North Dakota Climate Bulletin

Spring 2008

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In This Issue

NDSCO

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From the State Climatologist

The Climate Bulletin is a digital quarterly publication of the North Dakota State Climate Office, the College of Agriculture, Food Systems and Natural Resources, North Dakota State University in Fargo, North Dakota.

Compared historically, North Dakota had a dry and cold spring following a dry and another cold winter. Severe to moderate drought ruled the western 2/3 of the state. Western North Dakota was so dry during the past 6-month period, it lowered the statewide ranking as the11th driest 6-month period in the recorded history even thought eastern ND was wetter than normal. Temperature-wise, the spring of 2008 was the 37th coldest since 1895. Precipitation-wise, it was the 42nd driest spring since 1895. The spring temperature trend for the period of record (1895 to present) was 0.15° F per decade indicating that the current spring seasons in ND is 1.5°F warmer today than 100 years ago on the average. The total precipitation as percentage of the normal and average temperature departure from normal are shown on pages 4 through 12 (Season in-Graphics). The Season in-Graphics also displays the time series of monthly total precipitation and average temperature of North Dakota for respective months of the season. This bulletin can be accessed at http://www.ndsu.edu/ndsco/. This web site hosts other great resources for climate and weather information.

Adnan Akyüz, Ph.D.
North Dakota
State Climatologist

Photo by Mullins

Weather Highlights

Seasonal Summary: by B. A. Mullins

March 2008

The state average precipitation was 0.36 inches which is below the 1971-2000 normal of 0.80 inches. March 2008 state average precipitation ranked 18th driest in the last 114 years with a maximum of 2.72" in 1902 and a minimum of 0.09" in 1930.

March marks the 9th straight month in a row in which the state average precipitation was below the 1971-2000 normal. The north central part of the state had less than 25% of normal precipitation. The greatest majority of the state had half of normal precipitation. The highest amounts were in the south central and eastern edge with 70 to 80% of normal precipitation. The U.S. drought monitor has the eastern half of North Dakota listed as abnormally dry and the majority of the western half of the state as extreme drought (Figure 1).

On the 21st of March the National Weather Service (NWS) reported two precipitation records were broken at Fargo and Grand Forks. Fargo recorded a record precipitation of 0.75 inches breaking the previous record of 0.67 inches set in 1882. Grand Forks recorded a record precipitation of 0.22 inches breaking the previous record of 0.07 inches set in 1985.

The top three precipitation monthly totals measured from the National Weather Service (NWS) were 1.3 inches at Fortuna, 0.98 inches at Fargo, and 0.76 inches at Flasher. The top three snowfall monthly totals measured from the National Weather Service (NWS) were 11.2 inches at Fargo, 10 inches at Forbes, and 9 inches at Lidgerwood. The top five March daily maximum wind speeds recorded from the North Dakota Agricultural Weather Network (NDAWN) was 60.1 mph on the 24th at Watford City, 51.9 mph on the 24th at Sidney MT, 50.1 mph on the 29th at Linton, 49.4 mph on the 24th at Williston, and 48.7 mph on the 29th at both McHenry and Wishek. NDAWN wind speeds are measured at a height of 10 feet (3 m).

The state average air temperature was 26.7 °F which is nearly right on the 1971-2000 normal of 26.9 °F. March 2008 state average air temperature ranked 75th coolest (or 40th warmest) in the past 114 years with a maximum of 40.7 ° F in 1910 and a minimum of 6.9 ° F in 1899.

The coldest daily temperatures were between the 4th and the 9th of March in which eastern and northern areas fell to teens and twenty degrees below zero. The top five coldest daily wind chills recorded from NDAWN were all on the 7th of March and included Humboldt MN at -47.2°F, Bottineau at -45.6°F, Warren MN at -44.2°F, Wahpeton at -43.1°F, and Greenbush MN at -42.1°F. Following this cold streak the daily average temperatures across the state were in the upper 20's and 30's most days with some days at near 40 degrees plus. March average monthly temperatures ranged from close to 1 degree above normal in the western third of the state to 1 to 2 degrees below normal in the central third. The eastern third of the state had monthly average temperatures from 2 to nearly 6 (on the eastern edge) degrees below the 1971-2000 normal.

The National Weather Service (NWS) reported breaking two low temperature records on the 7th of March at Jamestown and Grand Forks. Jamestown recorded a record low temperature of -21°F

breaking the previous record of -19°F set in 1932. Similarly, Grand Forks Airport recorded a record low temperature of -21°F breaking the previous record of -19°F set in 1967. On the 10th of March, Bismarck recorded a record high temperature of 64°F breaking the previous record of 62°F set in 1900.

NDAWN's highest recorded daily air temperature for March was 66.5°F at Sidney, MT on the 3rd. The lowest recorded daily air temperature was -30.4°F at Bottineau on the 7th.

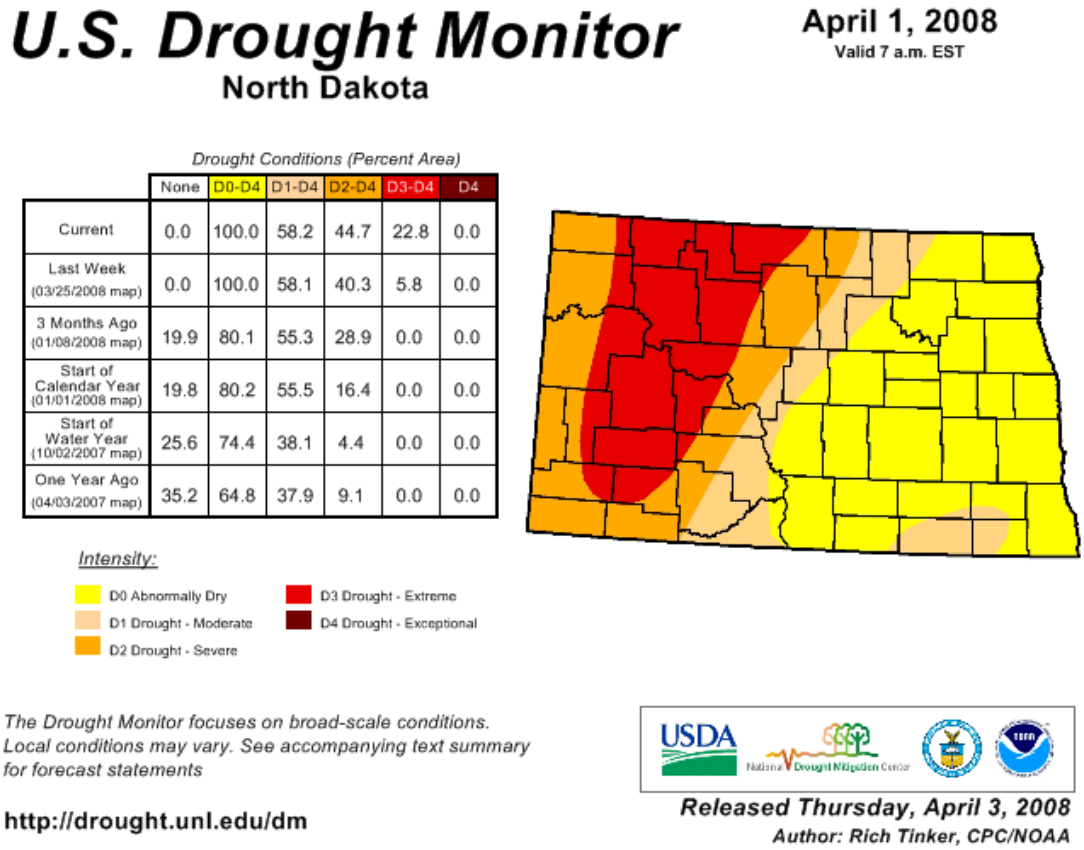


Figure 1. U.S. Drought Monitor, April 1, 2008.

