of -18 degrees F in 1977; highest daily minimum temperature of 34 degrees F in 1896, 1921, and 1930; record rainfall of 0.61 inches in 1911; and record snowfall of 1.4 inches in 1970. There have been sixteen measurable snowfalls on this date since 1891. The greatest snow depth on this date is 15 inches in both 1950 and 1991. The coldest windchill conditions were -58 degrees F in 1917.

Average dew point for December 10th is 10 degrees F, with a maximum of 35 degrees F and a minimum of -27 degrees F.

All-time state records for December 10th:

Scanning the state climatic data base: the all-time high for this date is 59 degrees F at Morris (Stevens County) in 1939; the all-time low is -41 degrees F at Thorhult (Beltrami County) in 1977.

Words of the Week: Billow Clouds

These are clouds which appear as if they are a series of breaking ocean waves. They are produced by the interaction of a saturated stable air layer, usually an inversion, and a pattern of vertical wind shear, which results in somewhat evenly spaced zones of updraft (where cloud tops crest in a wave-like pattern) and subsidence (where cloud droplets evaporate as they descend back to the stable layer. The height of the billows may vary from tens of feet to hundreds of feet and they may be spaced hundreds to thousands of feet apart horizontally.

Some classic pictures of billows and other cloud formations are available on the Internet at nature photographer Kay Ekwall's web site.....

<http://www.shastahome.com/kee/>

Outlook:

A mild, dry weekend is expected for most of the state, with

increasing clouds by Sunday and a chance for snow in northern areas. The early part of next week will see temperatures above normal, with a chance for snow on Tuesday. Much colder weather will move into the region by Wednesday and Thursday and there will be an increasing chance for snow over the Wednesday through Friday period.

To: Bob Potter, Jim Bickal, Julie Siple, and Eugene Cha
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Dec 17, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: National Weather Service 6th Live Radio Show

On Tuesday, December 21, from 7 to 8 pm the National Weather Service Forecast Office in Chanhassen, MN will broadcast its 6th live radio program over NOAA Weather Radio (162.55 Mhz). Mark Seeley from the University of Minnesota and Gary McDevitt, hydrologist with the National Weather Service will host the program and discuss historical Christmas weather and winter ice jam flooding. Listeners are encouraged to phone in their questions (612-361-6708)

Topic: New Monthly and Seasonal Outlooks

The Climate Prediction Center has issued the outlook for January and for the January through March period. Despite the prolonged dry spell this fall, the new climate outlooks favor above normal winter precipitation for the western Great Lakes region, including all of Minnesota. The temperature outlook suggests near normal temperature conditions for the balance of winter in the northern plains states and much of the midwest, including Minnesota. This is contrary to expected La Nina effects which have been tempered by the recent long-term trend of above normal temperatures across the region.

Topic: Sky watching during December nights

The winter solstice may bring a very bright night this year. The solstice will occur on the night of December 22nd, coincident with this month's full moon. But further, the moon will be at a point in its orbit which is closest to the Earth, while the Earth will also be at a point in its orbit that is closest to the sun. This means that the moon will be up to 14 percent larger in the night sky, and it will be reflecting up to 7 percent more light. Should the night sky be clear and the surrounding landscape covered with snow, it is likely to be a very bright night indeed. The last time all of these features were in coincidence on the winter solstice was 133 years ago.

Geomagnetic storms are supposed to be more frequent and perhaps more intense on the sun in the next several months. This means increased auroral activity for the northern hemisphere, where the nights are long at this time of year. Strong geomagnetic storms can cause large fluctuations in the Earth's magnetic field and a geographical expansion of the auroras in the northern hemisphere, making the

Northern Lights more visible in lower latitudes. Fluctuations in the Earth's magnetic field are measured by something called the Kp Index, which ranges from 1 to 9. The Space Environment Center of the National Oceanic and Atmospheric Administration posts recent measurements on their web site.....

<http://www.sec.noaa.gov>

Sky watchers may want to keep track of the Kp Index to anticipate upcoming nights that might be suitable for observing auroras. Look for higher values in the Kp Index, ranging from 6 to 9.

Topic: Heavy weather in Australia

Earlier this week on December 15th, Cyclone John hammered the north coast of Western Australia with the strongest winds ever recorded from a tropical cyclone in that region. With winds of 185-190 mph and waves of 22 feet or higher, the storm fortunately came ashore in a sparsely populated area, the little one-pub town of Whim Creek. Residents there were reported to be OK as they had taken shelter in a large sea cargo container, barricaded with concrete blocks.

