

North Dakota Climate Bulletin

Fall 2008

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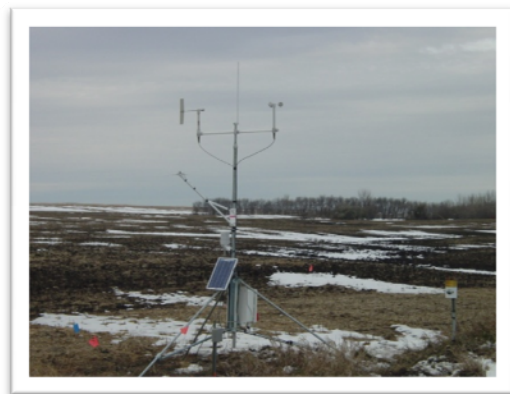
From the State Climatologist



The North Dakota 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 wet and a warm summer following a wet and a warm summer. When combined with the saturated soil in eastern ND, it brings up a concern for increased possibility of spring flooding in the Red River Valley. We addressed this concern in the Science Bits section of this bulletin. We also are proud to announce that North Dakota became the 37th addition to the Community Collaborative Rain Hail and Snow Network (CoCoRaHS). Temperature-wise, the fall of 2008 was the 31st warmest since 1895. Precipitation-wise, it was the 7th wettest fall since 1895. The total precipitation as percentage of the normal and average temperature departure from normal are shown on pages 6 through 8 (Season in-Graphics) followed by the Season in-Graphics which display 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





Weather Highlights



Seasonal Summary:

by B. A. Mullins

September 2008

The state average precipitation was 2.58 inches which is above the 1971-2000 normal of 1.74 inches. September 2008 state average precipitation ranked 18th wettest in the last 114 years with a maximum of 5.00" in 1900 and a minimum of 0.28" in 1897.

The first half of September had several events of scattered rains across ND. The second half of September was drier with the rain events falling on the 21st through the 24th. The eastern half of the state had greater than normal monthly precipitation with most areas between 125 and 375% of normal. The northwestern part of the state had near normal or slightly above normal monthly precipitation. The southwest part of the state had 25 to 50% of normal monthly precipitation. The US Drought Monitor classified the northwest part of the state as abnormally dry and the southwest part of the state as extreme drought. The eastern part of the state did not have drought conditions. The USDA, National Agricultural Statistics Service, North Dakota Field Office reported a topsoil moisture of 18% very short, 15% short, 62% adequate, and 5% surplus with a subsoil moisture reported as 23% very short, 21% short, 52% adequate, and 4% surplus (Weekly Weather and Crop Bulletin Vol. 95, No. 40).

The National Weather Service (NWS) reported breaking three rainfall records on the 1st. Bismarck recorded 1.15 inches of rain breaking the previous record of 0.72 inches set in 1986. Grand Forks recorded 1.67 inches of rain breaking the previous record of 0.98 inches set in 1957. Fargo recorded 2.50 inches of rain breaking the previous record of 2.32 inches set in 1999. The top five September daily rainfall totals measured from the North Dakota Agricultural Weather Network (NDAWN) was 2.47" at Fargo on the 1st, 2.45" at Prosper on the 10th, 2.28" at Hillsboro on the 1st, 2.23" at Prosper on the 1st, and 2.21" at Ada MN on the 1st. The top five September daily maximum wind speeds recorded from NDAWN was 56.6 mph at McHenry on the 22nd, 45.5 mph at Galesburg on the 23rd, 44.0 mph at McHenry on the 6th, 42.9 mph at Ada MN on the 1st, and 41.9 mph at Robinson on the 22nd. 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 September there were 3 reported high wind events, 9 reports of hail, and 0 reported tornadoes. The 28th had one report of hail in Richland County. The 24th also had one report of hail in Sargent County. One high wind event was reported on the 21st in Hettinger County.

The storm system that moved across ND on the 22nd produced some rain scattered across the state with the highest totals of over an inch in the northeast. Most of the wind and hail reports came from this September 22nd storm system. Hail was reported by SPC in Wells, Eddy, Nelson, Pembina, and Grand Forks Counties. SPC reported high winds in Pembina and Walsh Counties.

The state average air temperature was 56.4°F which is about the same as the 1971-2000 normal of 56.1 °F. September 2008 state average air temperature ranked 64th coolest in the past 114 years with a maximum of 63.4 °F in 1897 and a minimum of 45.2 °F in 1965.

September's average monthly temperatures ranged from around 65°F in the southeast to around 55°F in the northwest. For the most part, the east half of the state had 1 to 2°F above normal temperatures. The western part of the state was closer to normal. The central part of the state had a mix of near normal in the north central and slightly above normal in the south central with a few areas in the center as 1 to 2°F below normal. The western part of the state had scattered frost on the 24th and 29th.

The NWS reported a record high temperature at Dickinson of 89°F on the 19th which broke the previous record of 88°F set in 1960. NDAWN's highest recorded daily air temperature for September was 92.4°F at Wahpeton on the 1st. The lowest recorded daily air temperature was 29.8°F at Hillsboro on the 30th.

October 2008

The North Dakota (ND) state average precipitation was 2.24 inches which was above to the 1971-2000 normal state average of 1.41 inches. October 2008 state average precipitation ranked the 11th wettest in the past 114 years with a maximum of 4.71 inches in 1982 and a minimum of 0.10 inches in 1952.

The October precipitation percent of normal was normal to above normal with a general range of around 100% to 200% for the western half of ND. The precipitation percent of normal was above normal in the eastern half of the state with a general range of 150% to 300%. The south east corner of the state had the greatest amount of rainfall with greater than 300% of normal precipitation. The highest rainfall event was on the 10th in which the top four daily rainfall totals were reported from the North Dakota Agricultural Weather Network (NDAWN). The totals were 2.28" at Wyndmere, 2.17" at Wahpeton, 2.01" at Oakes, and 1.83" at Ekre, all of which are located in the south east corner of the state. The precipitation event from the 10th through the 13th included snowfall in the western third of the state. National Weather Service (NWS) reported that Williston had a record snowfall of 7 inches on the 12th which broke the previous record of 0.5 inches set in 1899.

The US Drought Monitor classified the areas to the north and east of the Missouri river as having no drought conditions. Most of the south west corner of the state was classified as severe drought conditions. The USDA, National Agricultural Statistics Service, North Dakota Field Office reported a topsoil moisture of 8% very short, 17% short, 63% adequate, and 12% surplus with a subsoil moisture reported as 20% very short, 17% short, 52% adequate, and 11% surplus (Weekly Weather and Crop Bulletin Vol. 95, No. 45).

The National Weather Service (NWS) reported breaking five rainfall records. Grand Forks recorded a record 1.16 inches of rain on the 11th which broke the previous record of 0.70 inches set in 1961. On the 12th, Grand Forks had a record 1.12 inches (breaking the 1981 record of 0.94), Fargo a record 1.23 inches (breaking the 1997 record of 0.84), and Williston a record 0.75 inches (breaking the 1994 record of 0.47). Minot recorded a record 0.53 inches of rain on the 21st which broke the previous record of 0.52 inches set in 1953. NWS also reported that Fargo had a record snowfall of 1.4 inches on the 27th which broke the previous record of 1.2 inches set in 1925.