April 2008

The state average precipitation was 0.82 inches which was below the 1971-2000 normal state average of 1.40 inches. April 2008 state average precipitation ranked the 26th driest in the past 114 years with a maximum of 3.86 inches in 1896 and a minimum of 0.11 inches in 1987.

The western half of the state continued to have below normal precipitation with percent of normal's at less than 50% and lower. The dry conditions in the west caused grass fires that damaged hay and pasture land. The eastern half of the state's precipitation was primarily below normal with only a portion of the northeast having slightly above normal and the far southeast corner having 150% of normal precipitation. Snow continued to fall throughout April. The National Weather Service (NWS) reported breaking the snowfall record at Grand Forks on the 11th with 4.2 inches. The previous record of 1.8 inches set in 1995. A major snow event dropped 8 to 18 inches of heavy wet snow in the southeast corner on April 25th and 26th. The 26th total snowfall set a new NWS record at Fargo of 4.8 inches which broke the previous record of 3.5

inches set in 1937. Fargo's April snowfall total ranked 2nd in the past 114 years. The USDA, National Agricultural Statistics Service, North Dakota Field Office reported a topsoil moisture of 27% very short, 32% short, 37% adequate, and 4% surplus with a subsoil moisture reported as 30% very short, 33% short, 36% adequate, and 1% surplus (Weekly Weather and Crop Bulletin Vol. 95, No. 19).

According to the preliminary reports of the National Weather Service's Storm Prediction Center (SPC), April had no reported high wind events, only 1 report of hail, and no reported tornadoes. The hail report was recorded on April 21st in Ransom County. The North Dakota Agricultural Weather Network (NDAWN) top five April daily maximum wind speeds were 45.5 mph at Crosby on the 20th, 45.1 mph at Lisbon on the 15th, 45.1 mph at McHenry on the 26th, 44 mph at Beach on the 15th, and 44 mph at Marion on the 30th. NDAWN wind speeds are measured at a height of 10 feet (3 m).

The state average air temperature was 40.0 °F which is slightly below the 1971-2000 normal of 41.7°F. April 2008 state average air temperature ranked the 43rd coolest in the past 114 years with a maximum of 50.2 °F in 1987 and a minimum of 31.1 °F in 1907.

April temperatures were cool as most areas were 1 to 3° F below normal. Daily average temperatures across the state hovered near 35 to 40° F from the 1st through the 13th. There was a warm-up from the 14th through the 20th after which average temperatures again reverted back to around 35° causing April record low temperatures at Williston, Jamestown, Bismarck and Grand Forks. The National Weather Service (NWS) recorded 22°F at Grand Forks on the 22nd which tied the previous record set in 2004. The NWS recorded a record low temperature at Williston on the 23rd of 14°F which broke the previous record of 17°F set in 1967. The NWS recorded a record low temperature on the 28th at Jamestown of 16°F which broke the previous record of 17°F set in 1956. Also on the 28th, the NWS recorded a record low temperature at Bismarck of 18°F which broke the previous record of 20°F in 1958.

NDAWN's highest recorded daily air temperature for April was 84.8°F at Carrington on the 15th. The lowest recorded daily air temperature was 4.9°F at Bottineau on the 6th.

May 2008

The state average precipitation was 1.81 inches which is below the 1971-2000 normal of 2.31 inches. May 2008 state average precipitation ranked 42nd driest in the past 114 years with a maximum of 5.73 inches in 1927 and a minimum of 0.31 inches in 1901.

The eastern half of the state had percent of normal precipitation that ranged from single digits in the south to around 35% in the north. The far southeastern corner had near normal precipitation. The western half of the state had a range of 50% to 150% of normal precipitation. The drought monitor has western North Dakota under extreme drought conditions. The eastern half of North Dakota ranges from moderate drought intensity in the north to abnormally dry to no drought conditions in the south. There were many scattered showers in the first half of May. During the second half of May, most of the rain fell on the 24th, 25th, 29th, and 30th. The USDA, National Agricultural Statistics Service, North Dakota Field Office reported a topsoil moisture of 16% very short, 39% short, 44% adequate, and 1% surplus with a subsoil moisture reported as 26% very short, 41% short, 32% adequate, and 1% surplus (Weekly Weather and Crop Bulletin Vol. 95, No. 23).

The National Weather Service (NWS) recorded a record snowfall of 0.7 inches at Grand Forks on the 10th which broke the previous record of 0.5 inches set in 1895. The NWS also recorded a record trace of snow on the 10th at Fargo which tied the previous record set in 1979. The top five May daily rainfall totals measured from the North Dakota Agricultural Weather Network (NDAWN) was 1.92 inches at Wahpeton on the 2nd, 1.74 inches at Hettinger on the 1st, 1.18 inches at Bowman on the 1st, 1.09 inches at Hettinger on the 24th, and 1.07 inches at Beach on the 1st. NDAWN's top five May daily maximum wind speeds were 60.1 mph on the 17th at Grafton, 58 mph on the 1st at Linton, 54.1 mph on the 1st at Wishek, 53.7 mph on the 19th at Linton, and 53.0 mph on the 17th at Marion. NDAWN wind speeds are measured at a height of 10 feet (3 m).

According to the preliminary reports of the National Weather Service's Storm Prediction Center (SPC), throughout May there was 1 reported high wind event, 11 reports of hail, and 6 reported tornadoes. On the 6th of May SPC had one reported hail event in Ransom County. On the 24th of May SPC recorded four tornadoes, 3 in Morton County and one in Dickey County. Also on the 24th, the SPC recorded hail in Dickey, Ransom, Morton, and Burleigh County. On the 29th, SPC recorded up to 1" hail that filled ditches in Williams County. SPC also reported hail in Dunn County on the 29th.

The state average air temperature was 51.4° F which is below the 1971-2000 normal of 54.8° F. May 2008 state average air temperature ranked the 37th coolest in the past 114 years with a maximum of 63.1 °F in 1977 and a minimum of 43.3 °F in 1907.

Cool temperatures continued throughout the month of May. The departure from normal May temperatures ranged from -7 in the northeast to -1 in the west. The NWS recorded a record low temperature on the 4th at Grand Forks of 23°F which tied the previous record set in 2005. On the 5th, the NWS recorded a record low temperature at Grand Forks of 20°F which broke the previous record of 22°F set in 1968. On the 11th, the NWS recorded a record low temperature of 24°F at Bismarck which tied the previous record set in 1952. On the 21st, the NWS recorded a record low temperature of 27°F at Grand Forks which broke the previous record of 29°F set in 1963. On the 27th, the NWS recorded a record low temperature of 27°F at Grand Forks which tied the previous record set in 1947.

NDAWN's highest recorded daily air temperature for May was 87.6°F at Wahpeton on the 16th. The lowest recorded daily air temperature was 12.4°F at Bottineau on the 3rd.