John was downgraded to tropical storm status as it moved inland over Western Australia with heavy rains on the 16th. Meanwhile, Cyclone Ilsa, formed in the very warm waters of the Timor Sea (85-90 degree F) like John did. It was expected to take a similar track to John, and was forecasted to strike the north coast east of Port Hedland on the 17th with winds gusts of 75 mph and waves up 15 feet.

MPR listener question: You mentioned the record-setting dry fall in parts of western Minnesota a couple of weeks ago. Don't we often start streaks of dry weather in the fall in Minnesota, or is it just my imagination?

Answer: Quite right. Many of the records in Minnesota for the most consecutive days without measurable precipitation start in the fall of the year and run into winter. Such was the case for Morris, MN which is currently suffering from one of their driest falls ever. Up until the 14th of this month, Morris had reported only 0.38 inches of precipitation since October 1st. Fortunately they received 2.0 inches of snow (0.15 inches of melted liquid) on Wednesday of this week. Their driest spell ever was from November 15, 1943 to January 26, 1944 when they measured no precipitation for 73 consecutive days.

Crookston in the Red River Valley has also suffered from a record setting dry fall, measuring only 0.09 inches of precipitation from October 1 to December 13, a period of 74 days. During the period from October 20 to December 13th, 55 days, they had measured no precipitation at all, the second longest dry spell in their historical record. Fortunately, they received an inch of snow on the 14th this week, which melted down to 0.27 inches of precipitation.

Twin Cities Almanac for December 17th:

The average MSP high temperature for this date is 24 degrees F (plus or minus 14 degrees standard deviation), while the average low is 10 degrees F (plus or minus 13 degrees standard deviation).

MSP Local Records for December 17th:

MSP weather records for this date include: highest daily maximum temperature of 53 degrees F in 1939; lowest daily maximum temperature of -5 degrees F in 1945; lowest daily minimum temperature of -17 degrees F in 1983 and 1985; highest daily minimum temperature of 35 degrees F in 1977; record precipitation of 0.81 inches in 1911; and record snowfall of 8.1 inches in 1908. There have been twenty-four measurable snowfalls on this date since 1891. The greatest snow depth on this date is 19 inches in 1983. The coldest windchill conditions were -52 degrees F in 1964.

Average dew point for December 17th is 7 degrees F, with a maximum of 40 degrees F and a minimum of -22 degrees F.

All-time state records for December 17th:

Scanning the state climatic data base: the all-time high for this date is 63 degrees F at Farmington (Dakota County) in 1939; the all-time low is -44 degrees F at Mora (Kanabec County) in 1983.

Word of the Week: Yowdendrift

This is an old Scottish term, perhaps a derivative of yowt which means to scream or howl. Anyway it is a term for snow that is driven by the wind, such as in a blizzard. I suspect it would have been appropriately used to describe the weather on Wednesday of this week in the Red River Valley, where up to 4 inches of snow fell, followed by strong northwesterly winds.

Outlook:

Cooler weather is settling in over the state, along with increased cloudiness. There will be increasing chances for snow Sunday through Tuesday statewide, and perhaps in the north until Wednesday. Temperatures will be near seasonal normals or even a few degrees colder than normal for much of Christmas week. Winds will be relatively strong on Monday and Tuesday so prepare for some testy windchill values. There will be another chance for snow on Thursday and Friday (Christmas Eve).

To: Bob Potter, Jim Bickal, Julie Siple, and Eugene Cha
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Dec 24, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: Measuring the water equivalence of snowfall

Anybody who shovels snow knows that not all snowfalls are the same in terms of weight or density. Reducing the measurement of snowfall to liquid water equivalence can be difficult. The preferred method is to take the snow captured in a rain gage or take a snow core from that which has fallen on a snow board and melt it down, then remeasure the amount of water. Sometimes this cannot be done because of a mixture of freezing and liquid precipitation, because the wind blows the snow board clean, or because it is impractical to sample and melt snow during a prolonged snow storm. In many cases the observer is instructed to simply measure the depth of snow that has fallen and calculate water equivalence as one tenth. This was the method used for a number of years, despite the recognition that snow density varies with temperature. The variation of snow density with temperature is shown in the table below.....

Air temperature	Snow/Liquid Moisture Ratio
35 F	1 inch of snow equals .15 to .20 liquid (5/1-7/1)
30 F	1 inch of snow equals .10 to .15 liquid (7/1-10/1)
20 F	1 inch of snow equals .07 liquid (14/1)
10 F	1 inch of snow equals .05 liquid (20/1)
0 F	1 inch of snow equals .03 liquid (33/1)
-10 to -15F	1 inch of snow equals .02 liquif (50/1)

The National Weather Service in Minnesota now suggests a reduction factor of .078 (13/1) as an average conversion from snowfall to liquid water equivalence. This is what is used to convert the snowfall measured at MSP International Airport into liquid precipitation equivalence.

