North Dakota Climate Bulletin

Winter 2014-2015

Volume: 9 No: 1

In This Issue

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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, College of Agriculture, Food Systems and Natural Resources, North Dakota State University in Fargo, North Dakota.

This winter was the 25th warmest on record in ND and it was the 32nd driest statewide since 1895. Lack of snow cover allowed frost to penetrate deeper in the soil. The deepest penetration of frost in Fargo, Dickinson, and Williston was at least 100cm, 60cm and 80cm respectively. First measurable seasonal snowfall came in record late time in Fargo on Feb 10. There were only two events with snowfall greater than 1" in Fargo, yet still was able to receive a seasonal total of 15.8" of snow which ranks the 8th least amount since 1885. Snow-free ground with warm winter is also pointing towards warmer and dryer conditions in spring. More on the seasonal outlooks and tools we use can be found later in this issue. It will also contain graphical displays of statewide temperature, precipitation and the other weather highlights.

This bulletin can be accessed at http://www.ndsu.edu/ndsco/. This website hosts other great resources for climate and weather information.

Adnan Akyüz, Ph.D.
North Dakota State Climatologist

Aurora Borealis *by Jan Curtis*

Weather Highlights

Seasonal Summary:

by Daryl Ritchison

December 2014

The state average precipitation was 0.17 inches which is below the 1981-2010 normal of 0.52 inches. December 2014 state average precipitation ranked as the 9th driest in the last 120 years with a maximum of 1.27 inches in 2008 and a minimum of 0.05 inches in 1944.

The US Drought Monitor on December 30, 2014 reported 66.5% of the state in Abnormally Dry conditions (D0) and 1.5% in Moderate Drought (D1). The Moderate Drought conditions were all located in Richland County. (http://droughtmonitor.unl.edu/)

The top five December daily maximum wind speeds recorded from NDAWN were Leonard with 41.2 mph, Wahpeton with 40.8 mph, Dazey with 40.4 mph, Prosper with 40.4 mph and Crary with 39.7 mph. All those maximum wind speeds occurred on December 15. NDAWN wind speeds are measured at a height of 10 feet (3 m).

The state average air temperature was 18.2 °F which is above the 1981-2010 normal of 14.0 °F. December 2014 state average air temperature was the 30th warmest in the past 120 years with a maximum of 25.4. °F in 1939 and a minimum of -3.2 °F in 1927.

NDAWN's highest recorded daily air temperature for December was 61.3 °F at Hettinger on the 12th. The lowest recorded daily air temperature was -25.2 °F at Hofflund, on the 1st.

January 2015

The state average precipitation was 0.49 inches which is right at the 1981-2010 normal state-wide average of 0.49 inches. January 2015 state average precipitation ranked as the 47th wettest in the last 121 years with a maximum of 1.27 inches in 1916 and a minimum of 0.09 inches in 1942.

The US Drought Monitor January 27, 2015 reported 58.6% of North Dakota in Abnormally Dry Conditions (D0) and 9.5% in Moderate Drought (D1). (http://droughtmonitor.unl.edu/).

The top five January daily maximum wind speeds recorded from NDAWN were 53.3 mph at Mandan, 51.5 mph at Linton, 49.0 mph at Wishek, 48.7 mph at Warren, MN and 48.0 mph at Beach. All those wind speeds were recorded on January 8. NDAWN wind speeds are measured at a height of 10 feet (3 m).

The state average air temperature was 16.1 °F which is above the 1981-2010 normal of 10.1 °F. January 2015 state average air temperature ranked the 17th warmest in the past 121 years with a maximum of 25.9 °F in 2006 and a minimum of -11.9 °F in 1950.

NDAWN's highest recorded daily air temperature for January was 63.5 °F at Mott on the 27th. The lowest recorded daily air temperature was -31.4 °F at Kennedy on the 4th.

February 2015

The state average precipitation was 0.41 inches which is just barely below the 1981-2010 normal of 0.44 inches. February 2015 state average precipitation ranked as the 64th driest with 121 years of records with a maximum of 1.59 inches in 1998 and a minimum of 0.07 inches in 1934.

The US Drought Monitor March 3, 2015 report had 58.9% of North Dakota in Abnormally Dry conditions (D0) and 9.5% of the state in Moderate Drought (D1) conditions (http://droughtmonitor.unl.edu/).

The top five February daily maximum wind speeds recorded from NDAWN were Greenbush, MN on the 23rd with 44.0 mph, Humboldt, MN on the 10th with 42.9 mph, Kennedy, MN on the 10th with 42.9 mph, McHenry on the 24th with 42.9 mph and Roseau, MN on the 23rd with 42.6 mph. NDAWN wind speeds are measured at a height of 10 feet (3 m).

The state average air temperature was 8.6 °F which is below the 1981-2010 average of 15.7 °F. That would place February 2015 state average as the 42nd coldest in the past 121 years with a maximum of 29.6 °F in 1954 and a minimum of -14.1 °F in 1936.

NDAWN's highest recorded daily air temperature for November was 63.8 °F at Linton on the 2th. The lowest recorded daily air temperature was -36.1 °F at Bottineau, on the 22th.

Winter 2014-2015

Using analysis from the National Climatic Data Center (NCDC), the average North Dakota precipitation for the autumn season (December 1 through February 28) was 1.07 inches which is 0.35 inches below average. That would rank the winter of 2014-2015 as the 32th driest winter since such records began in 1895.

The North Dakota winter 2014-2015 average temperature was 14.3 degrees, which is 0.8 degrees above average. That would rank as the 25th warmest winter on record.

Season in Graphics

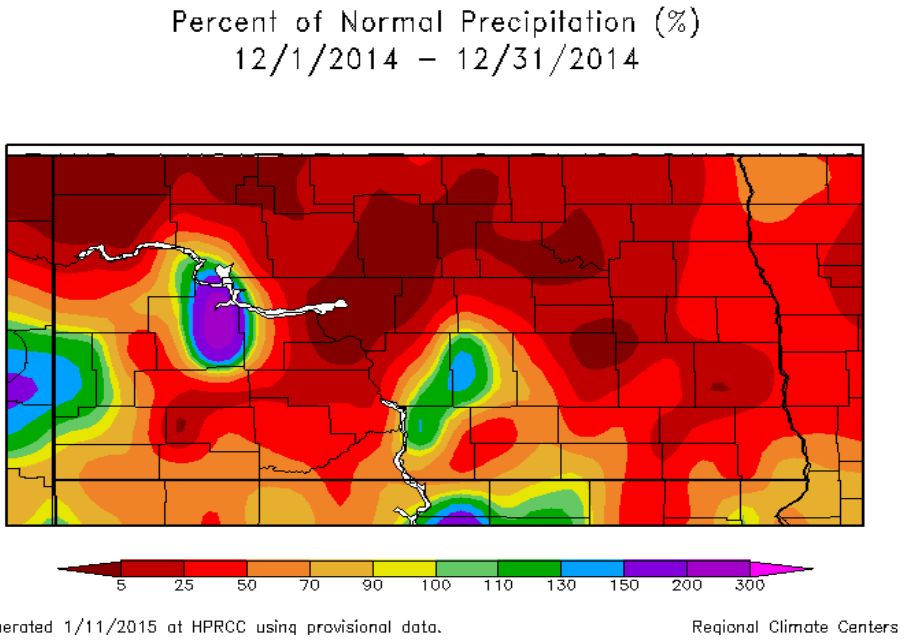
Winter 2014-2015 Weather in North Dakota:

December 2014

Total Precipitation percent of mean (1981-2010)

Precipitation Percent of Normal

(Data from High Plains Regional Climate Center (HPRCC))