Season in Graphics

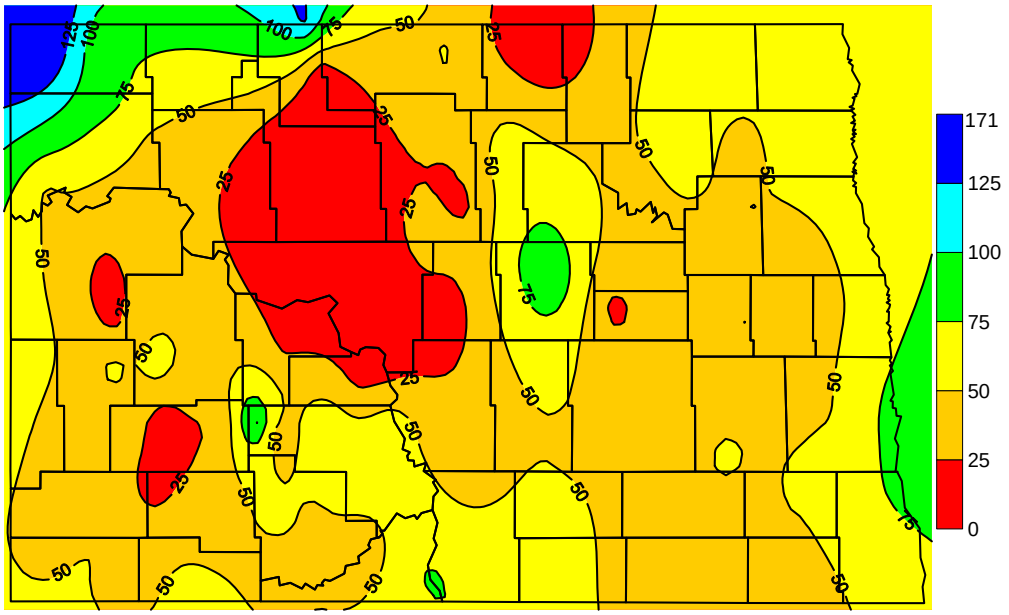
Spring 2008 Weather in North Dakota:

March 2008

Total Precipitation percent of mean (1971-2000)

Precipitation Percent of Normal

(Data from NWS Cooperative Network)



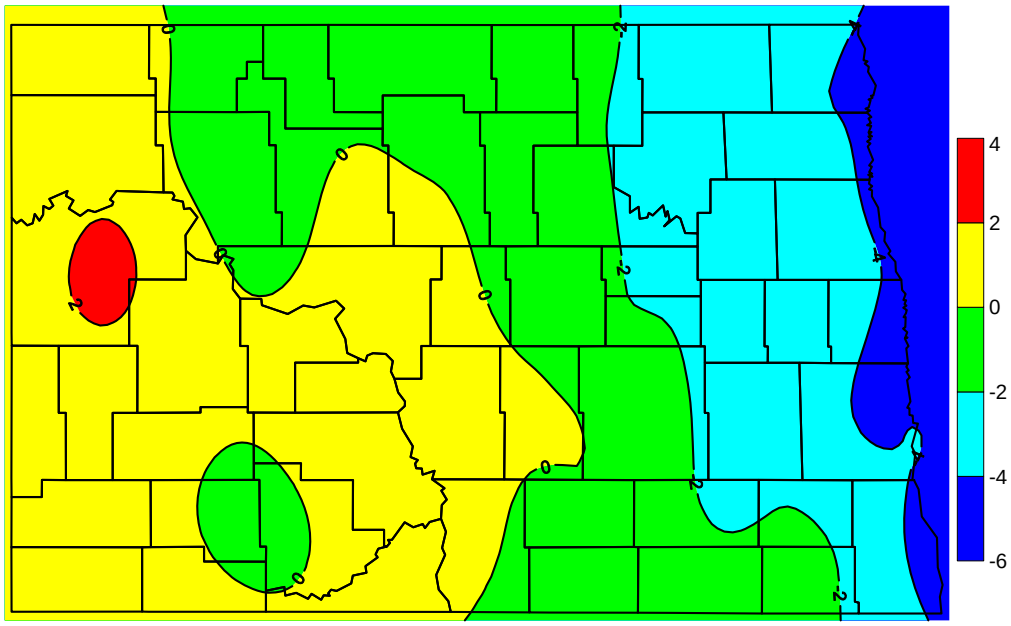
North Dakota State Climate Office

Average Temperature (°F) Deviation from Mean (1971-2000)

Departure From Normal Monthly

Average Air Temperature in degrees F

(Data from North Dakota Agricultural Weather Network (NDAWN))



North Dakota State Climate Office

Season in Graphics

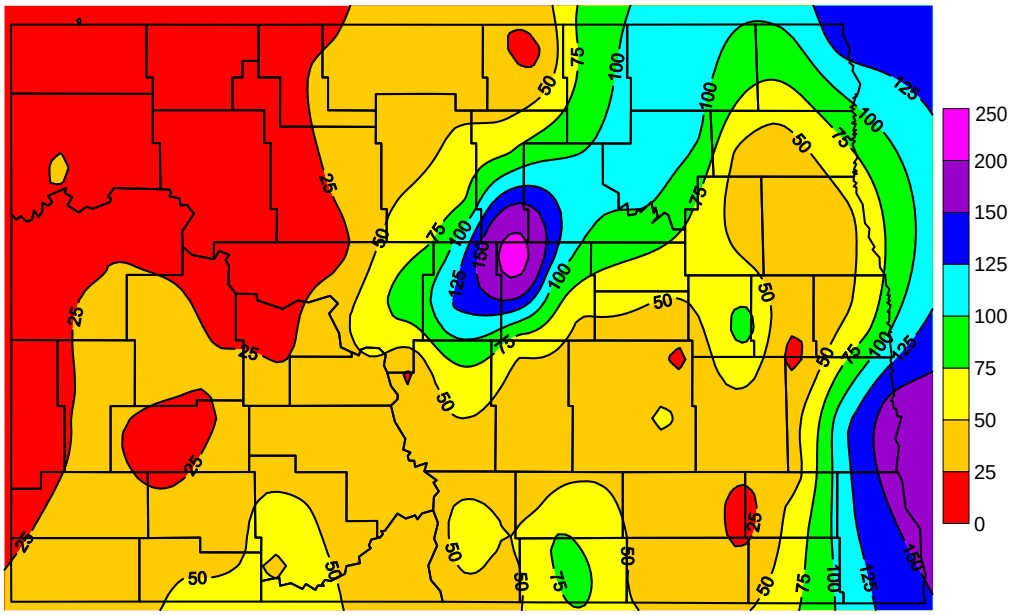
Spring 2008 Weather in North Dakota:

April 2008

Total Precipitation percent of mean (1971-2000)

Precipitation Percent of Normal

(Data from NWS Cooperative Network)



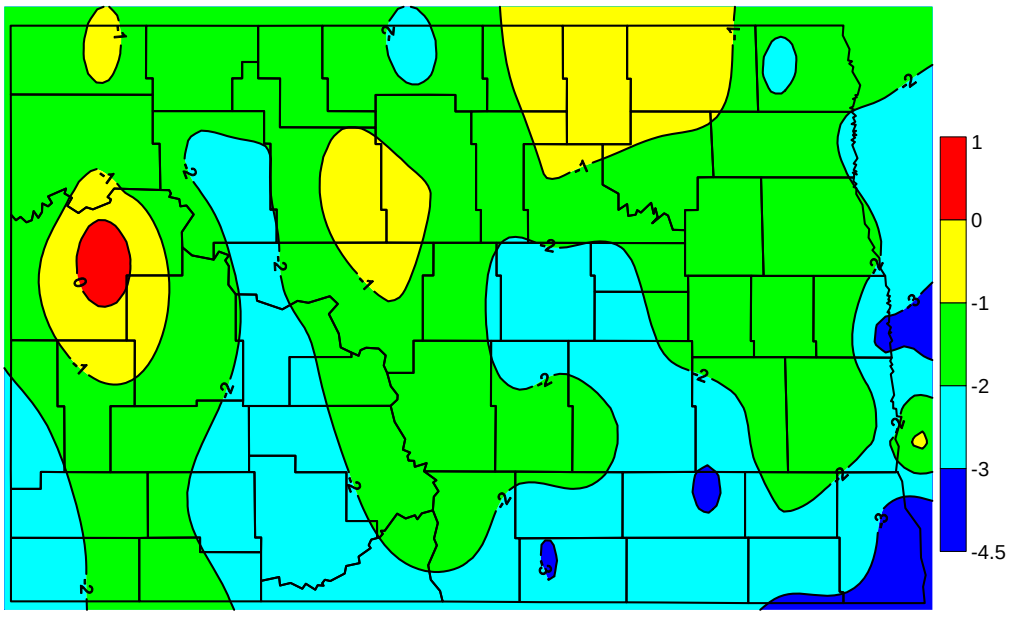
North Dakota State Climate Office

Average Temperature (°F) Deviation from Mean (1971-2000)