MPR listener question: I have heard you say that December of 1983 was the coldest in the Twin Cities climate record. Didn't we also measure the coldest windchill conditions ever in the Twin Cities?

Answer: Perhaps. The absence of hourly climate records of temperature and wind speed prevents historical windchill calculations back to the late 19th century. However, in the 20th century records, the -79 degrees F windchill of Christmas Eve 1983 was the worst ever for the Twin Cities.

Topic: Christmas Eve Windchill Conditions

There have been 12 Christmas Eves this century in the Twin Cities when windchill conditions met the advisory criteria for the National Weather Service (-40 F or colder). They were.....

Year	Christmas Eve Windchill Conditions (F)
1902	-48
1910*	-40
1914	-40
1917	-49
1921	-55
1924	-44
1926*	-40
1933	-50
1935	-43
1980	-42
1983	-79
1985	-53

*denotes windchill criteria met by rounding up to nearest value.

Topic: Rapid soil freezing

It was not surprising to see soil freezing depths increase this week with the onset of an arctic cold air mass over the region. Many soils had recently frozen to a depth of 4 inches by December 17th, but since that time the depth of freezing has more than doubled to 8 to 10 inches. The shallow snow cover is not sufficient to protect the soils from freezing even deeper with another outbreak of arctic air. For stabilizing the depth of soil freezing additional snowfalls would help. Studies have shown that six inches of snow depth helps to stabilize soil temperature and prevent deeper frost penetration.

Twin Cities Almanac for December 24th:

The average MSP high temperature for this date is 25 degrees F (plus or minus 11 degrees standard deviation), while the average low is 9 degrees F (plus or minus 13 degrees standard deviation).

MSP Local Records for December 24th:

MSP weather records for this date include: highest daily maximum temperature of 47 degrees F in 1909; lowest daily maximum temperature of -10 degrees F in 1983; lowest daily minimum temperature of -25 degrees F in 1983; highest daily minimum temperature of 35 degrees F in 1982; record precipitation of 1.26 inches in 1982; and record snowfall of 2.8 inches in 1916. There have been thirty-four measurable snowfalls on this date since 1891. The greatest snow depth on this date is 20 inches in 1983. The coldest windchill conditions were -79 degrees F in 1983.

Average dew point for December 24th is 10 degrees F, with a

maximum of 36 degrees F and a minimum of -38 degrees F.

All-time state records for December 24th:

Scanning the state climatic data base: the all-time high for this date is 52 degrees F at Montevideo (Chippewa County) in 1922; the all-time low is -41 degrees F at Pokegama Dam (Itasca County) in 1921.

Words of the Week: The Equation of Time

The Equation of Time is a simple way of expressing a complex periodic function. For any specific time zone, it represents the difference between mean solar time (local noon) and real solar time (solar noon) measured by the Sun's transit across the sky. The time between successive transits of the Sun across the same point in the sky varies throughout the year, by as much as 15 minutes. This is because of orbital features of the Earth, both its elliptical shape which causes the orbital speed to vary and because of the tilt of the Earth's axis with respect to the plane of the elliptical orbit. This is a primary reason why the earliest sunset in the winter is not coincident with the latest sunrise. More on this complex relationship can be found at the U.S. Naval Observatory web site..

<http://aa.usno.navy.mil/AA/>

Outlook:

It looks like Christmas weekend will be a mild one, with a chance for snow in northern Minnesota counties and mostly dry in the south. Temperature will climb into the 20s and 30s F. A low pressure system will bring a chance for snow on Monday, Tuesday and Wednesday, especially in the north. Temperatures will fall again as we approach the New Year's weekend. We may see some below zero readings return to the state, along with some nasty windchills.

To: Bob Potter, Jim Bickal, Julie Siple, and Eugene Cha
From: Mark Seeley
Re: Suggestions for MPR's Morning Edition, Dec 31, 1999

The following will be posted as WeatherTalk on the MNONLINE web site (<http://www.mnonline.org>), also accessible through the Morning Edition section of Minnesota Public Radio's web site: (<http://news.mpr.org/programs/morninged>).