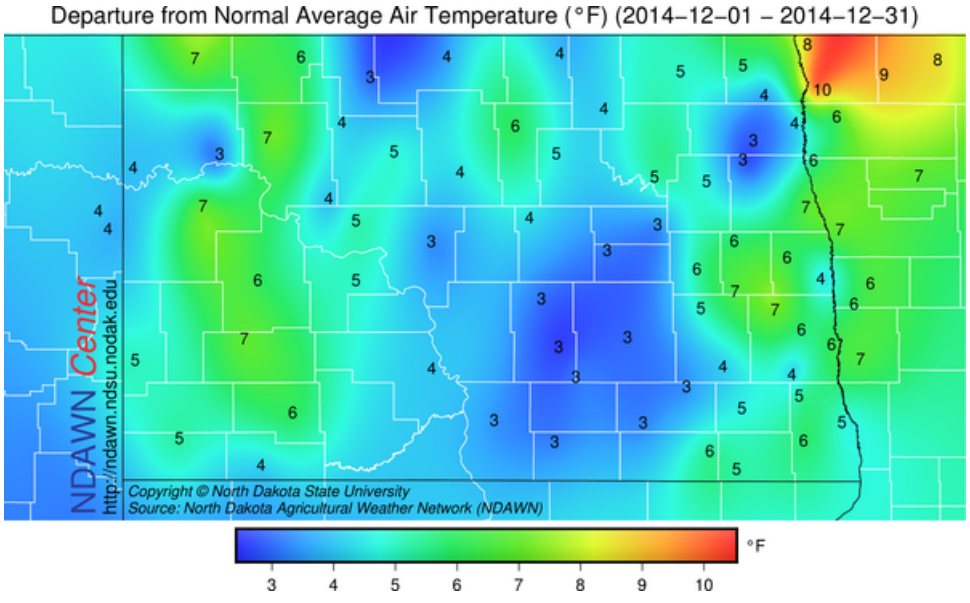


North Dakota State Climate Office

Average Temperature (°F) Deviation from Mean (1981-2010)

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

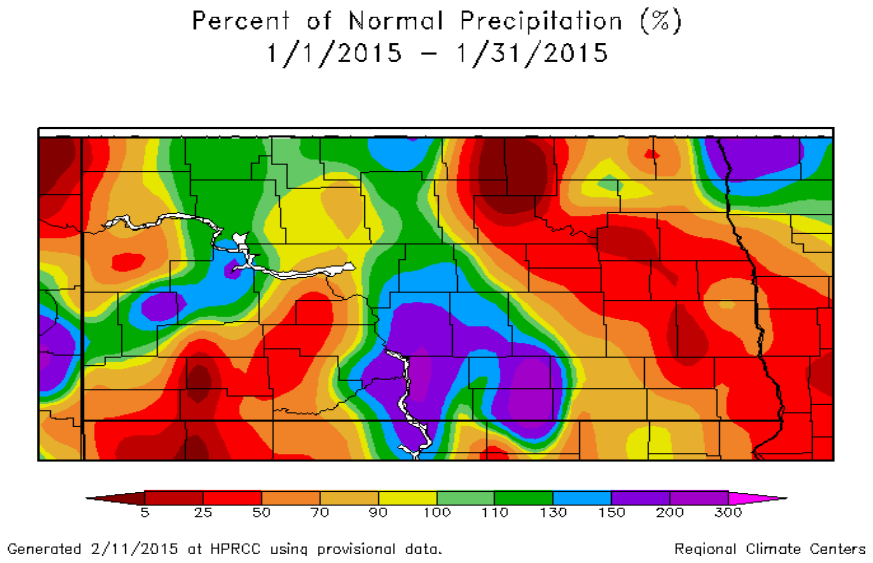
January 2015

Winter 2014-2015 Weather in North Dakota:

Total Precipitation percent of mean (1981-2010)

Precipitation Percent of Normal

(Data from High Plains Regional Climate Center (HPRCC))

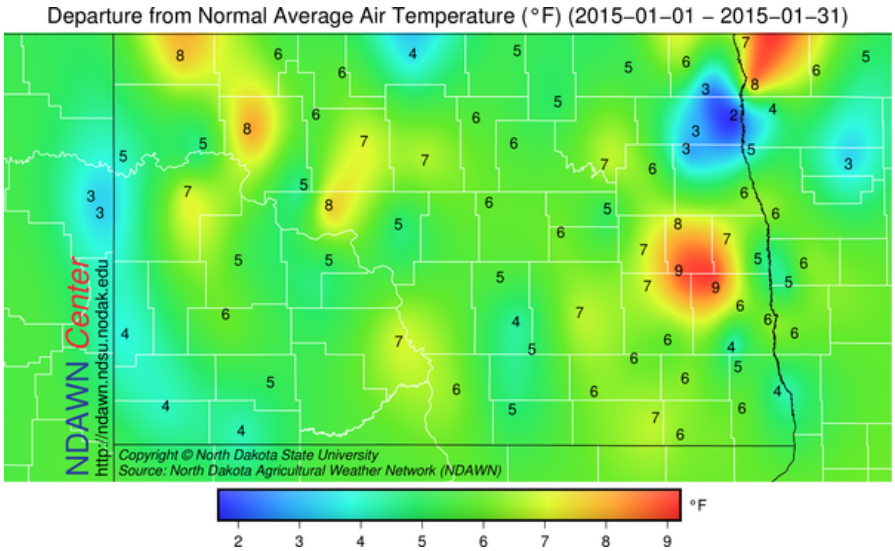


North Dakota State Climate Office

Average Temperature (°F) Deviation from Mean (1981-2010)

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

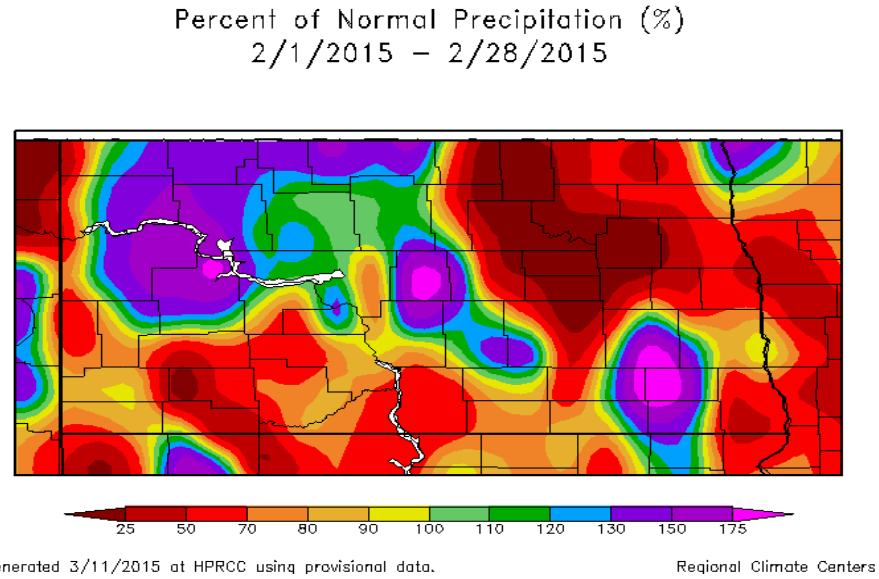
Winter 2014-2015 Weather in North Dakota:

February 2015

Total Precipitation percent of mean (1981-2010)

Precipitation Percent of Normal

(Data from High Plains Regional Climate Center (HPRCC))

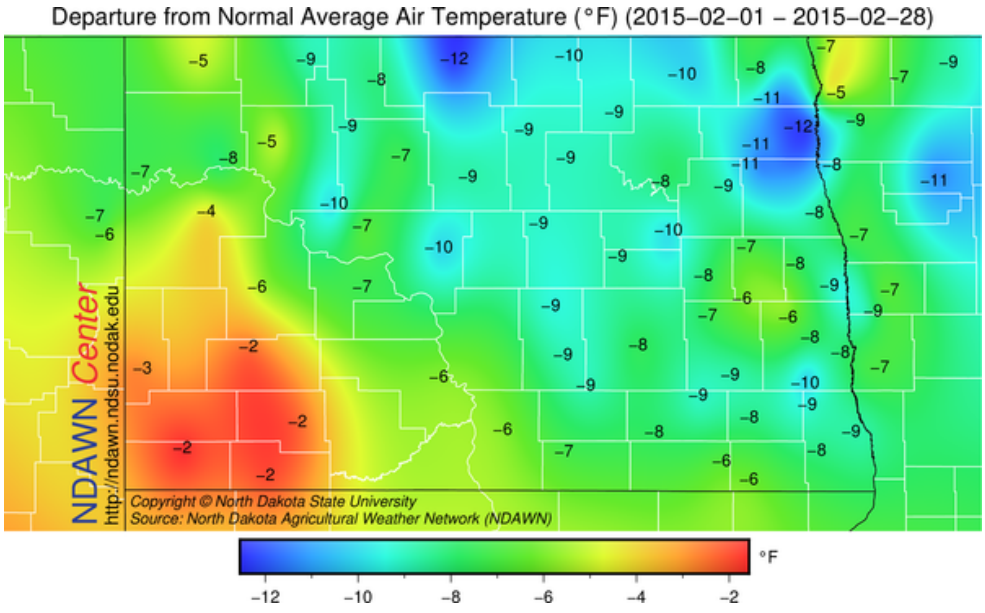


North Dakota State Climate Office

Average Temperature (°F) Deviation from Mean (1981-2010)