Departure From Normal Monthly

Average Air Temperature in degrees F

(Data from North Dakota Agricultural Weather Network (NDAWN))



North Dakota State Climate Office

Season in Graphics

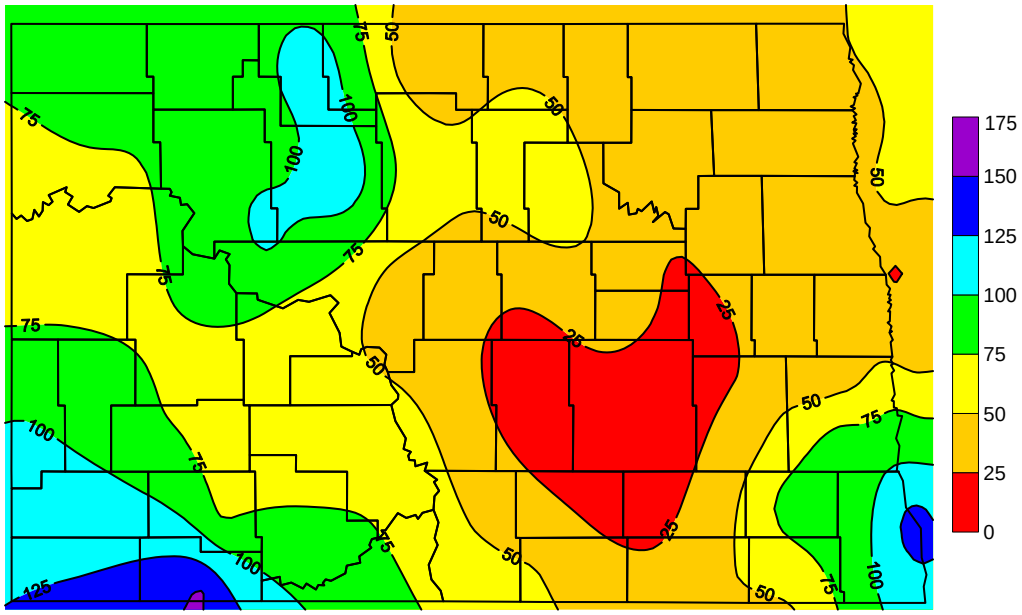
Spring 2008 Weather in North Dakota:

May 2008

Total Precipitation percent of mean (1971-2000)

Precipitation Percent of Normal

(Data from NWS Cooperative Network)

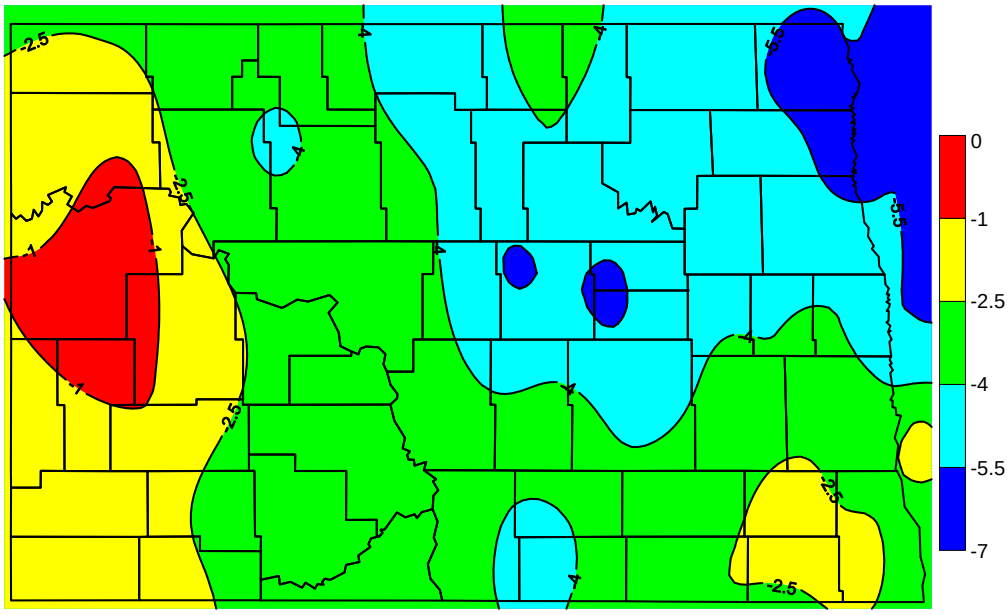


North Dakota State Climate Office

Average Temperature (°F) Deviation from Mean (1971-2000)

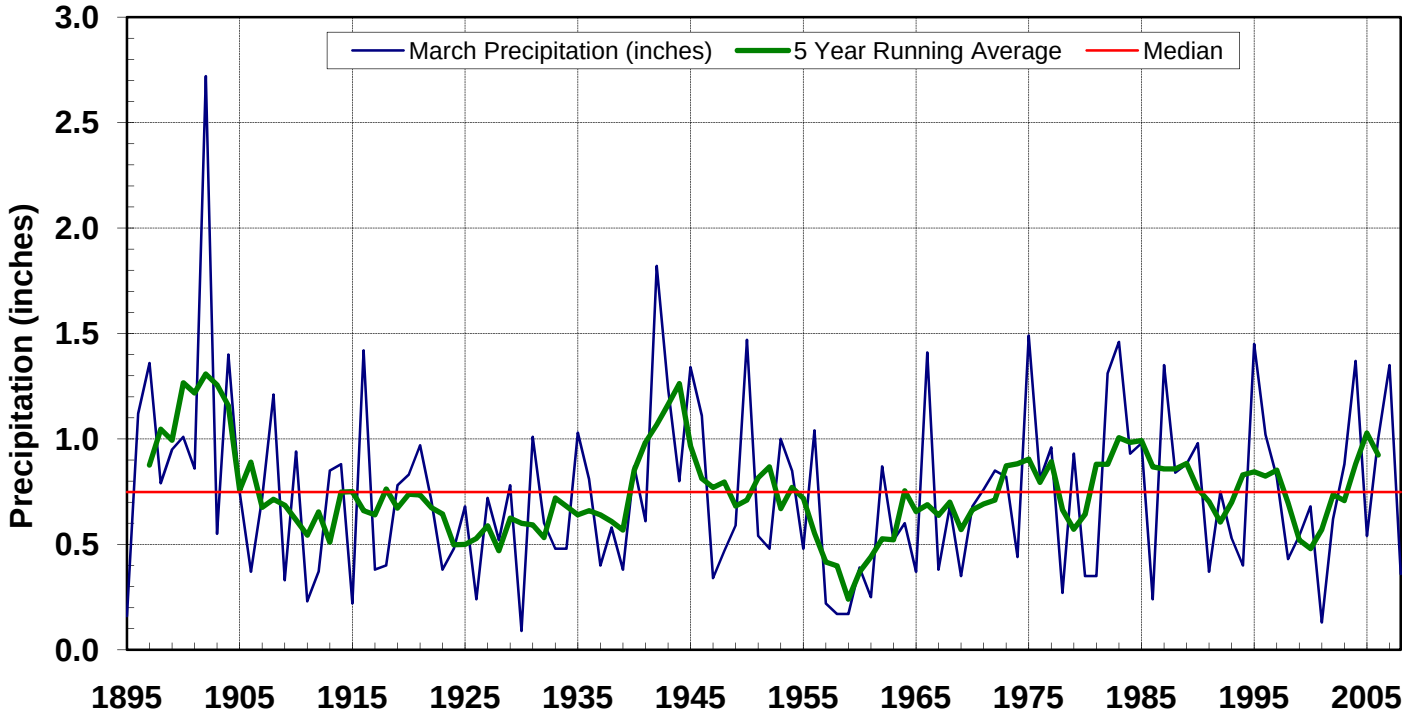
Departure From Normal Monthly
Average Air Temperature in degrees F

(Data from North Dakota Agricultural Weather Network (NDAWN))