The top eight October daily maximum wind speeds recorded from the North Dakota Agricultural Weather Network (NDAWN) all fell on the 26th and were over 50 mph. The top five were 54.8 mph at McHenry, 53.3 mph at Marion, 53.0 mph at Robinson, 53.0 mph at Wyndmere, and 51.9 mph at Dazey. NDAWN wind speeds are measured at a height of 10 feet (3 m).

The state average air temperature was 44.1 °F which is slightly above the 1971-2000 normal of 43.6°F. October 2008 state average air temperature ranked the 60th coolest in the past 114 years with a maximum of 54.8°F in 1963 and a minimum of 32.5°F in 1925.

The October departure from normal temperatures ranged from around -1°F below normal in the south west corner to about 3°F above normal in the north east. The northern third of the state had October average temperatures in the low 40's. The lower two-thirds of the state had average October temperatures in the mid40's. By mid October most of the state had experienced a killing frost. All areas received a killing frost on the 27th when minimum air temperatures ranged from 11°F in the west to 27°F in the east.

The National Weather Service (NWS) reported that Bismarck had a record latest first fall freeze date on October 14th with 32°F which broke the previous fall freeze date set on October 11, 1980. The NWS reported that Dickinson had a record high temperature of 78°F on the 29th which broke the previous record of 77°F set in 1968.

NDAWN's highest recorded daily air temperature for October was 80.9°F at Sidney, MT on the 4th. The lowest recorded daily air temperature was 11.0°F at Ross on the 27th.

November 2008

The state average precipitation was 1.47 inches which is above the 1971-2000 normal of 0.73 inches. November 2008 state average precipitation ranked 8th wettest in the past 114 years with a maximum of 2.51 inches in 2000 and a minimum of 0.02 inches in 1939.

The state November total precipitation for the majority of the western part of the state ranged from 0.5 to 1.5 inches. Most of the central regions of the state received between 1 and 2.5 inches. The northeast part of the state total precipitation ranged from 2.5 to 4.0 inches and the southeast was between 0.5 and 1.5 inches. Most of the states percent of normal precipitation was between 150% to greater than 300% of normal. The wettest fall (September through November total precipitation) on record was set in Grand Forks, ND with 11.97 inches which broke the previous record of 10.41 inches set in 1957. Fargo, ND also set a new record for the wettest fall (September through November total precipitation) with 10.67 inches which broke the previous record of 10.25 inches set in 1977.

National Weather Service (NWS) reported breaking precipitation records on the 5th and 6th. The rainfall records on the 5th were Bismarck with 0.83 inches breaking the 1922 record of 0.66, Dickinson with 0.86 inches breaking the 1986 record of 0.37, Williston with 1.51 inches breaking the 1895 record of 1.00, Minot with 0.53 inches breaking the 1956 record of 0.32, Jamestown with 1.37 inches breaking the 1956 record of 0.28, and Grand Forks with 0.85 inches breaking the 1956 record of 0.84. On the 6th, Grand Forks had record rainfall of 0.93 inches breaking the 1996 record of 0.41, Bismarck had snowfall of 5.7 inches breaking the 1901 record of 3.0, Bismarck had liquid equivalent of 0.92 inches breaking the 1880 record of 0.44, and Dickinson had liquid equivalent of 0.21 inches breaking the 1966 record of 0.14.

The US Drought Monitor classified the areas to the north and east of the Missouri river as having no drought conditions. Most of the southwest corner of the state was classified under moderate drought conditions. The USDA, National Agricultural Statistics Service, North Dakota Field Office reported a topsoil moisture of 7% very short, 11% short, 64% adequate, and 18% surplus with a subsoil moisture reported as 13% very short, 20% short, 51% adequate, and 7% surplus (Weekly Weather and Crop Bulletin Vol. 95, No. 48).

According to the preliminary reports of the National Weather Service's Storm Prediction Center (SPC), November had 2 reports of hail, and no reports of high winds or tornadoes. The two reports of hail were on November 5th and were from Stutsman and Cass County.

The top eight November daily maximum wind speeds recorded from the NDAWN all fell on the 6th of November. The top five were 51.9 mph at Robinson, 50.5 mph at Mott, 50.1 mph at Hettinger, 49.0 mph at Bowman, and 47.6 mph at Beach.

The state average air temperature was 30.3°F which is above the 1971-2000 normal of 26.1° F. November 2008 state average air temperature ranked the 26th warmest in the past 114 years with a maximum of 37.4°F in 2001 and a minimum of 7.3 °F in 1896.

The state November average air temperature ranged from 25 to 28°F in the northeast to 30 to 32°F in the southwest. The departure from normal air temperature was above normal across the state. The western part of the state was 3 to 6°F above normal, the central region was 2 to 4°F above normal and the eastern part ranged from 3 to 5°F above normal.

The National Weather Service (NWS) reported Grand Forks had a record high temperature of 66°F on November 3rd which broke the previous record of 63° set in 1981. NDAWN's highest recorded daily air temperature for November was 73.5°F at Wishek, ND on the 2nd. The lowest recorded daily air temperature was -12.2°F at Rugby, ND on the 20th.

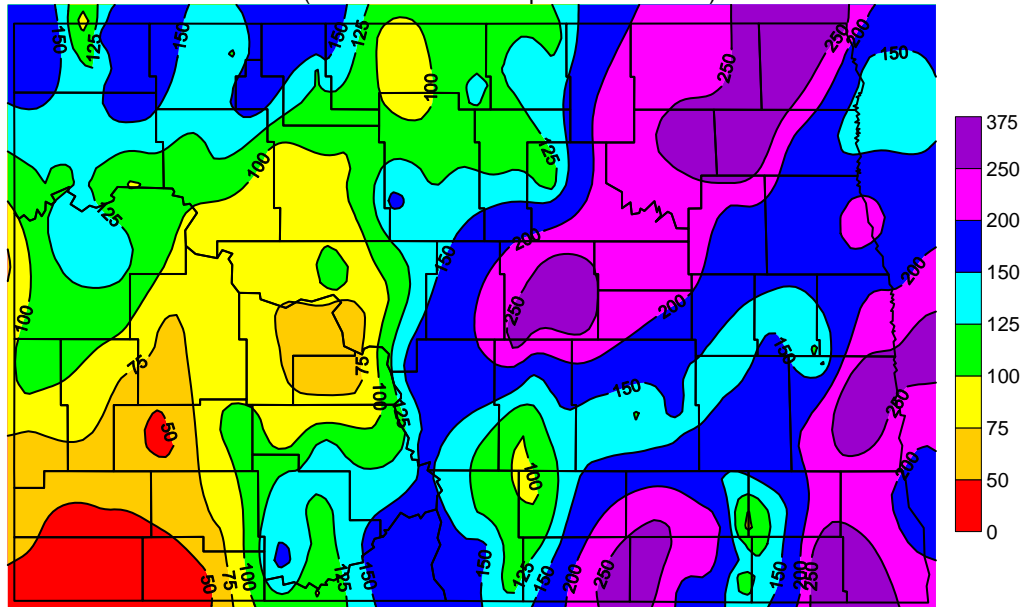
Season in Graphics

Fall 2008 Weather in North Dakota:

Total Precipitation percent of mean (1971-2000)

Precipitation Percent of Normal

(Data from NWS Cooperative Network)

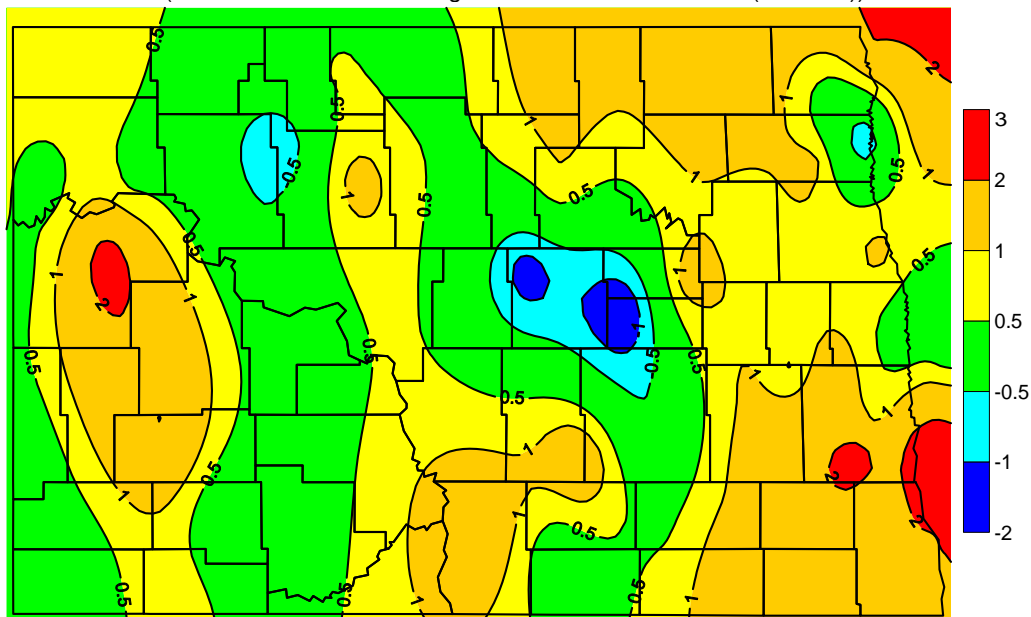


North Dakota State Climate Office

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

September 2008

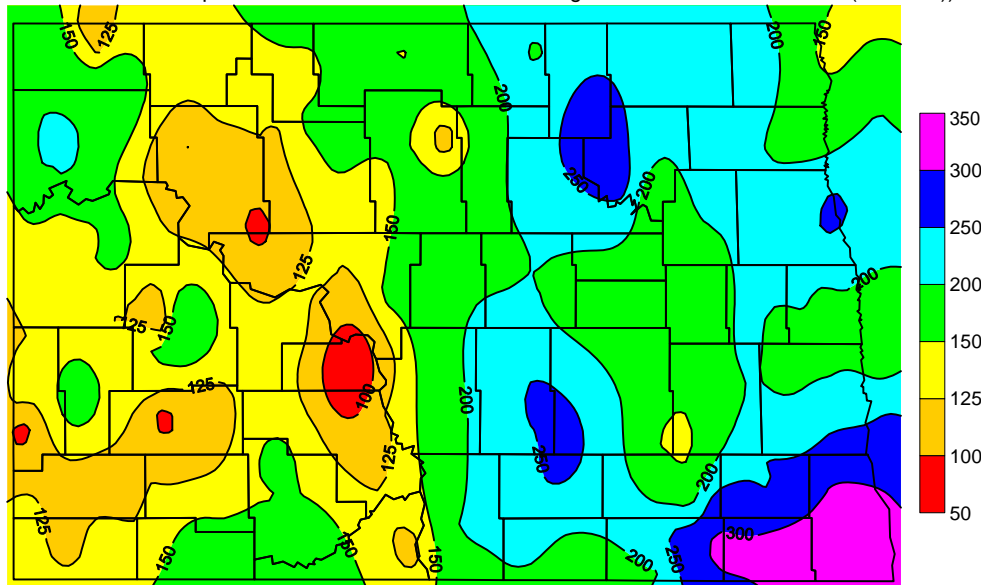
Season in Graphics

Fall 2008 Weather in North Dakota:

Total Precipitation percent of mean (1971-2000)

Precipitation Percent of Normal

(Data from NWS Cooperative Network)