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

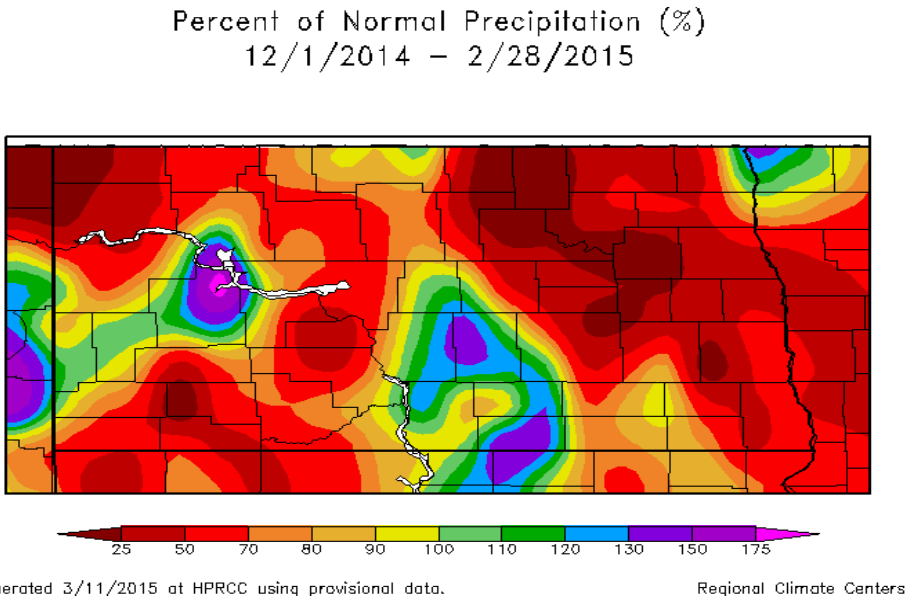
Winter 2014-2015 Weather in North Dakota:

Winter 2014-2015

Total Precipitation percent of mean (1981-2010)

Precipitation Percent of Normal

(Data from High Plains Regional Climate Center (HPRCC))

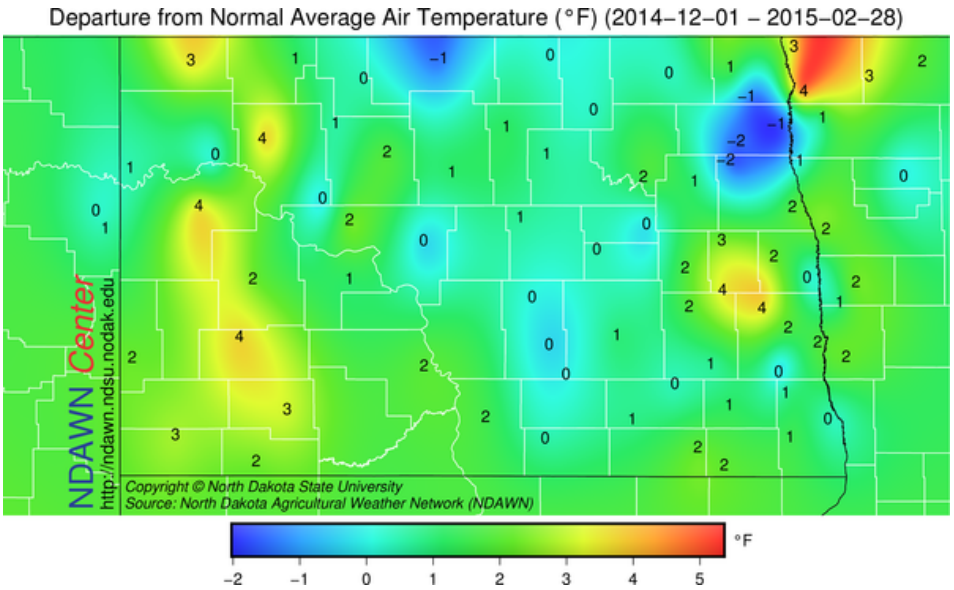


North Dakota State Climate Office

Average Temperature (°F) Deviation from Mean (1981-2010)

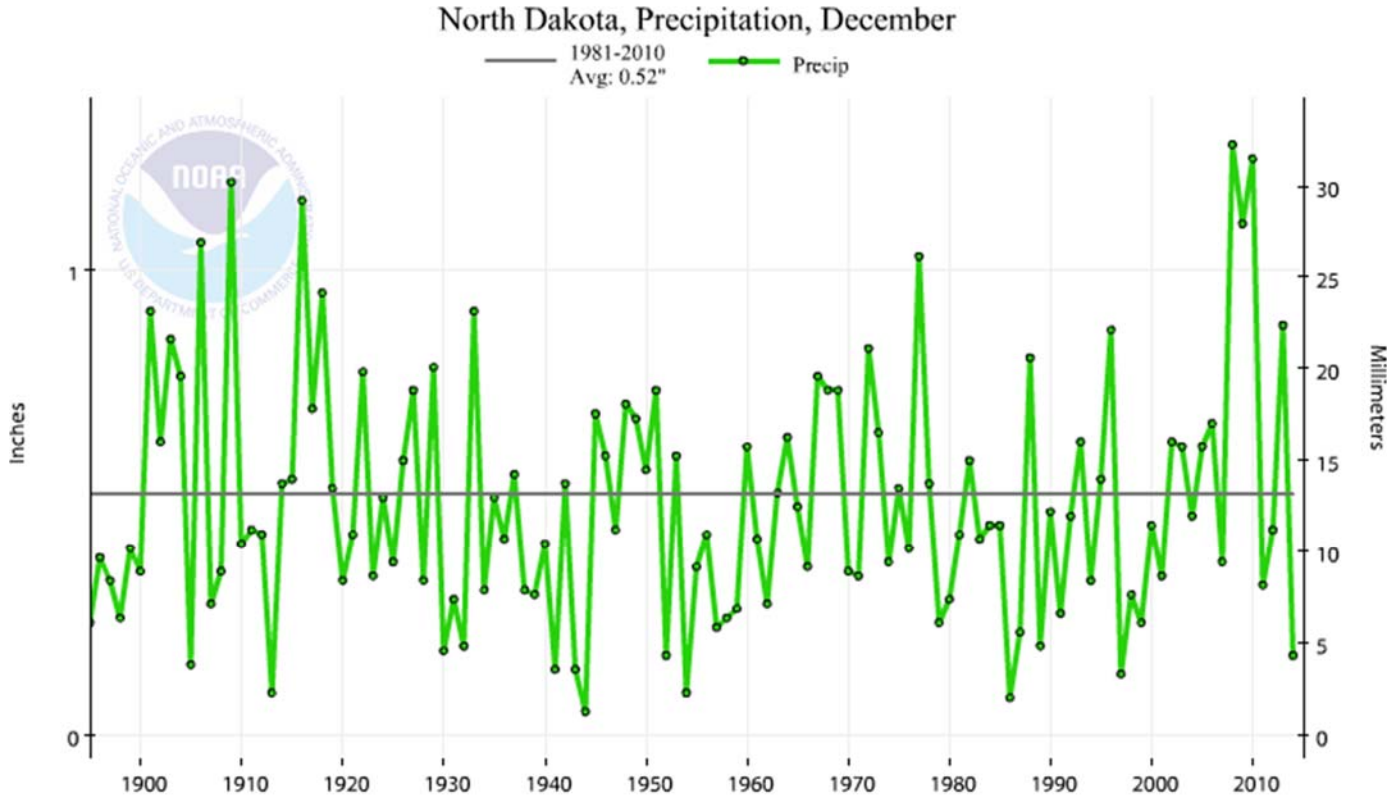
Departure From Normal Monthly Average Air Temperature in degrees F