North Dakota State Climate Office

Historical March Precipitation for North Dakota

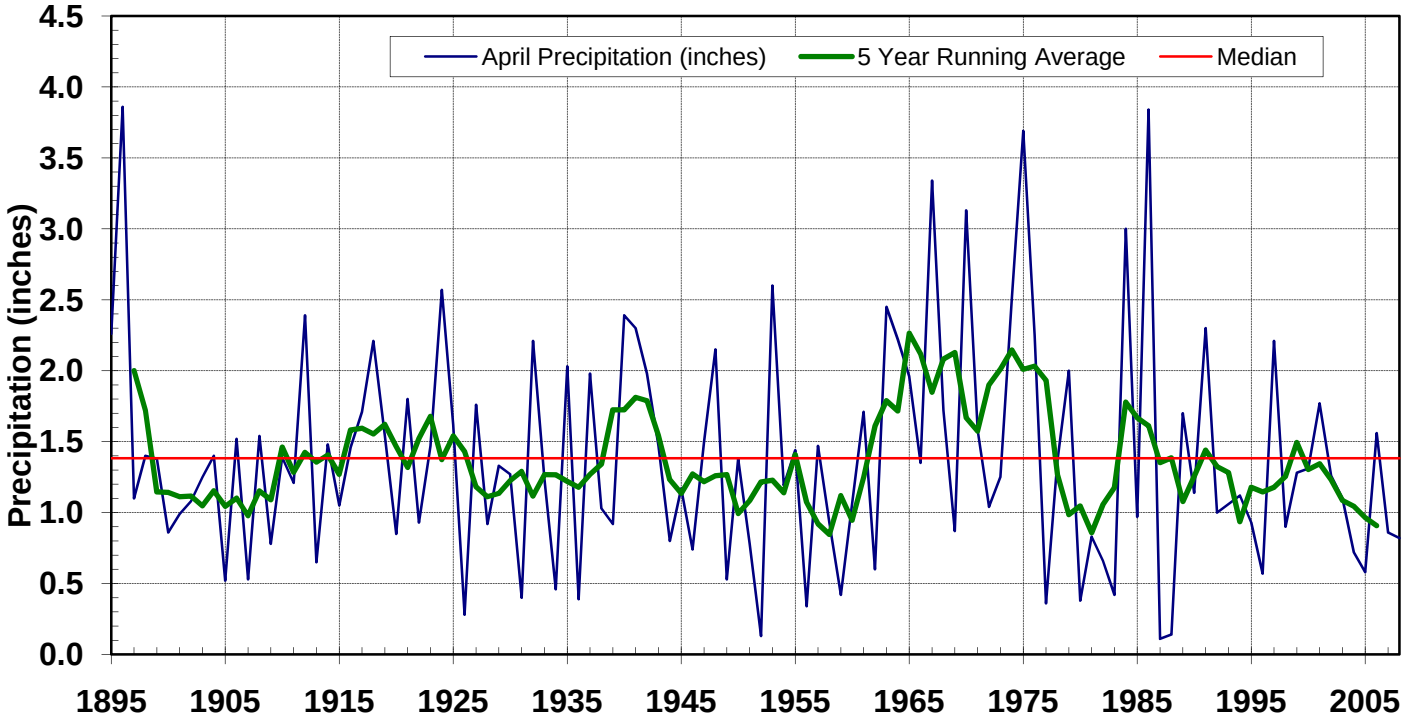


March Precipitation Statistics

2008 Amount: **0.36 inches**
Maximum: 2.72 inches in 1902
State Normal: 0.80" (1971-2000)

Monthly Ranking: 18th Driest in 114 years
Minimum: 0.09 inches in 1930
Years in Record: 114

Historical April Precipitation for North Dakota

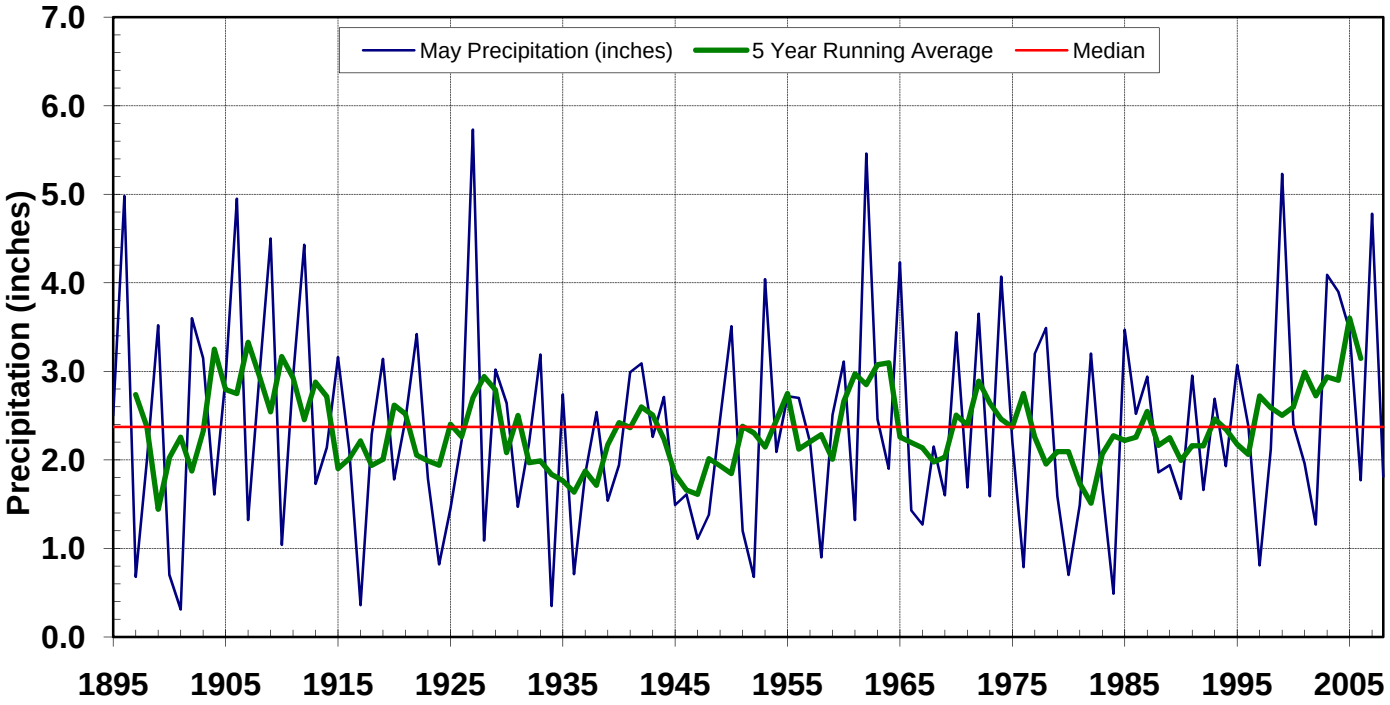


April Precipitation Statistics

2008 Amount: 0.82 inches
Maximum: 3.86 inches in 1896
State Normal: 1.40” (1971-2000)

Monthly Ranking: 26th Driest in 114 years
Minimum: 0.11 inches in 1987
Years in Record: 114