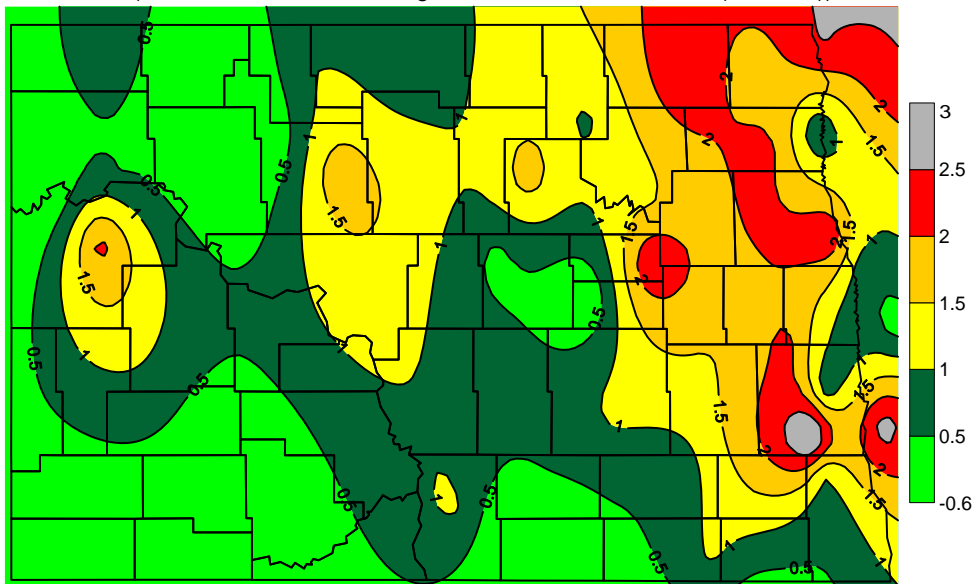


North Dakota State Climate Office

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

October 2008

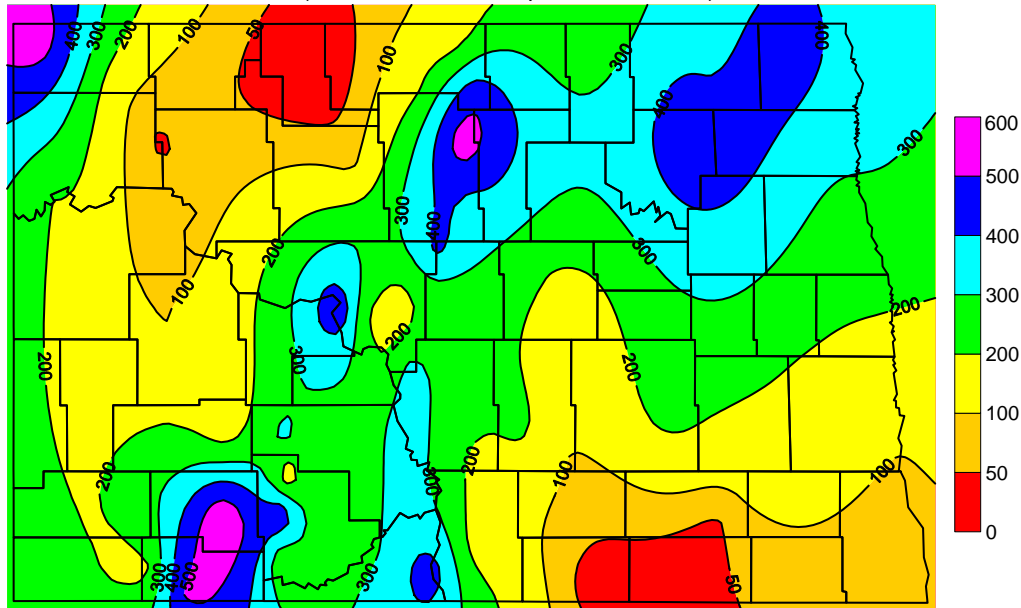
Season in Graphics

Fall 2008 Weather in North Dakota:

Total Precipitation percent of mean (1971-2000)

Precipitation Percent of Normal

(Data from NWS Cooperative Network)

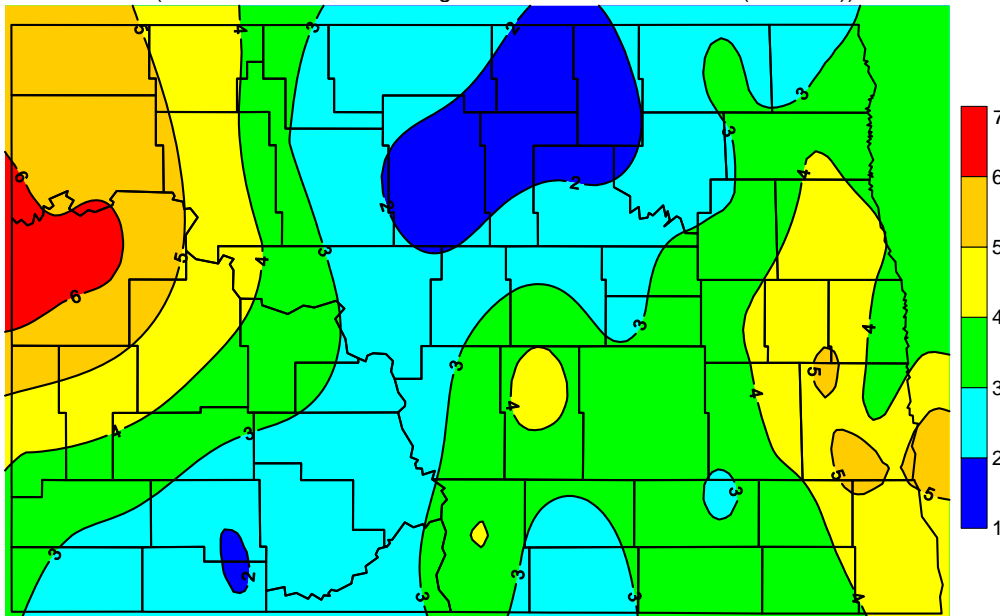


North Dakota State Climate Office

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

Departure From Normal Monthly Average Air Temperature in degrees F

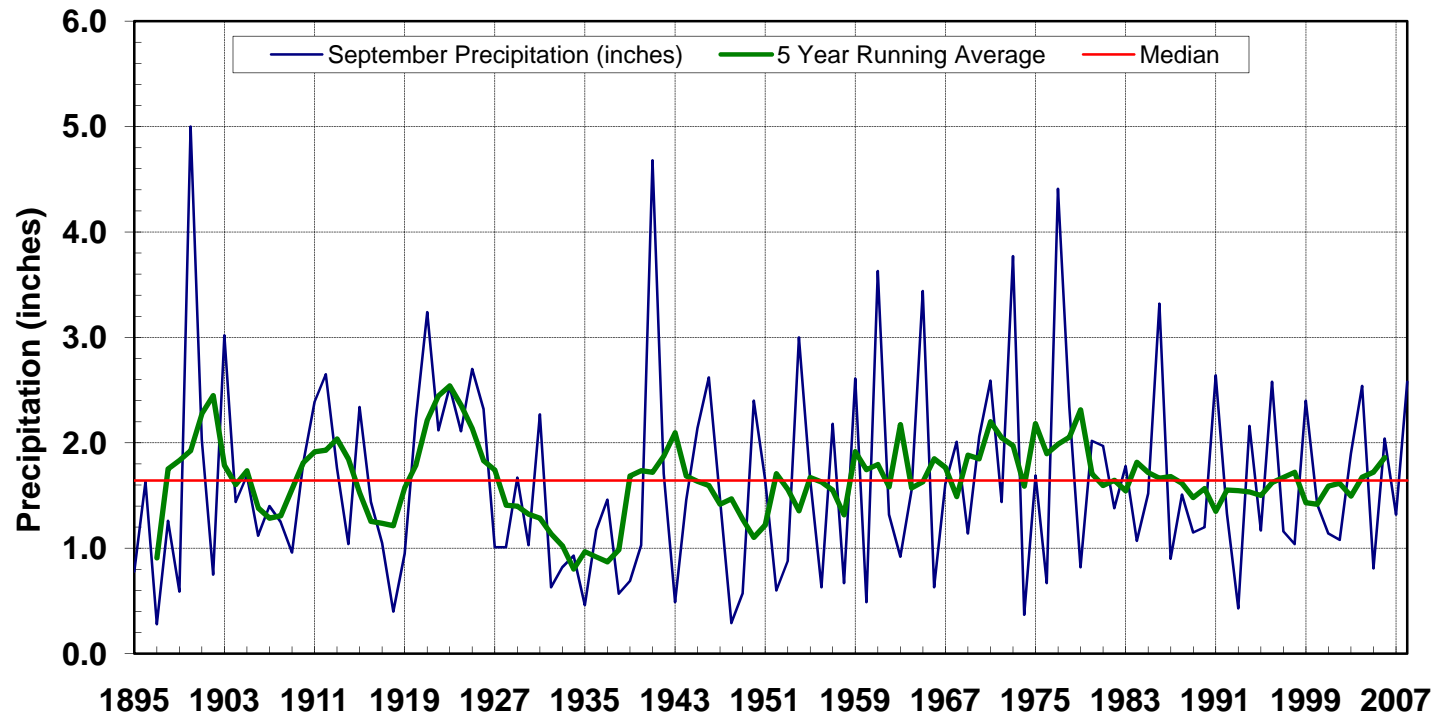
(Data from North Dakota Agricultural Weather Network (NDAWN))