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



North Dakota State Climate Office

Historical December Precipitation for North Dakota

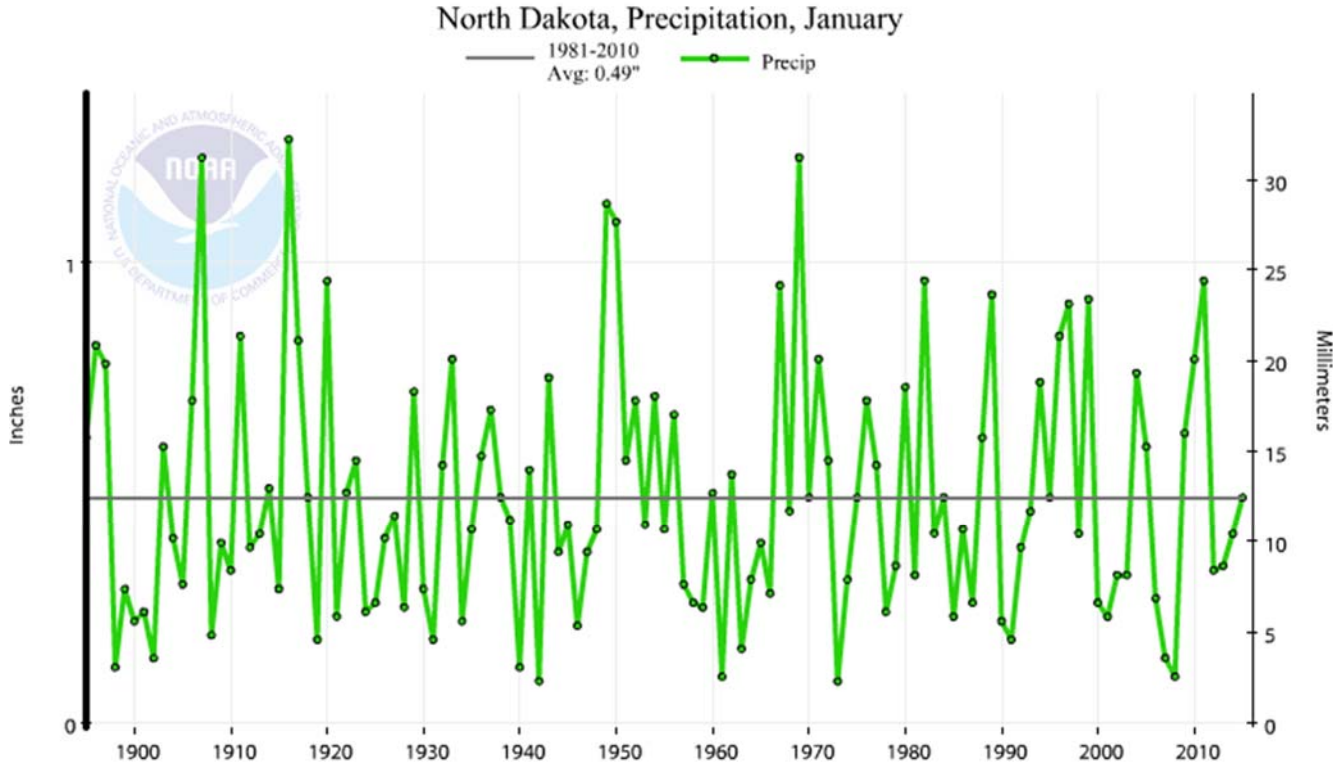


December Precipitation Statistics

2014 Amount: **0.17 inches**
Maximum: 1.27 inches in 2008
State Normal: 0.52 inches (1981-2010)

Monthly Ranking: 9th driest in 120 years
Minimum: 0.05 inches in 1944
Years in Record: 120

Historical January Precipitation for North Dakota

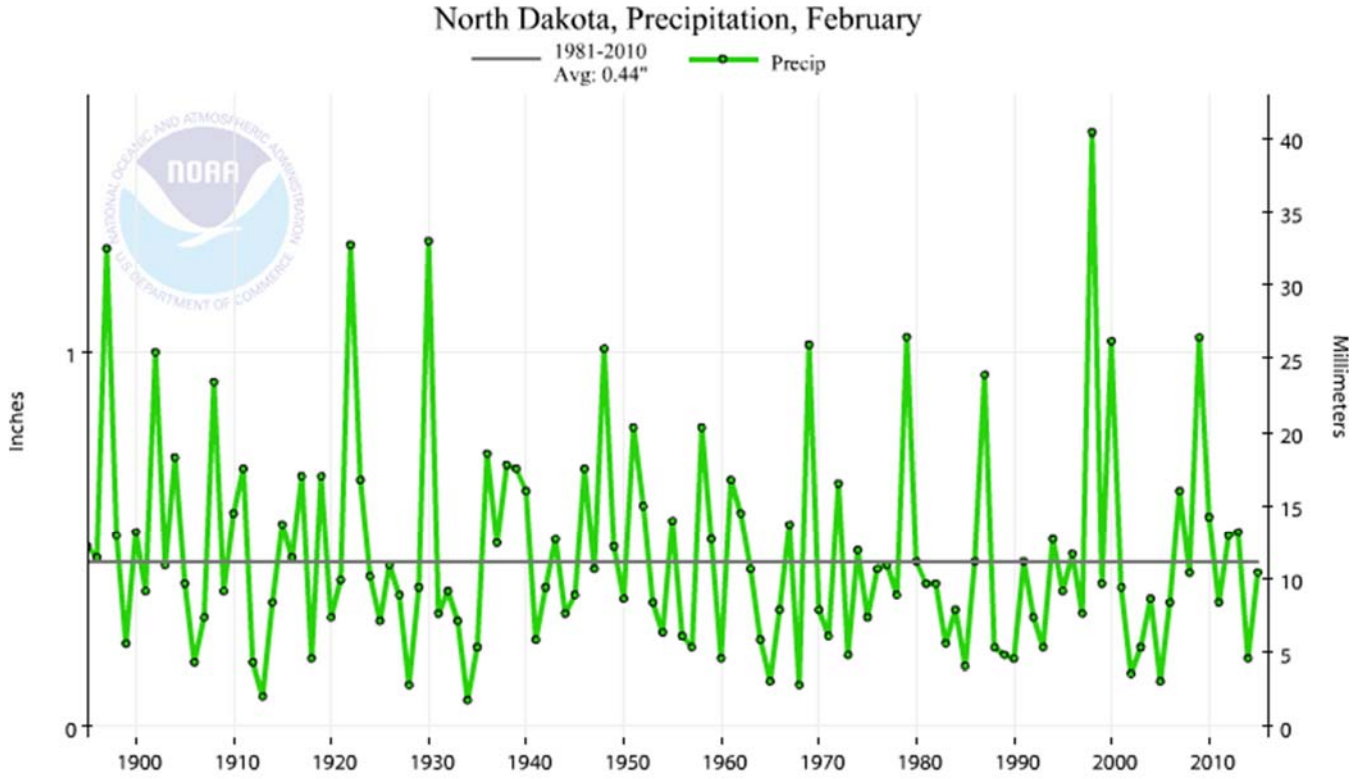


January Precipitation Statistics

2015 Amount: **0.49 inches**
Maximum: 1.27 inches in 1916
State Normal: 0.49 inches (1981-2010)

Monthly Ranking: 74th driest in 121 years
Minimum: 0.09 inches in 1942 and 1973
Years in Record: 121