Historical May Precipitation for North Dakota

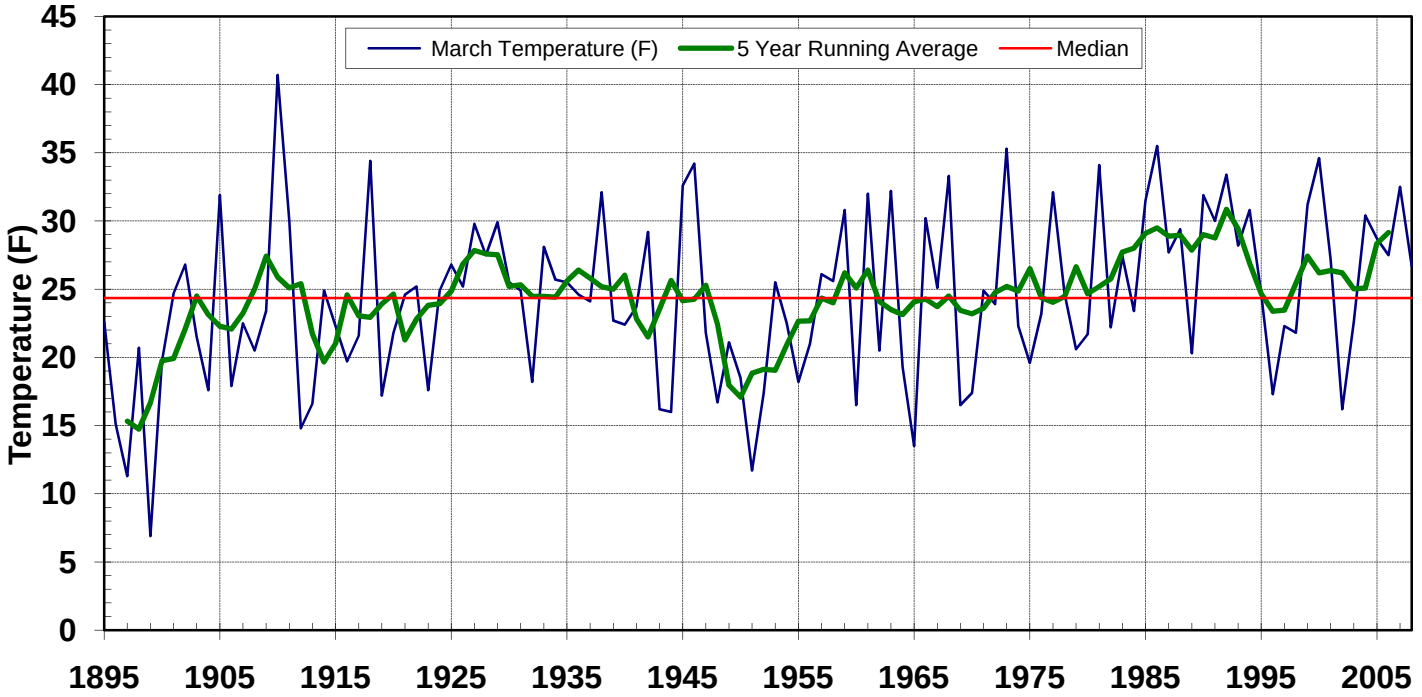


May Precipitation Statistics

2008 Amount: 1.81 **inches**
Maximum: 5.73 inches in 1927
State Normal: 2.31" (1971-2000)

Monthly Ranking: 42nd Driest in 114 years
Minimum: 0.31 inches in 1901
Years in Record: 114

Historical March Temperature for North Dakota

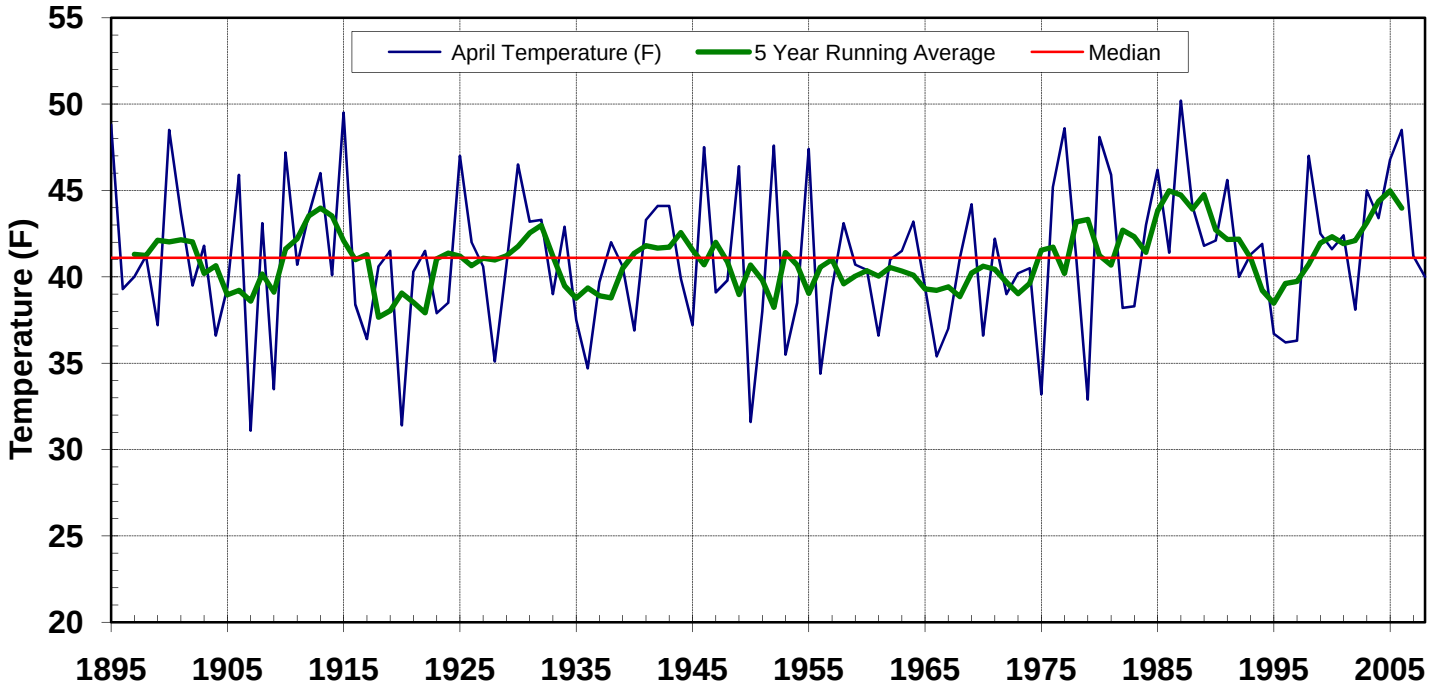


March Temperature Statistics

2008 Average: **26.7 °F**
Maximum: 40.7° F in 1910
State Normal: 26.9° F (1971-2000)

Monthly Ranking: 40th Warmest in 114 years
Minimum: 6.9° F in 1899
Years in Record: 114