North Dakota State Climate Office

November 2008

Historical September Precipitation for North Dakota

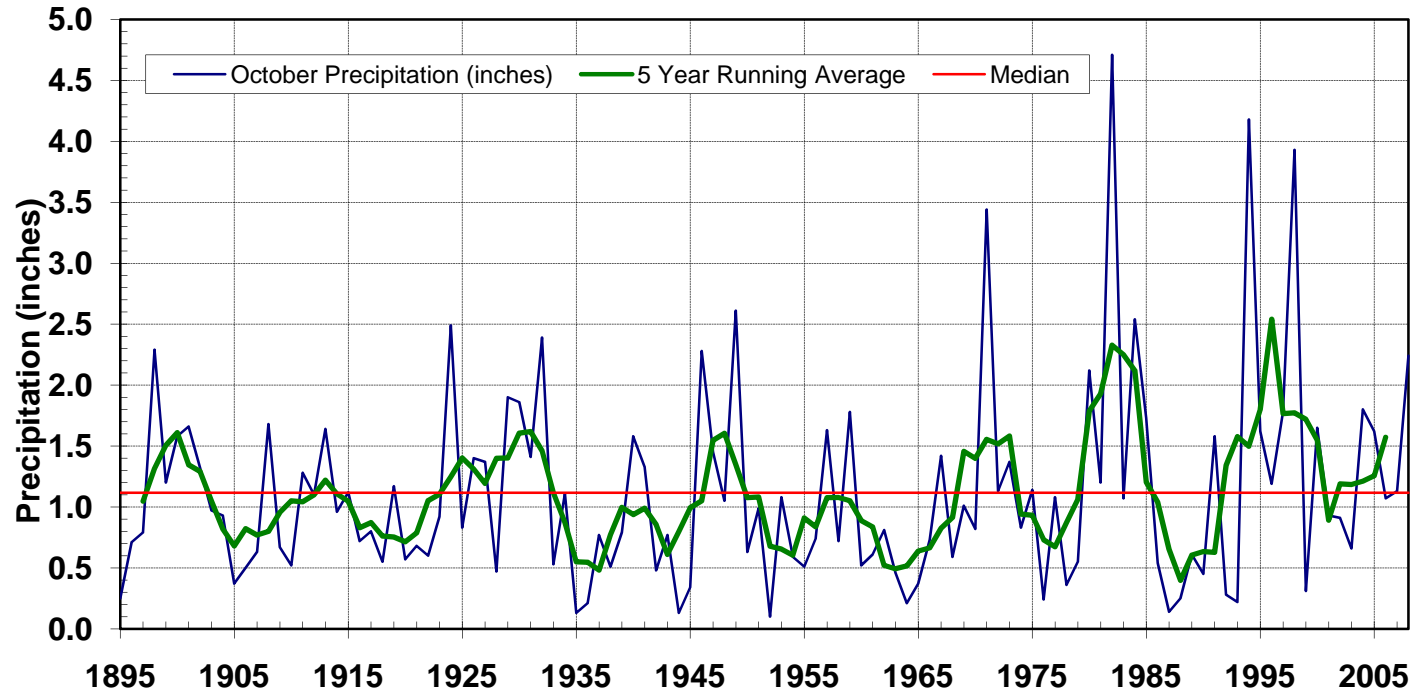


September Precipitation Statistics

2008 Amount: **2.58 inches**
Maximum: 5.00 inches in 1900
State Normal: 1.74" (1971-2000)

Monthly Ranking: 18th Wettest in 114 years
Minimum: 0.28 inches in 1897
Years in Record: 114

Historical October Precipitation for North Dakota

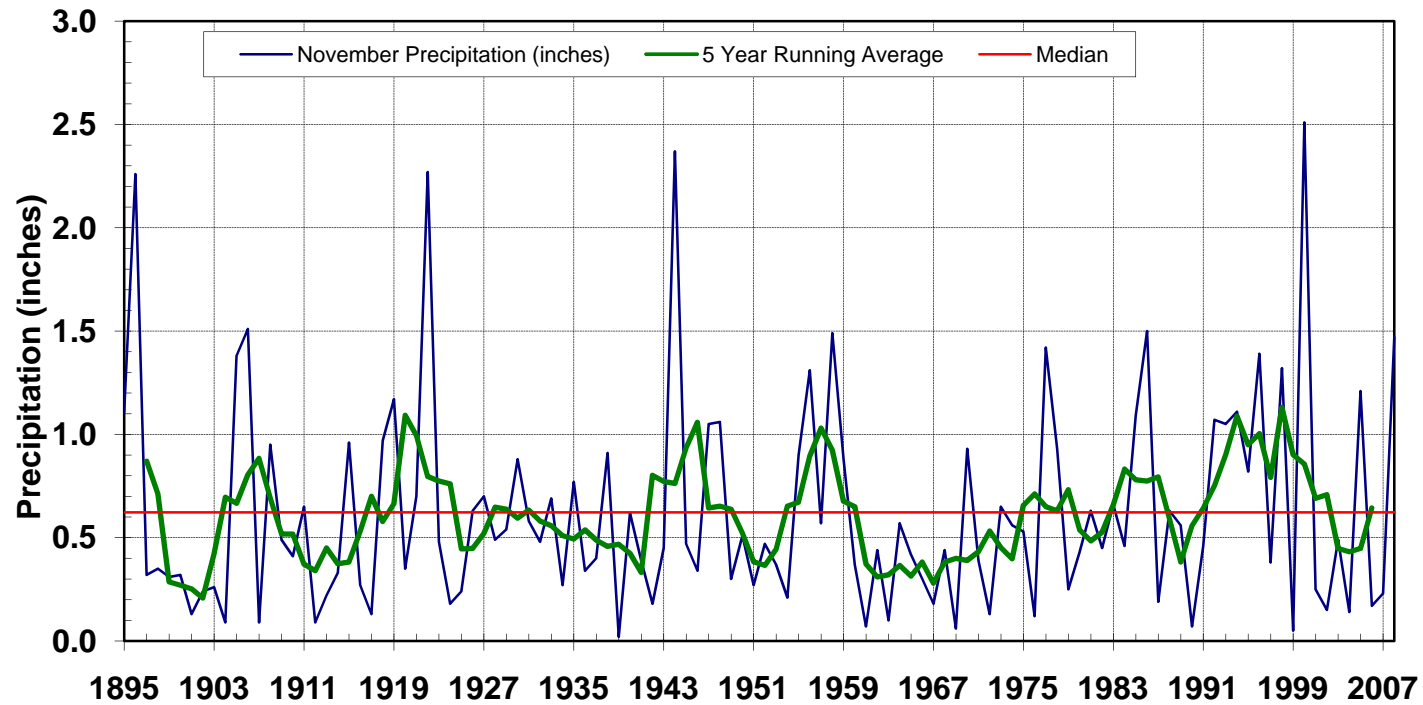


October Precipitation Statistics

2008 Amount: 2.24 inches
Maximum: 4.71 inches in 1982
State Normal: 1.41" (1971-2000)

Monthly Ranking: 11th Wettest in 114 years
Minimum: 0.10 inches in 1952
Years in Record: 114