Historical February Precipitation for North Dakota

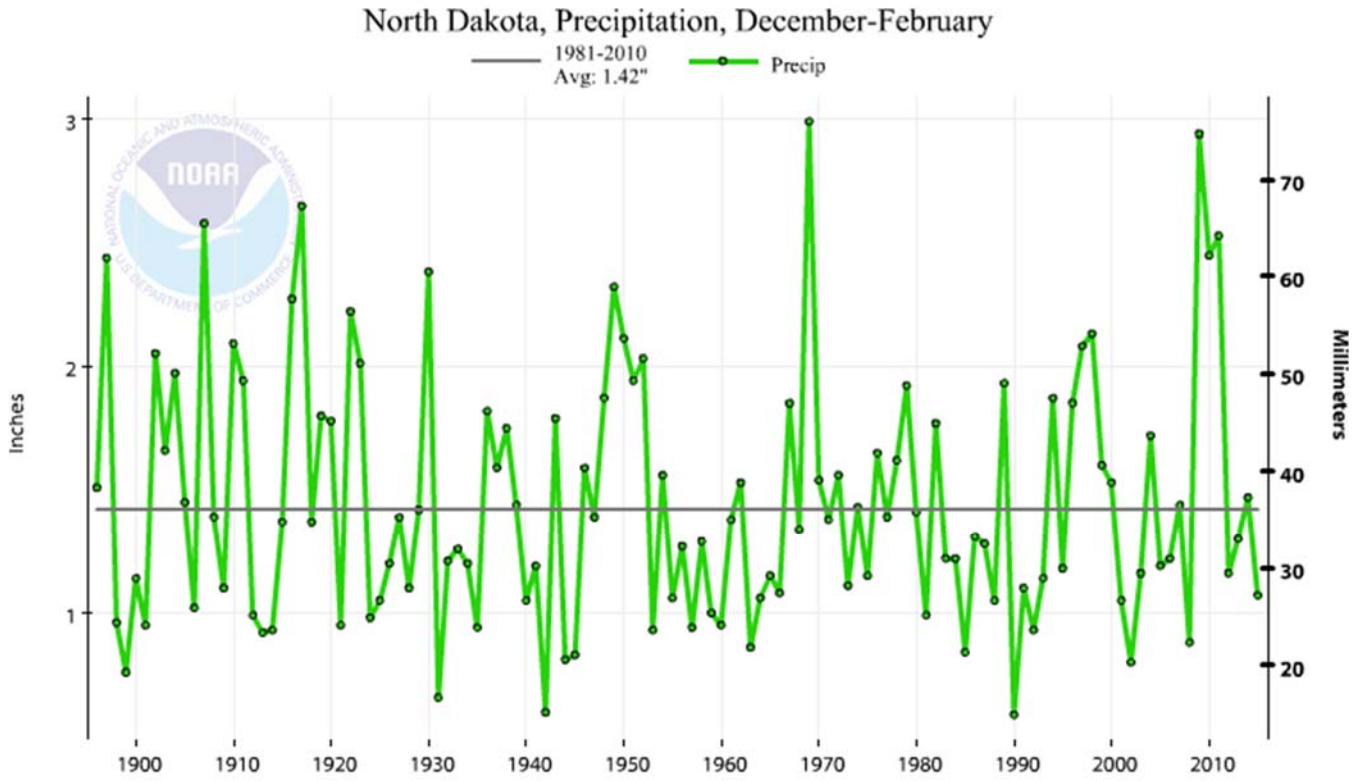


February Precipitation Statistics

2015 Amount: 0.41 inches
Maximum: 1.59 inches in 1998
State Normal: 0.44 inches (1981-2010)

Monthly Ranking: 64th driest in 121 years
Minimum: 0.07 inches in 1934
Years in Record: 121

Historical Winter Precipitation for North Dakota

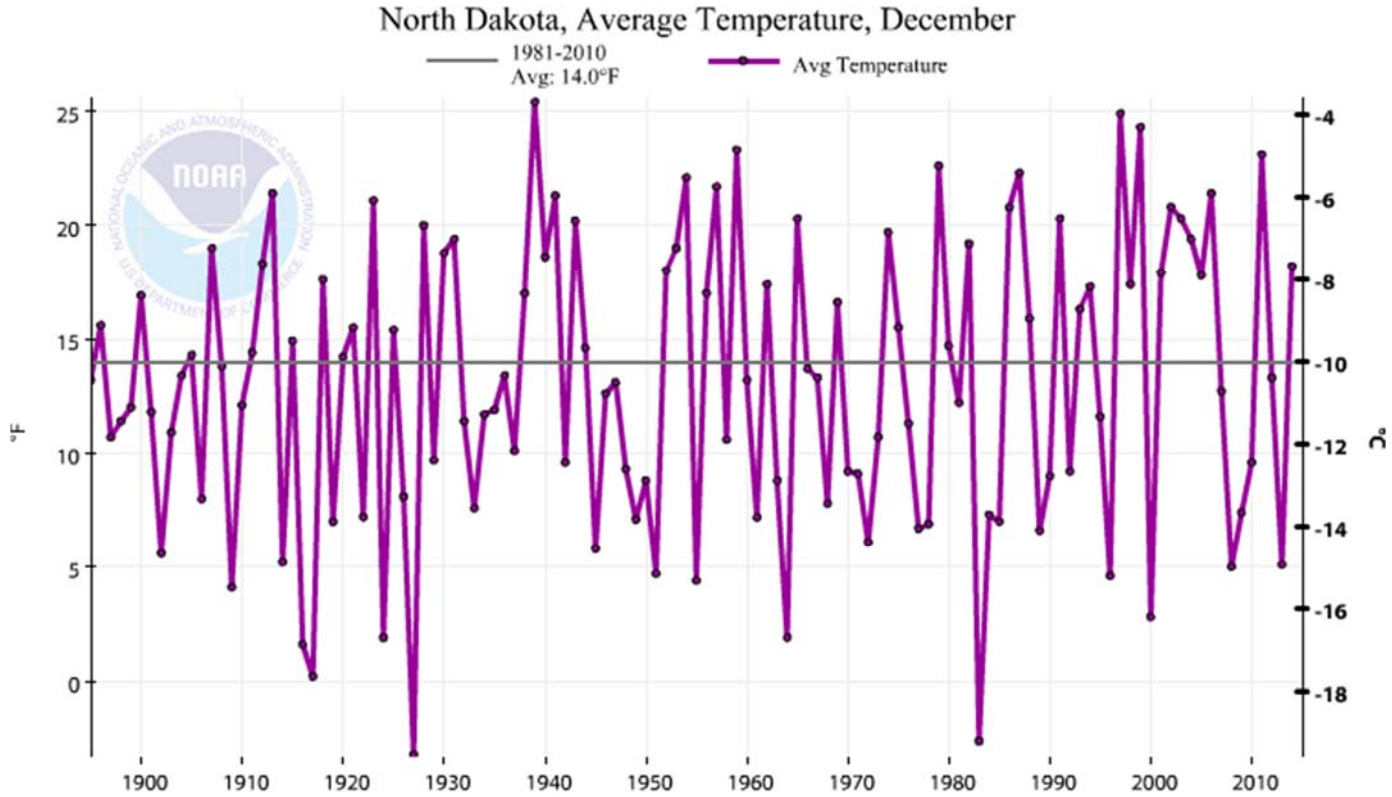


Winter Precipitation Statistics

2014-2015 Amount: 1.07 inches
Maximum: 2.99 inches in 1968-1969
State Normal 1.42 inches (1981-2010)

Monthly Ranking: 32nd driest in 120 years
Minimum: 0.59 inches in 1989-1990
Years in Record: 120