Historical April Temperature for North Dakota

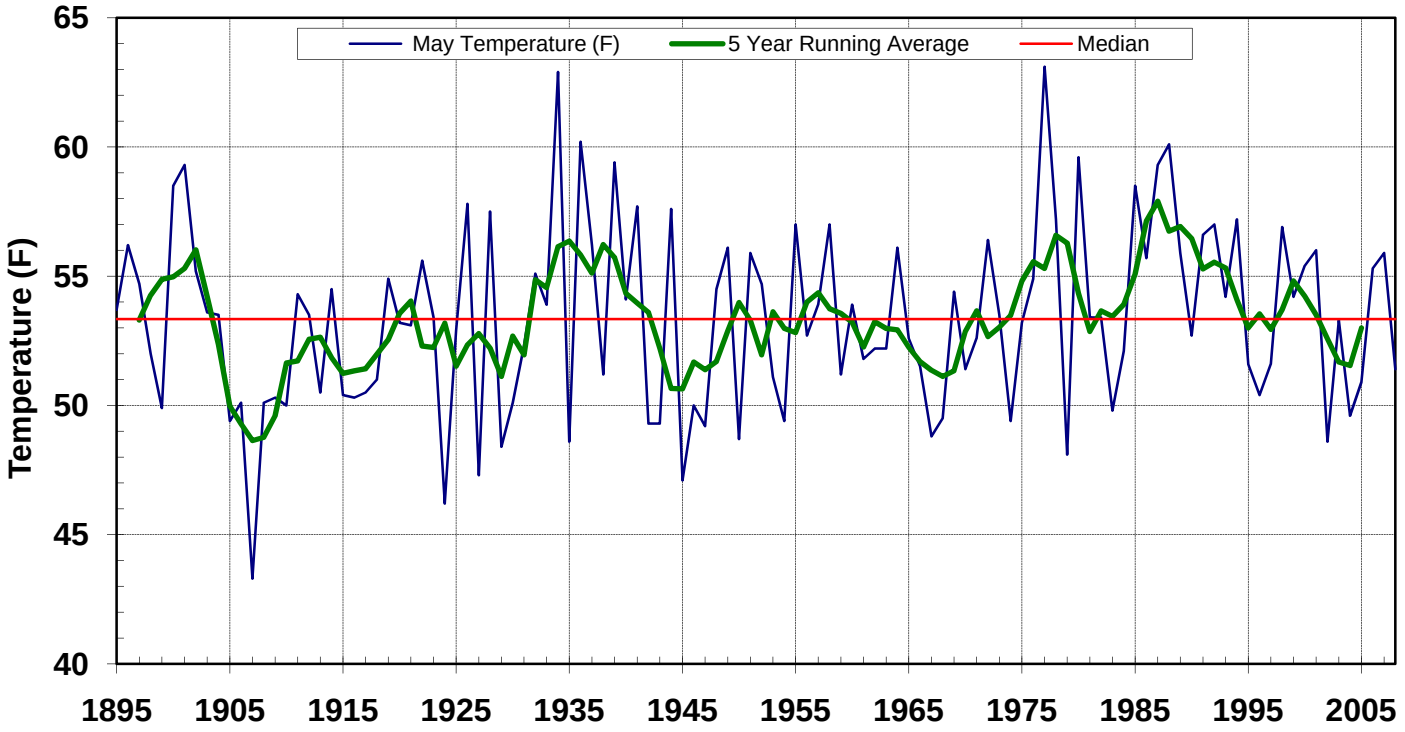


April Temperature Statistics

2008 Average: 40.0 °F
Maximum: 50.2 °F in 1987
State Normal: 41.7 °F (1971-2000)

Monthly Ranking: 43rd Coolest in 114 years
Minimum: 31.1 °F in 1907
Years in Record: 114

Historical May Temperature for North Dakota



May Temperature Statistics

2008 Average: **51.4 °F**
Maximum: 63.1 °F in 1977
State Normal: 54.8 °F (1971-2000)

Monthly Ranking: 37th Coolest in 114 years
Minimum: 43.3 °F in 1907
Years in Record: 114

Storms & Record Events

State Tornado, Hail, and Wind Reports for Spring 2008 by B. A. Mullins

North Dakota 3 Month Total	Wind 1	Hail 12	Tornado 4
Reports by Month			
Month	**Wind**	**Hail**	**Tornado**
Total March	0	0	0
Total April	0	1	0
Total May	1	11	4

North Dakota Record Event Reports for Spring 2008

Date	Location	Type of Record	Previous Record
03/07/08	Jamestown	Record low temperature of -21°F.	-19°F set in 1932.
03/07/08	Grand Forks	Record low temperature of -21°F.	-19°F set in 1967.
03/10/08	Bismarck	Record high temperature of 64°F.	62°F set in 1900.
03/21/08	Fargo	Record snowfall of 7.6 inches.	2.2 inches set in 1898.
03/21/08	Fargo	Record precipitation of 0.75 inches.	0.67 inches set in 1882.
03/21/08	Grand Forks	Record precipitation of 0.22 inches.	0.07 inches set in 1985
04/11/08	Grand Forks	Record snowfall of 4.2 inches.	1.8 inches set in 1995.
04/11/08	Grand Forks NWS	Record snowfall of 3.6 inches.	2.6 inches set in 1934.
04/22/08	Grand Forks	Record low temperature of 22°F.	It ties the previous record set in 2004.
04/23/08	Williston	Record low temperature of 14°F.	17°F set in 1967.
04/26/08	Fargo	Record snowfall of 4.8 inches.	3.5 inches in 1937.
04/28/08	Jamestown	Record low temperature of 16°F.	17°F in 1956.
04/28/08	Bismarck	Record low temperature of 18°F.	20°F in 1958.
05/04/08	Grand Forks	Record low temperature of 23°F.	It ties the previous record set in 2005.
05/05/08	Grand Forks	Record low temperature of 20°F.	22°F in 1968.
05/10/08	Grand Forks NWS	Record snowfall of 0.7 inches.	0.5 inches in 1895.
05/10/08	Fargo	Record trace of snow.	It ties the previous record set in 1979.
05/11/08	Bismarck	Record low temperature of 24°F.	It ties the previous record set in 1952.
05/21/08	Grand Forks	Record low temperature of 27°F.	29°F set in 1963.
05/27/08	Grand Forks	Record low temperature of 27°F.	It ties the previous record set in 1947.

Seasonal Outlook

Summer Climate Outlooks

by M. Ewens

With the start of the growing seasons slowed, or even delayed in some areas due to the spring, many are anxiously looking to a rapid reversal of fortune to the growing season. In the southern Red River Valley it has been quite wet, while the northern Valley and Devils Lake basin quite dry. Recent rainfall in the north has dramatically improved the overall situation for the Devils Lake basin; but it's becoming too much of a good thing in the south.

What does the rest of the growing season hold? Large scale patterns, including the Atlantic Multidecadal Oscillation, Pacific Decadal Oscillation and the El Nino/Southern Oscillation would suggest a warmer and drier weather across the northern plains. This would certainly be good news for the area growers.

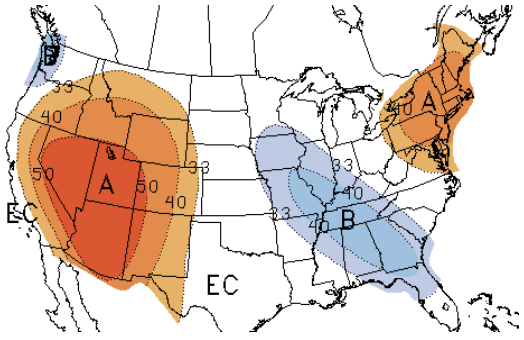
The Climate Prediction Center expects the remainder of June to remain cooler and wetter than average, with a reversal of sorts as we get into the last half of the summer season. July and August, on balance, are anticipated to be warmer and drier. This is based on a technique called compositing, in which previous years with similar patterns are used to make assessments of the upcoming weather.

In this case, those years include 1951, 1968, 1976, 1989 and 2001. The spring of those years were cold and dry to the north, with more normal precipitation to the south. Similar to this year, June was cool and wet, with warmer weather for July and August. While it was considerably drier in July, August on average experienced above normal precipitation over the northern Valley. Temperatures were also cooler in August over the north.

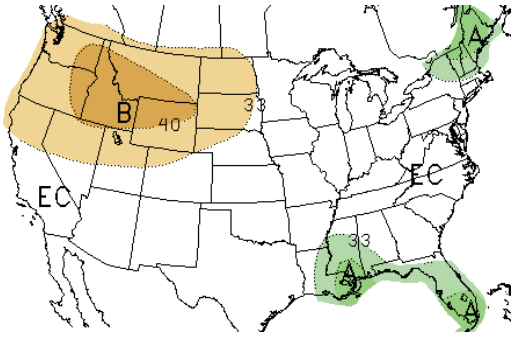
Does that mean this summer will follow that exact pattern? Not certainly! This technique, plus others are used as tools to predict the seasonal weather trends. One important tool is climate change, or the "long term trend". Since the overall atmosphere moves in one direction, then back in another e.g. oscillates, these trends may be used to indicate potential changes.

The bulk of the upcoming summer season will, on balance, see more normal temperature trends with a gradual decrease to average or below average rainfall. The main message is, expect tremendous variability from week to week as various climate forcings battle for dominance.