Historical November Precipitation for North Dakota

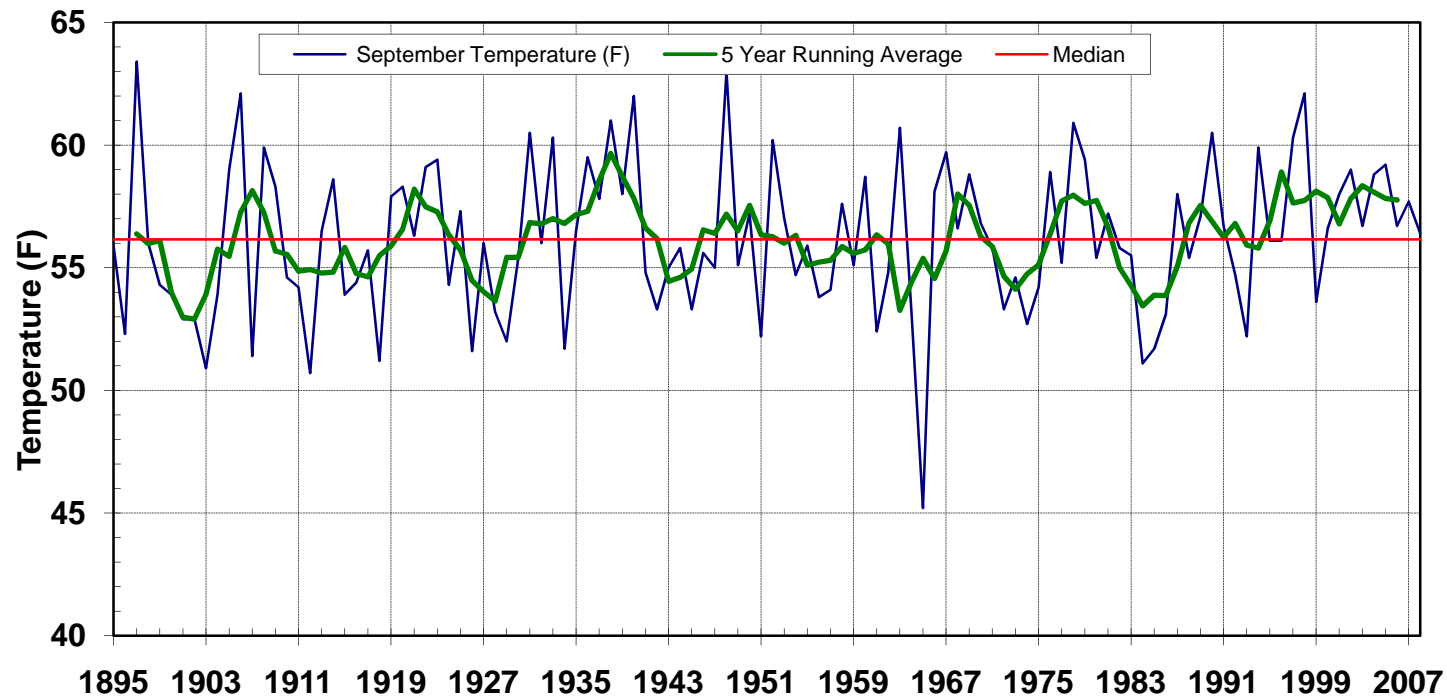


November Precipitation Statistics

2008 Amount: 1.47 **inches**
Maximum: 2.51 inches in 2000
State Normal: 0.73" (1971-2000)

Monthly Ranking: 8th Wettest in 114 years
Minimum: 0.02 inches in 1939
Years in Record: 114

Historical September Temperature for North Dakota



September Temperature Statistics

2008 Average: **56.4°F**

Maximum: 63.4° F in 1897

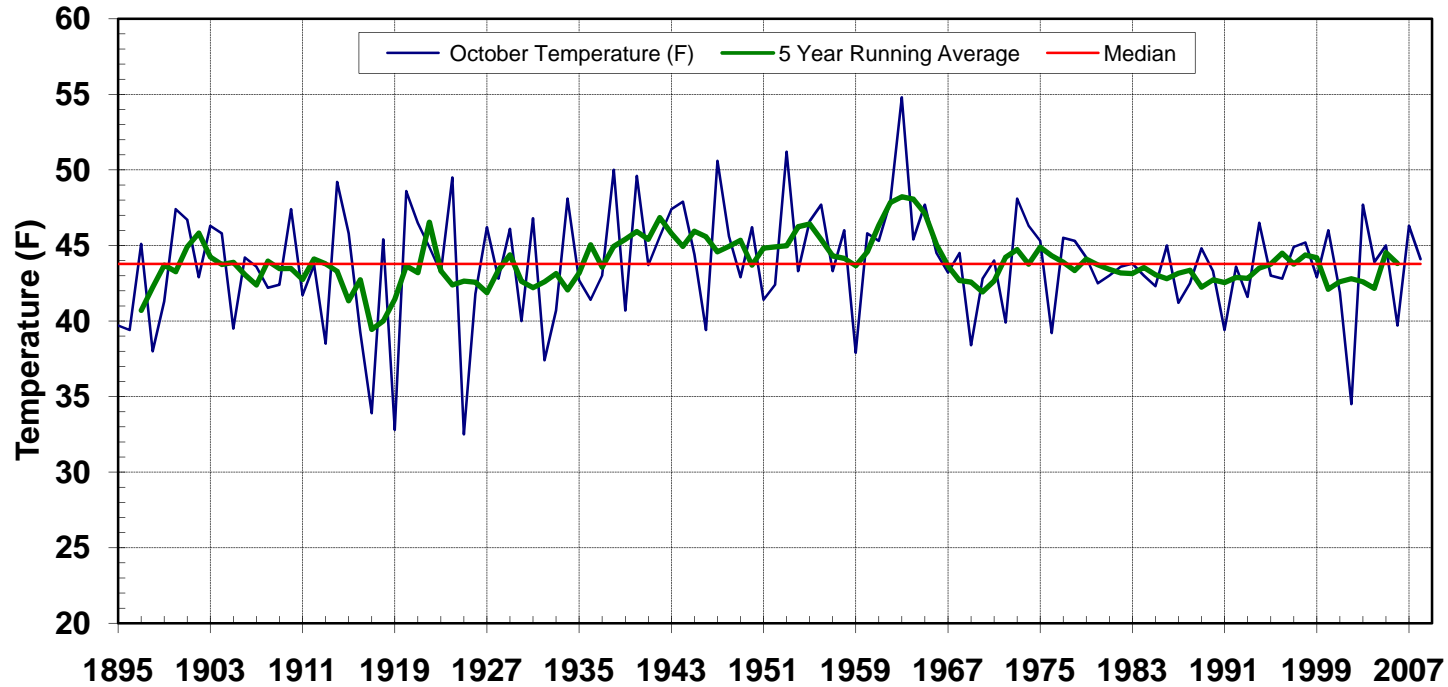
State Normal: 56.1° F (1971-2000)