Historical December Temperature for North Dakota

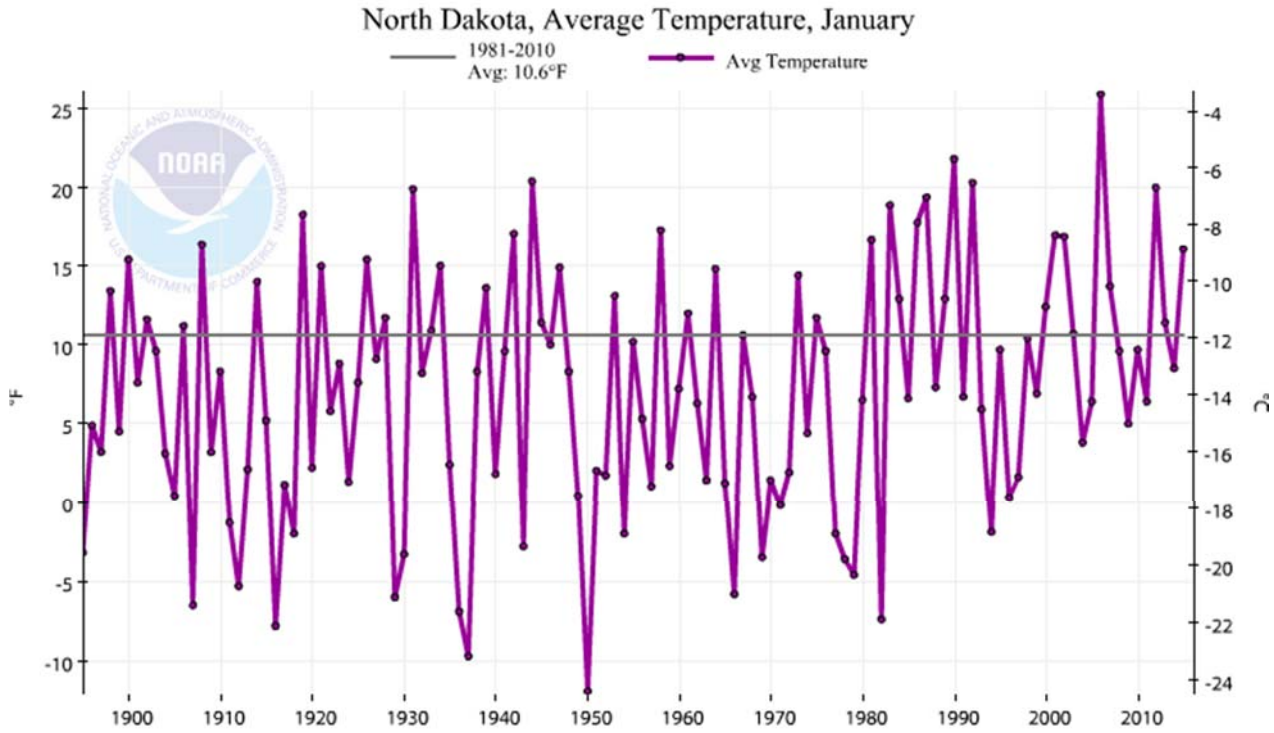


December Temperature Statistics

2014 Average: **18.2** °F
Maximum: 25.4 °F in 1939
State Normal: 14.0 °F (1981-2010)

Monthly Ranking: 30th warmest in 120 years
Minimum: -3.2 °F in 1927
Years in Record: 120

Historical January Temperature for North Dakota

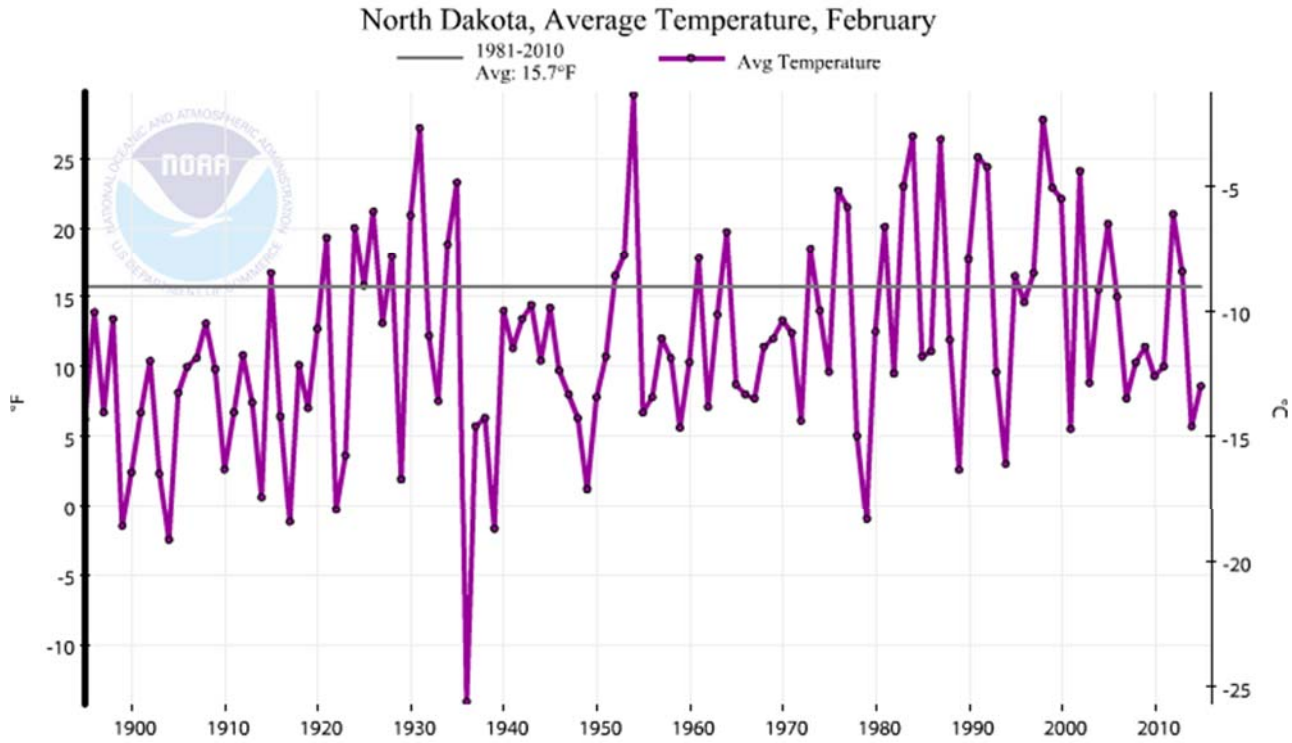


January Temperature Statistics

2015 Average: **16.1** °F
Maximum: 25.9 °F in 2006
State Normal: 10.6 °F (1981-2010)

Monthly Ranking: 17th warmest in 121 years
Minimum: -11.9 °F in 1950
Years in Record: 121