These outlooks are available at http://www.cpc.ncep.noaa.gov/products/OUTLOOKS_index.shtml



Summer 2008 Temperature Outlook (CPC, NOAA)



Summer 2008 Precipitation Outlook (CPC, NOAA)

Hydro-Talk

Flood Insurance-Are you covered?

by Charlene Prindiville

With the approach of summer comes the possibility for heavy rains and flash flooding from thunderstorms. Even though much of North Dakota is experiencing a drought, it is important to understand the need for flood insurance. Everyone needs flood insurance but only those living in a community that participates in the National Flood Insurance Program (NFIP) can purchase flood insurance. There are many myths regarding flood insurance. The following information is provided by the NFIP which is administrated by FEMA:

The Federal flood insurance can be purchased even if you live in a high-risk area. Lenders are to notify borrowers if their property is located in an SFHA, or Special Flood Hazard Area.

You can purchase flood coverage at any time. However, there is a 30-day waiting period after you've applied and paid the premium before the policy is effective.

Homeowner's policies do not cover flooding. Unfortunately, many people do not find out until it is too late. Federal flood insurance protects your most valuable assets, your home and belongings.

Federal flood insurance is available to protect homes, condominiums, apartments, and nonresidential buildings, including commercial structures. A maximum of $250,000 of building coverage is available for single-family residential buildings; $250,000 per unit for multi-family residences. The limit for contents coverage on all residential building is $100,000, which is also available to renters. Commercial structures can be insured to a limit of $500,000 for the building and $500,000 for the contents.

It doesn't matter how many times your home, apartment or business has flooded. You are still eligible to purchase flood insurance, provided you community is participating in the NFIP.

The NFIP provides basement coverage which covers cleanup expenses, elevators, furnaces, hot-water heaters, washers and dryers, freezers, pumps, and circuit-breaker boxes. The policy does not cover the contents of a finished basement such as walls, floors and ceilings.

Federal disaster assistance is awarded in less than 50% of flooding events. A Federal disaster must be declared before a community is eligible for disaster assistance. The annual premium for a NFIP policy, which averages $300 a year, is less expensive than the interest on a federal disaster loan, even though they are granted on favorable terms. And, if you are uninsured and receive Federal disaster assistance after a flood, you must purchase flood insurance to receive disaster relief in the future.

Federal flood insurance is sold and serviced directly through the NFIP or through a Write Your Own company (WYO).

Wind-driven rain is not considered flooding. It is considered wind damage and most homeowner's policies provide coverage. Federal flood insurance only covers damage caused by a storm surge, tidal wave, or the overflow of a river above normal levels.

For more information on flood insurance, visit: FloodSmart.gov or call 1-800-427-2419.

The Bismarck National Weather Service Forecast Office: www.weather.gov/bis
The Grand Forks National Weather Service Forecast Office: www.weather.gov/fgf

Science Bits

Drought and Row-Crop Disease

by Sam Markell &Mohamed Khan

Drought impacts many diseases of row crops. In some cases, drought conditions will impact disease by making the environment more or less favorable for infection, disease development, and/or disease spread. In other cases, drought may not impact the pathogen at all, but may exacerbate the damage caused by disease in drought stressed plants. Although the effects of drought on disease are variable, certain diseases of some crops tend to be consistently more or less severe in drought conditions (Table 1).

Diseases less severe in droughts

Root Diseases: Many different species cause root rots in North Dakota. Oomycete organisms (commonly called water molds, or near-fungi) such as *Phytophthora, Pythium, Aphanomyces,* and *Plasmopara* need wet soils to cause disease. Some common diseases caused by oomycete pathogens that are usually less severe in drought conditions include downy mildew of sunflower, Phytophthora root rot of soybeans, Aphanomyces root rot of sugarbeet, and damping off of many plants caused by *Pythium* species.

Leaf Diseases: Many foliar pathogens are able to infect plants only when leaves are wet. In drought situations, there may be a lack of free moisture on the leaves, which reduces the pathogens ability to infect plants. Fungal or bacterial pathogens causing leafspots and some rusts tend to fall into this category. Additionally, many foliar pathogens produce spores that are only dispersed by rain splash. Pathogens that need rain to spread are unlikely to cause epidemics in drought years. Many pathogens causing leaf spots fall into this category, but rusts do not.

Stem Diseases: Some stem diseases may be less likely to occur in drought years. White mold (caused by *Sclerotinia sclerotiorum*) infects many broadleaf crops grown in North Dakota including canola, edible beans, soybeans and sunflower. The soil must be wet for the white mold pathogen to germinate and produce spores, and an extended wet period is needed for those spores to infect plants. When soils are dry and limited wet periods occur in the canopy, white mold is unlikely. One notable white mold exception is sunflower wilt, which is caused when the white mold pathogen infects sunflower plants through the roots. This method of infection is less likely to be influenced by drought.

Diseases more severe in droughts

Root Diseases: Most root rot pathogens need some soil moisture to cause infection. However, once disease has been established in a drought stressed plant, the impact of the root rots may be significant. Some fungal species (*Fusarium* and *Verticillium*) that cause wilts reduce the plants ability to transport water. The pathogen plugs the xylem tissue that transports water through the plant. When root rots caused by these pathogens occur in drought stressed plants, the damage may be much greater than might occur in plants in a non-drought situation. These wilts are most severe when there is enough moisture to cause infection in the early part of the growing season, but the rest of the season experiences a drought.

Leaf Diseases: Droughts occur when there is a lack of rainfall, but that does not necessarily translate into a lack of humidity. Dew is likely to form if the air is humid and nights are cool. Dew on leaves creates a favorable environment for some pathogens, and in drought stressed plants, damage from some leaf diseases may be extreme. Dew on leaves often provides enough moisture for rust pathogens to infect plants. While many leaf spot pathogens cause dead spots on leaves, rust pathogens produce an open wound in living plant tissue. This open wound allows moisture to readily escape from the plant, causing a drought stressed plant to lose water more quickly. Additionally, rusts do not need rain to disperse spores, so if adequate dew is available for infection, rust epidemics may occur. In some drought situations, rusts are a major concern. Powdery mildew is occasionally found on most crops in North Dakota. High humidity provides a favorable environment for the infection and development of powdery mildew. Powdery mildew is likely to occur in drought years when the humidity is high.

Stem Diseases: Many stem diseases that begin as infections on leaves or florets (*Phomopsis* and *Phoma* of sunflower, white mold) are inhibited by drought conditions. However, stem diseases that first infect roots are largely unaffected. Charcoal rot is a stem disease of corn, soybean, sunflower, edible beans and other crops grown in North Dakota. The disease begins when microsclerotia (the pathogen's survival structure) germinate in the soil and infect the plants roots. Once infection progresses into the stem, the disease partially degrades the pith. This limits the plants ability to transport water. Charcoal rot is favored by high temperatures and water stressed plants, so the disease is more likely to be a problem in drought years.

Table 1. General impacts of drought on different diseases.

		*Disease Damage		
Disease	Crop	Greater	No effect	Less
Oomycete root rots (Phytophthora, Pythium, Aphanomyces)	Many			X
Fungal root rots causing wilt (Verticillium, Fusarium species)	Many	X		X
Downy Mildew	Sunflower			X
White Mold (Sclerotinia)	Many broadleaf crops			X
Sclerotinia Wilt (root infection only)	Sunflower		X	
Charcoal Rot	Soybeans, Sunflower, Edible Beans, Corn, others	X		
Leaf Spot Pathogens	All			X
Powdery Mildew	Most Crops	X		X
Rusts	Most Crops	X		X
Late Blight	Potato, Tomato			X
Rhizoctonia Stem Canker	Potato		X	
Early Dying (Verticillium)	Potato	X		
Black Scurf (tuber)	Potato			X
Ascochyta Blight	Pulse Crops (Pea, lentil, chickpea)			X

*These are general effects only, exceptions occur in all categories. In categories with more than one box checked, drought may cause different effects under different conditions. See text for detail.

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