Monthly Ranking: 64th Coolest in 114 years

Minimum: 45.2° F in 1965

Years in Record: 114

Historical October Temperature for North Dakota



October Temperature Statistics

2008 Average: 44.1 °F

Maximum: 54.8°F in 1963

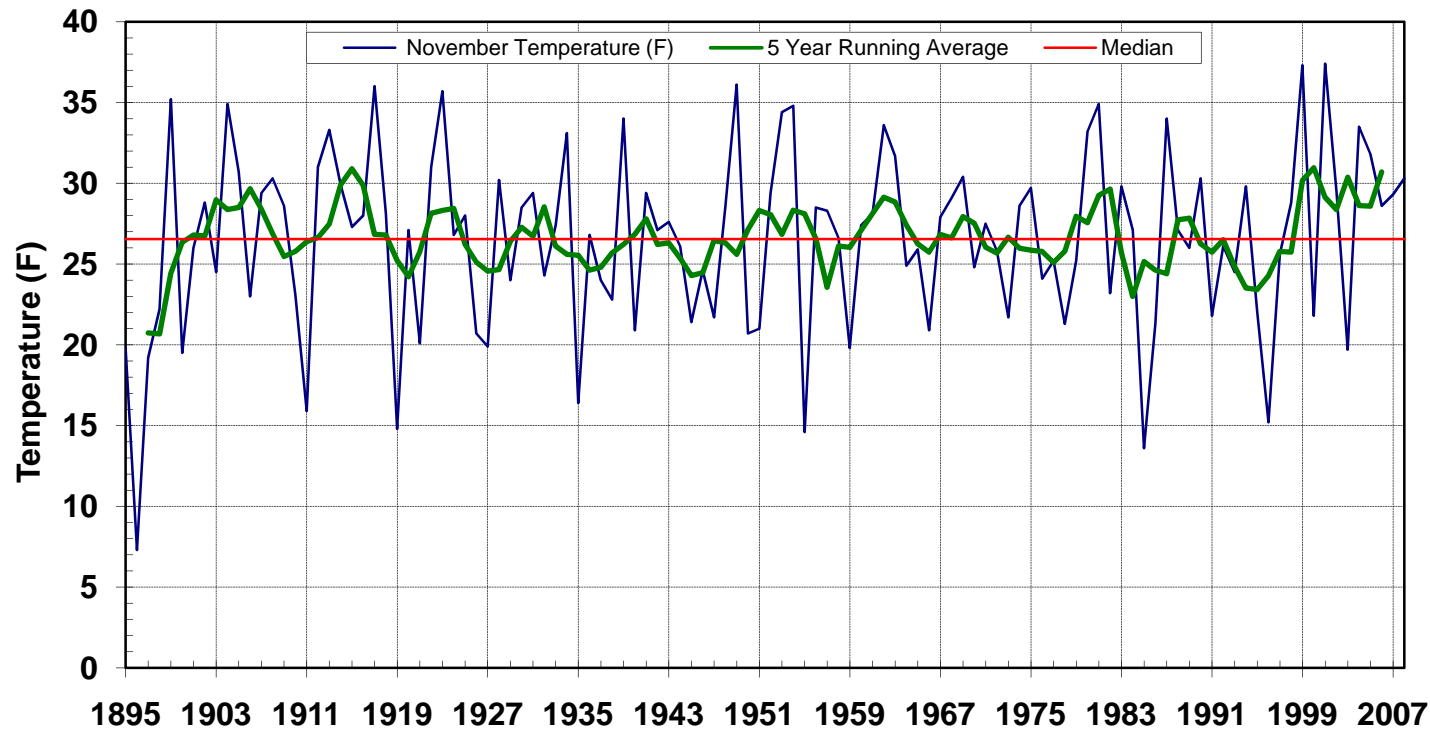
State Normal: 43.6°F (1971-2000)

Monthly Ranking: 60th Coolest in 114 years

Minimum: 32.5°F in 1925

Years in Record: 114

Historical November Temperature for North Dakota



November Temperature Statistics

2008 Average: **30.3°F**

Maximum: 37.4°F in 2001

State Normal: 26.1°F (1971-2000)

Monthly Ranking: 26th Warmest in 114 years

Minimum: 7.3°F in 1896

Years in Record: 114



Storms & Record Events



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

North Dakota 3 Month Total	Wind	Hail	Tornado
	3	11	0

Reports by Month			
Month	Wind	Hail	Tornado
Total September	3	9	0
Total October	0	0	0
Total November	0	2	0

North Dakota Record Event Reports for Fall 2008

Date	Location	Type of Record	Previous Record
09/01/08	Bismarck	Record rainfall of 1.15 inches.	0.72 inches set in 1986.
09/01/08	Grand Forks	Record rainfall of 1.67 inches.	0.98 inches set in 1957.
09/01/08	Fargo	Record rainfall of 2.50 inches.	2.32 inches set in 1999.
09/19/08	Dickinson	Record high temperature of 89°F.	88° set in 1960.
10/11/08	Grand Forks	Record rainfall of 1.16 inches.	0.70 inches set in 1961.
10/12/08	Grand Forks	Record rainfall of 1.12 inches.	0.94 inches set in 1981.
10/12/08	Fargo	Record rainfall of 1.23 inches.	0.84 inches set in 1997.
10/12/08	Williston	Record rainfall of 0.75 inches.	0.47 inches set in 1994.
10/12/08	Williston	Record snowfall of 7.0 inches.	0.5 inches set in 1899.
10/14/08	Bismarck	Record latest first fall freeze date.	10/11/1980.
10/21/08	Minot	Record rainfall of 0.53 inches.	0.52 inches set in 1953.
10/27/08	Fargo	Record snowfall of 1.4 inches.	1.2 inches set in 1925.
10/29/08	Dickinson	Record high temperature of 78°F.	77° set in 1968.
11/03/08	Grand Forks	Record high temperature of 66°F.	63° set in 1981.
11/05/08	Bismarck	Record rainfall of 0.83 inches.	0.66 inches set in 1922.
11/05/08	Dickinson	Record rainfall of 0.86 inches.	0.37 inches set in 1986.
11/05/08	Williston	Record rainfall of 1.51 inches.	1.00 inches set in 1895.
11/05/08	Minot	Record rainfall of 0.53 inches.	0.32 inches set in 1956.
11/05/08	Jamestown	Record rainfall of 1.37 inches.	0.28 inches set in 1956.
11/05/08	Grand Forks	Record rainfall of 0.85 inches.	0.84 inches set in 1956.
11/06/08	Grand Forks	Record rainfall of 0.93 inches.	0.41 inches set in 1996.
11/06/08	Bismarck	Record snowfall of 5.7 inches.	3.0 inches set in 1901.
11/06/08	Bismarck	Record liquid equivalent of 0.92 inches.	0.44 inches set in 1880.
11/06/08	Dickinson	Record liquid equivalent of 0.21 inches.	0.14 inches set in 1966.
11/30/08	Fargo	Record wettest fall (Sep-Nov) of 10.67 inches	10.25 inches set in 1977.
11/30/08	Grand Forks	Record wettest fall (Sep-Nov) of 11.97 inches	10.41 inches set in 1957.



Seasonal Outlook



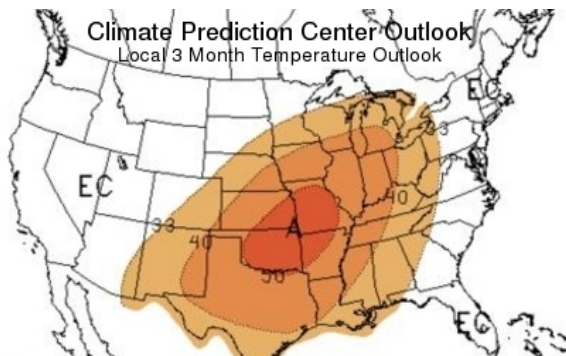
Winter Climate Outlooks by M. Ewens¹

This past fall was warm across the northwest half of United States, and cool in the southeast third. Temperatures in the Red River Valley region were generally 2 to 3 degrees above the average. The big news however was the record rainfall which saturated the top soil. This is especially true in the far southern Red River Valley, and in the Devils Lake Basin. While the wet fall may have implications for the potential of spring 2009 flood potential, the most significant factors are snowfall and rate of snow melt in the spring. A wet fall, in of itself, has little direct bearing on the next spring flood potential.