Historical February Temperature for North Dakota

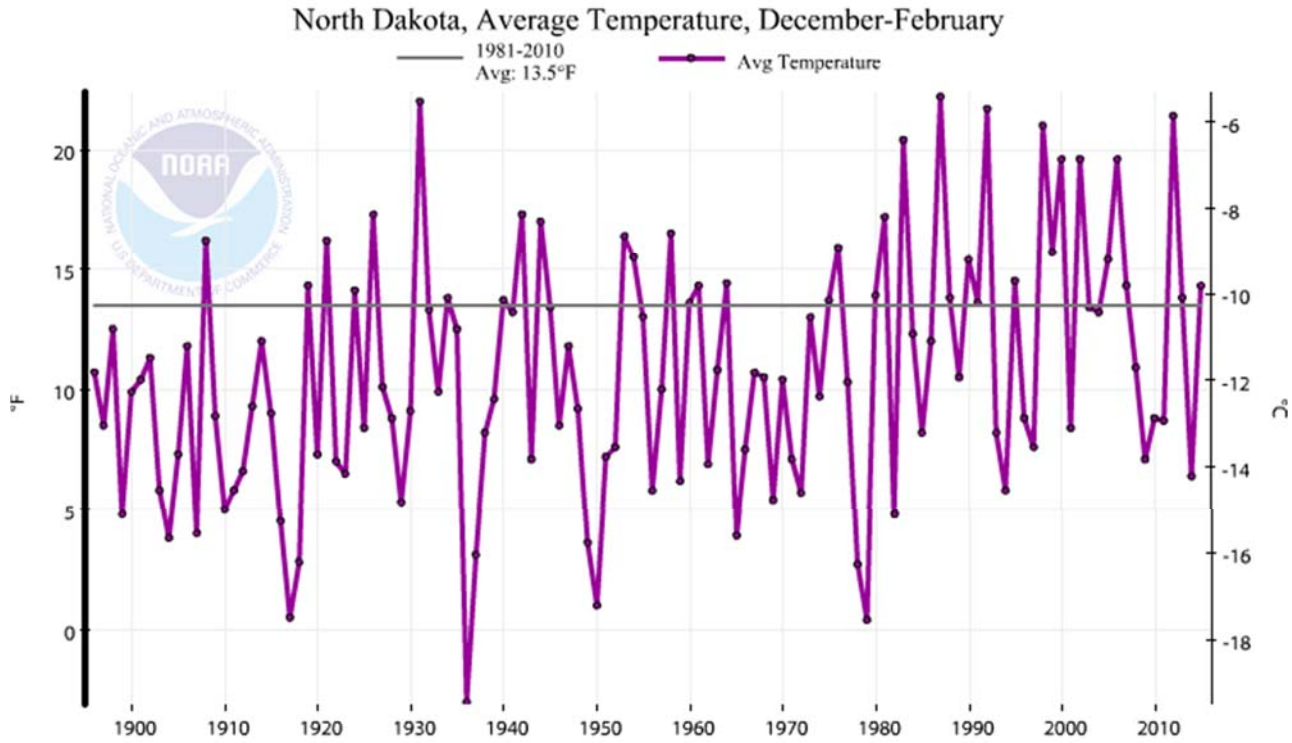


February Temperature Statistics

2015 Average: **8.6 °F**
Maximum: 29.6 °F in 1954
State Normal: 15.7 °F (1981-2010)

Monthly Ranking: 42nd coolest in 121 years
Minimum: -14.1 °F in 1936
Years in Record: 121

Historical Winter Temperature for North Dakota



Autumn Temperature Statistics

2014-2015 Average: **14.3 °F**
Maximum: 22.2 °F in 1986-1987
State Normal: 13.5 °F (1981-2010)

Monthly Ranking: 25th warmest in 120 years
Minimum: -3.0 °F in 1935-1936
Years in Record: 120

Storms & Record Events

North Dakota Record Event Reports for Winter 2014-2015

Date	Location	Type of Record	Previous Record
December 1	Minot	Low Minimum -19 degrees	-10 degrees set in 1985
December 1	Jamestown	Low Minimum -24 degrees	-14 degrees set in 1978
December 1	Bismarck	Low Minimum -18 degrees	-11 degrees set in 1978
December 12	Dickinson	High Maximum 61 degrees	47 degrees set in 2006
December 12	Bismarck	High Maximum 49 degrees	Tied with 49 degrees set in 2002
December 13	Dickinson	High Maximum 60 degrees	56 degrees set in 1998
January 17	Grand Forks	High Maximum 39 degrees	38 degrees set in 1981
January 17	Fargo	High Maximum 39 degrees	Tied with 39 degrees set in 1944
January 20	Bismarck	Rainfall of 0.22 inches	Tied with 0.22 inches set in 1950
January 22	Minot	High Maximum 41 degrees	40 degrees set in 1981
January 23	Grand Forks	High Maximum 44 degrees	42 degrees set in 1981
January 24	Bismarck	Rainfall of 0.24 inches	Tied 0.20 inches set in 1982
January 26	Williston	High Maximum 50 degrees	47 degrees set in 2006
January 26	Dickinson	High Maximum 52 degrees	46 degrees set in 2006
January 26	Bismarck	High Maximum 50 degrees	48 degrees set in 1990
January 27	Williston	High Maximum 53 degrees	47 degrees set in 1931
January 27	Minot	High Maximum 49 degrees	46 degrees set in 2008
January 27	Dickinson	High Maximum 62 degrees	51 degrees set in 2008
January 27	Bismarck	High Maximum 53 degrees	48 degrees set in 2008
February 3	Williston	Rainfall of 0.15 inches	0.13 inches set in 1959
February 10	Grand Forks	Rainfall of 0.23 inches	0.15 inches set in 2009
February 22	Grand Forks	Low Minimum -26 degrees	-19 degrees set in 1966
February 22	Jamestown	Low Minimum -22 degrees	-18 degrees set in 1957

Seasonal Outlook

Spring 2015 Climate Outlooks

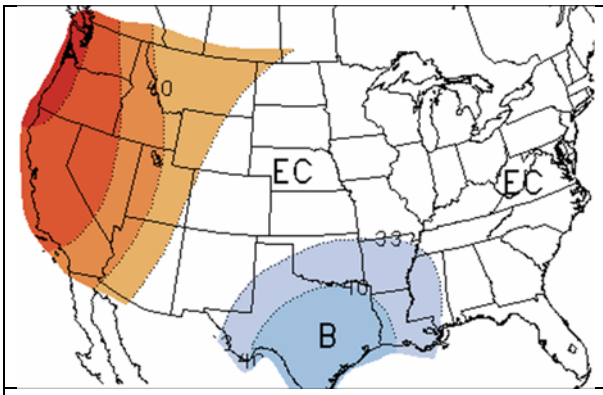
by Rob Kupec[1]

Sea surface data from parts of the Southern Pacific Ocean continue to indicate the presence of a weak El Niño. However the atmosphere has not received that memo, and largely appears as it would when there is no positive or negative El Niño signal. The El Niño pattern typically relates to a mild winter across North Dakota, a characteristic that will often carry into the spring. Currently the Climate Prediction Center (CPC) predicts a 50 to 60 percent chance that a positive El Niño will still develop this spring. This winter's weak El Niño correlated with warmer than normal temperatures for the December, January, February (meteorological winter) time period. Even though the winter finished warmer than average it was with a high degree of variability. February was several degrees below average across the state and there were a few pronounced cold snaps in January.

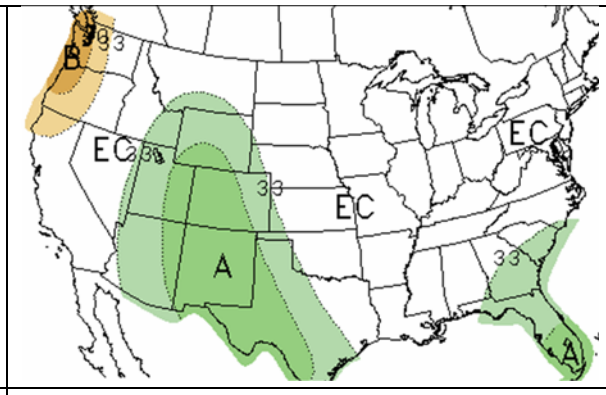
It may be fair to assume that this warmer than average trend, with high variability, will continue into the spring months. The CPC's Spring Outlook gives all but the far northwest corner of North Dakota an equal chance of seeing above or below average temperatures (see figure below). If the lack of snow cover across much of the state continues through March, it would allow temperatures in the early part of spring to be warmer. Even with cold air masses in late February, areas with little or no snow were a few degrees warmer than snow covered areas.

For the most part our dry fall weather continued into the winter across the state. The CPC, as with their Winter Outlook, predicts an equal chance of a dry/wet/average spring (see below). During an El Niño spring, there is a tendency for slightly drier than average conditions across the state in March and April and slightly more precipitation than average in May. The northeast corner is the one exception, where all three months are slightly drier during an El Niño.

The lack of snow this winter following the dry fall also concerns the CPC's drought monitoring forecasters. Their Spring Drought Outlook calls for the drought conditions that exist in the southern Red River Valley to persist or intensify. The remainder of eastern North Dakota will likely see drought development through the period. The next CPC outlook will be out around March 19th and is available at: http://www.cpc.ncep.noaa.gov/products/predictions/90day .