Topic: A Review of Significant Climate Features of 1999

Following another mild winter, it was a very wet spring across most of Minnesota in 1999. March 8-9 brought significant snows ranging from 8 to 17 inches across southern and central counties. This was one of the heaviest snowfalls observed this century during the month of March. A heavy spring snowfall hit parts of central and northern Minnesota on April 5-6, depositing up to 11 inches in places. Southern Minnesota was experiencing an abundance of moisture as well, recording measurable rainfall on 16 to 18 days during April. Most soils became saturated and tile lines flowed persistently throughout the month.

The rains abated in early May for several days and allowed some timely planting of crops around the state. However, rivers continued to run at higher than normal levels well into the summer. Northern Minnesota lakes and water tables were nearly at all-time highs.

In July two significant weather events occurred. July 4-5 brought heavy rains to northern Minnesota and exceptionally strong straight-line winds (called a derecho) in the Boundary Waters Canoe Area downed thousands of old trees. Flooding occurred in many watersheds. Then, the last ten days of the month brought a heat wave, with unusually high dewpoints that put stress on livestock throughout southern Minnesota. The Heat Index reached a near state-record of 124 degrees F at Faribault, MN on July 30th and dewpoints of 80 degrees F were recorded at many places.

Minnesota crop producers benefitted from favorable fall weather which provided consistently good harvesting conditions. However, a dry spell began in earnest about mid September and has lasted for the balance of the year in many places. October was very dry and a number of grass fires were reported around the state. On the 25th of October new record low relative humidity values, ranging from only 5 to 9 percent, occurred at a number of locations in southern Minnesota. The dryness and warmth continued in November, with many locations in western Minnesota reporting only a trace of precipitation. For the state as a whole it was the warmest November since 1899.

The string of warmth and absence of snow cover was finally broken by December 19th, with a widespread snow storm and intrusion of

arctic air. A big, brief warm up produced record-setting high temperatures on Christmas Day for many western and northern cities. The climate forecast however, favored snowy conditions for the coming January 2000. We'll soon find out.....

MPR listener question: Christmas Day brought some very mild temperatures around the state. I heard a record high of 45 degrees F was set at International Falls, MN. Did any other communities set record high temperatures on Christmas Day?

Answer: Yes, indeed. Listed below are some other communities and the record highs recorded on Christmas Day of 1999

Lamberton, MN 49 F	Redwood Falls, MN 49 F
Fargo, ND 47 F	Duluth, MN (airport) 44 F
Hibbing, MN 45 F	Hutchinson, MN 43 F

In addition, Grand Rapids, Crookston, Aitkin, Fergus Falls, Morris, St Cloud, Willmar, Canby, Montevideo, and La Crosse (WI) all recorded the second warmest Christmas Day in their respective climate record.

MSP airport at 43 degrees F was 3rd warmest in history, and Rochester airport at 39 degrees F was 4th warmest.

Twin Cities Almanac for December 31st:

The average MSP high temperature for this date is 24 degrees F (plus or minus 13 degrees standard deviation), while the average low is 8 degrees F (plus or minus 14 degrees standard deviation).

MSP Local Records for December 31st:

MSP weather records for this date include: highest daily maximum temperature of 50 degrees F in 1904; lowest daily maximum temperature of -12 degrees F in 1968; lowest daily minimum temperature of -24 degrees F in 1973; highest daily minimum temperature of 34 degrees F in 1904; record precipitation of 0.48 inches in 1911; and record snowfall of 7.2 inches in 1977. There have been twenty-nine measurable snowfalls on this date since 1891. The greatest snow depth on this date is 18 inches in both 1969 and 1996. The coldest windchill conditions were -59 degrees F in 1968.

Average dew point for December 31st is 9 degrees F, with a maximum of 43 degrees F and a minimum of -34 degrees F.

All-time state records for December 31st:

Scanning the state climatic data base: the all-time high for this date is 58 degrees F at Winona in 1965; the all-time low is -57 degrees F at Pokegama Dam (Itasca County) in 1898.

Words of the Week: Frazil Ice

This is an interesting term not frequently used. It refers to ice crystals or needle-like spicules which form in supercooled water of river or stream currents which move too fast for surface ice sheets to form. In salt water it is called lolly ice. The term frazil is from the French fraisil which means cinders. These ice crystals form under the surface in pools or along channel edges and often build up into masses which extend to the stream bottom. The mass of ice may become so large that it effectively dams the flow of the river or stream and causes local flooding. A similar situation can develop from anchor ice, which develops on the rocky bottom of some rivers and builds up toward the surface.

Outlook:

Somewhat colder than normal temperatures and more frequent chances for snowfall are in store for the first full week of January 2000. Snow chances are greatest in the northern counties.