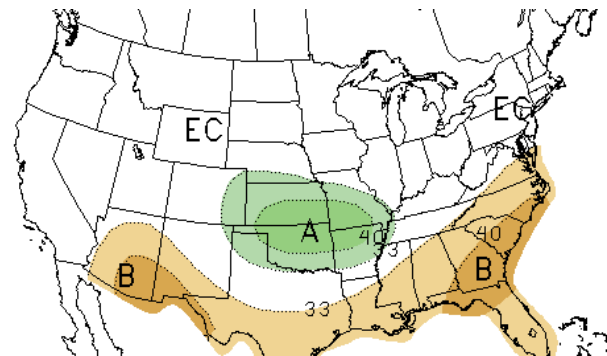
One of the big signals used to predict the next season's climate is the previous season's precipitation. This is due to the fact that soil conditions can affect the temperature patterns. Based, in part, on the wet fall the Climate Prediction Center indicates that the temperatures this winter in the northern plains will feature normal climatic variability in both temperature and precipitation. Based on the lack of either a La Niña or El Niño, other climate mechanisms come into play. The two most important are the Pacific Decadal Oscillation and the East Pacific/North Pacific Oscillation. These two oscillations suggest that, on balance, the snowfall will be less than climatologically average. Temperatures will end up averaging just a bit below the long term normals, with February being an unusually cold month.

There is a slight chance for above normal warmth in southern Minnesota and southeast South Dakota, and the chances for a warm winter extend farther south and east into the Ohio and mid Missouri river valley.

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



Winter 2008 Temperature Outlook (CPC, NOAA)



Winter 2008 Precipitation Outlook (CPC, NOAA)

North Dakota State Climate Office has links to National Weather Service's local 3-month temperature outlooks into the fall of 2009. Those outlooks can be accessed from the following web site for your location: <http://www.ndsu.nodak.edu/ndsu/ndSCO/outlook/L3MTO.html>

Also the readers will find the following National Weather Service office web sites very useful for shorter term weather forecasts:

- Eastern North Dakota: <http://www.crh.noaa.gov/fgf/>
- Western North Dakota: <http://www.crh.noaa.gov/bis/>

¹ The corresponding author: Mark Ewens is the Data Acquisition Program Manager and the Climate Services Focal Point at the NOAA's National Weather Service, Weather Forecast Office in Grand Forks, ND. E-Mail: Mark.Ewens@noaa.gov



Hydro-Talk



Western North Dakota Hydrology

by A. Schlag²

Warmer and wetter is probably the most concise way to describe the fall within the Bismarck Hydrologic Service Area. Perhaps the most beneficial aspect of the wetter fall and early November snowstorm was that with warmer weather preceding the snowstorm had kept soil temperatures above freezing. The cool temperatures during the snowstorm coupled with soils that were not yet frozen allowed for slow melting of the snow and replenishment of soil moisture versus creating a large runoff event as would have been expected from an equivalent amount of moisture from rain.

One of the more interesting records set this year was when Bismarck did not record a temperature after summer below 32 degrees until October 14th. This broke the old record of October 11th, set in 1980. This fall was the 6th wettest on record for both Bismarck and Williston and the 8th wettest for Jamestown. A well written and more detailed description of the recent climate observations in Bismarck area is available at:

http://www.crh.noaa.gov/news/display_cmsstory.php?wfo=bis&storyid=19749&source=0

As fall wore on, the long-term hydrographs for many of the unregulated small streams and rivers across the western and southern portions of Bismarck’s Hydrologic Service Area tended to remain slightly above normal stages for this time of the year. However, at no point were streams in western North Dakota in danger of flooding.

The Souris River and its tributaries in the north central part of the Bismarck Hydrologic Service Area are notable in that they are much closer to seasonal norms with a lack of runoff attributable to lesser precipitation.

In terms of water supply and storage, Table 2 shows that even with the recent wet period, many reservoirs are still below long-term averages. Clearly, the lasting effects of drought in the region will need more normal to above normal precipitation before E.A. Patterson Lake at Dickinson recovers. Similarly, while Lake Sakakawea has shown great improvement due to restricted flows and increased runoff this past year, it could use another year or two of improved runoff.

Table 2. Water Storage Data for Select Reservoirs in Western ND.

Reservoir	Watershed	Conservation		10-yr Average	Percent of 10-yr Average
		Pool %	Storage (acft)		
E.A. Patterson	Heart River	26.4	2,364	5,035	46.9
Lake Tschida	Heart River	65.9	43,817	54,502	80.4
Pipestem Dam	James River	93.7	9,070	10,041	90.3
Jamestown Dam	James River	91.4	28,767	26,816	107.3
Lake Sakakawea	Missouri	81.7	14,698,000	17,647,000a	83.3a

a. This long-term average is from 1967-2008.

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

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

² The corresponding author: Allen Schlag is the Service Hydrologist at the NOAA’s National Weather Service, Weather Forecast Office in Bismarck, ND. E-Mail: Allen.Schlag@noaa.gov



Science Bits



Wet Soil at Freezeup a Problem?

by L. Prunty³

Unusually heavy rains in the Red River Valley this fall have led to questions about the possibilities for spring flooding. This is because wetter soil at freezeup could be expected to bring greater spring thaw runoff. How much greater is an important question. Besides flooding prospects, spring soil wetness can also influence conditions for spring fieldwork and early spring crop growth.

I will try to address these questions indirectly by describing behaviors of freezing and frozen soils. What actually happens next spring will depend greatly on the weather in the interim.

It is no surprise to say that frozen water is relatively immobile. In frozen soil, likewise, the water is mostly locked in place. Changes in soil water content can only take place slowly, if at all. We studied soil water dynamics in sandy soils near Oakes, ND for 15 years. We found very little drainage at the 8-foot depth from December through early March in most years. The maximum depth of freezing was usually about three feet. Greatest frost depth occurred in early spring shortly after thawing began at the surface.

Even though soil conditions change slowly in winter, winter is (very) long in ND and some changes can accumulate. Where a water table is within several feet of the surface, a dense frost layer can form at the depth where the soil above is frozen and the soil below is unfrozen. This happens because water rises from the warmer water table to the frozen layer, where it freezes. In contrast, I have seen in Fargo, when the winter is long, cold, and snowless, that large cracks develop in the earth. This indicates that some degree of soil drying occurs near the surface under these conditions.

Soil water does not freeze all at once. Water in the larger soil pores freezes at 32 °F but water in very small pores and immediately next to soil particles can remain liquid at lower temperatures. This plays a role in frost heaving and even the formation of layers of solid ice (ice lenses) within soil. Silty soils are reputed to be most subject to frost heave.

Soil moisture when crops are planted could be greater than otherwise in a year with little snowfall. Normal snowfall, if it accumulates on the field rather than only in ditches, will usually result in near-saturated soil immediately after snowcover disappears, regardless of fall soil moisture.

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