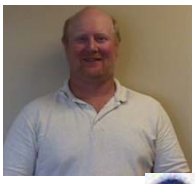
December through FebruaryTemperature Outlook



December through February Precipitation Outlook

[1] The corresponding author: Rob Kupec is Chief Meteorologist - KVRR TV in Fargo, ND. <rkupec@kvrr.com>

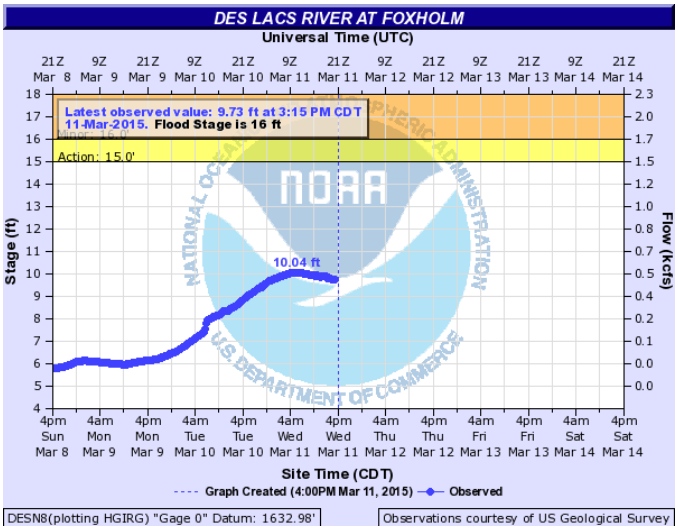
Hydro-Talk

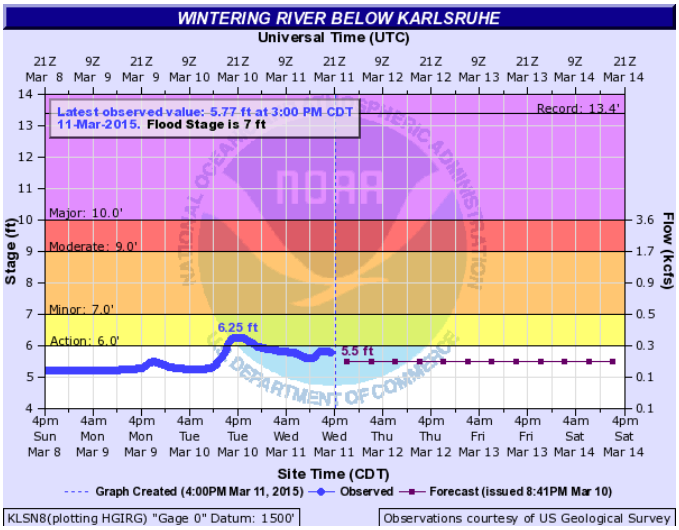


Hydrologic Conditions in Missouri Basin

by A. Schlag[2]

Greetings everyone, here we are in early March and the spring melt season is in full force! Realistically speaking, most of the state is below normal for snowpack and well below the last few years where the state has experienced severe flooding. Accordingly, the region's risk of widespread flooding due to runoff from melting snow is fairly minimal. Similarly, with the lack of strong runoff across much of North Dakota, the risk of ice jam related high water should also be below normal as there simply may not be enough water early on to lift the ice enough to allow it to mobilize. The following two stream flow stage graphics show the river stages on Des Lacs River at Foxholm and on Wintering River below Karlsruhe locations respectively.





Truth be told, there is likely a greater risk of increased drought designations and wild fires across North Dakota as the early melt season exposes last year's vegetation and it begins to dry out.

In short, the snowmelt flood season is upon us and all indications are that it will be quite a modest one at that. However, if recent history is any indicator of the future, there will likely be at least a few flood warnings for minor flooding if we find ourselves with a typical spring rain season.

[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

When Howling Wolves Greet the Northern Lights

by Jan Curtis[3]

North Dakotans are very lucky. Sure, they have to endure extreme heat in the summer and cold in the winter. However, their northern latitude provides them with a unique front row seat to what I consider nature's greatest show: the Northern Lights (a.k.a. the Aurora Borealis). Just think; **most people** have never seen the aurora. In fact, the aurora is rarely seen in the southern hemisphere because there is very little land area that extends into high latitudes where the aurora occurs most frequently. Also, because the earth's northern magnetic pole is located in northern Canada and not at the North Pole, the western hemisphere experiences more northern lights than over Siberia and the eastern hemisphere.

Just what is the aurora? In the simplest terms, it is high-speed particles from the sun that interact with the earth's upper atmosphere in much the same way that old TV screens and computer monitors are lit up when the high-energy beam from a cathode-ray tube hit the inner screen and excites the fluorescent on it to produces an image by a processes known as the photoelectric effect.

Because our upper atmosphere contains mostly oxygen (O & O_2) and nitrogen (N & N_2), when these atoms and molecules get excited from an extra pulse of solar energy, they glow red, green, or a mixture of these colors and will stay lit for a few seconds to a few minutes until a new energy impulse excites the particle again.

Northern light displays can last a few seconds to many hours, depending on whether the sun is experiencing solar storms (as indicated by sun spots) and whether these storms are strong and long lasting. It usually takes 36 to 72 hours for the solar storm particles to reach the earth so space weather forecasters can provide the public with a good degree of warning about when the aurora will be visible (forecasts are available at: s**paceweather.com**). Of course, because the aurora is relatively faint, it can only be seen at night (when the sun is 12 degrees below the horizon or more) but is bright enough to be seen in full moonlight. In fact, the aurora can often cast shadows that shimmer as it moves very quickly across the sky. If there is snow on the ground, the snow can even turn to a bright green color! Quite often in Alaska, I have heard dogs, wolves, and coyote start howling at these lights when they get this bright.

The aurora becomes visible in the east, usually around 10PM as a faint **band (**http://latitude64photos.com/types/structure/homo_bands/band.html**)** near the horizon. During the next hour, it slowly rises higher in the sky and starts to take on the form of vertical **rays** (http://latitude64photos.com/types/structure/rayed_bands/rayed_bands.html**)** and **arcs** (http://latitude64photos.com/types/structure/arcs/arc.html**)** and **curtain (**http://latitude64photos.com/types/structure/curtains/curtains.html**)** shapes that appear to move like the wind on one's window drapes.

Around midnight, if the aurora is intense, a short-lived formation known as a corona (or crown) **(**http://latitude64photos.com/types/structure/corona/corona.html**)** forms nearly overhead and signals the near end of the display.

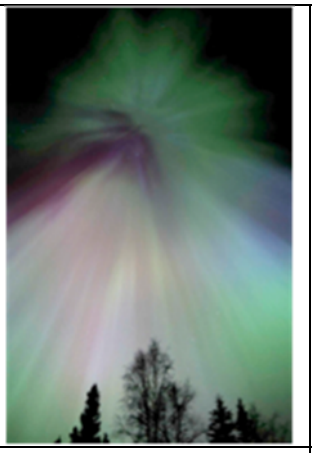
Suddenly, the aurora quiets down and is seen as a **faint diffuse glow** that covers much of the sky. This glow is often seen to pulse slowly or flicker rapidly. However, if the solar storm persists, this entire cycle of forms can repeat two or three more times before dawn breaks. My experience while viewing in central Alaska is that intense aurora forecasts are accurate about a third of the time. For the Lower-48, the

[3]The corresponding author: Jan Curtis: jancurtis.nl@gmail.com.

forecast prediction falls to about 10 percent. Still, sometimes the aurora occurs without being forecasted because the earth's magnetic field changes without warning. As more sensors are deployed into space, such as the Deep Space Climate Observatory (http://www.nesdis.noaa.gov/DSCOVR/), the more accurate the forecasts will become.

Taking Photos

If you want to capture these fascinating lights with your camera, there are a few techniques to consider. You will need a digital single lens reflex camera (dSLR) like a Nikon or Canon that allows for interchangeable lenses. A wide-angle lens (e.g. 24mm or 35mm) is best to use because it covers a lot of sky where the aurora usually resides. Since time exposures range from a few seconds up to 30 seconds; depending on the brightness and speed of the aurora across the sky, you will need a tripod. An ISO setting at 800 to 1250 is sensitive enough to allow for short exposures. Longer exposures with fast moving aurora will blur and result in lost structural details. Since aurora occurs in winter, temperatures below freezing require that your camera be heated (I use a heating pad around the camera). Prolonged extreme cold can permanently damage your camera's CCD sensor as I learned the hard way. Since every aurora display is different, it is best to take lots of shots in rapid succession. If your camera can take interval (time lapse) exposures, you can produce a sequence movie clip that reveals the subtle changes of the aurora over short periods. There are great examples of this on the internet such as: http://vimeo.com/56433821

			
An Example of Bands Formation	An Example of Rayed Arcs Formation	An Example of a Curtain Formation	An Example of Multicolor Corona Formation

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Please contact us if you have any inquiries, comments, or would like to know how to contribute to this quarterly bulletin.

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