North Dakota Climate Bulletin

Summer 2014

Volume: 8 No: 3

In This Issue

NDSCO

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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 summer was the 36th coldest on record in ND and it was the 9th wettest statewide since 1895. Statewide, the colder than normal streak continued with the past 11 months in a row being below average. September 2013 was the last month to record an above average temperature. Colder than normal conditions slowed crop development. Late planting in spring due to the wet conditions exacerbated the already heightened concern among producers. As we get into the harvest season, we wish for warmer and dryer weather. The only parts of the state that was dryer than normal throughout summer was the Devils Lake Basin which helped lake stages decline coupled with evaporative loss. Will El Niño bring warmer temperatures in late fall and winter? More on the seasonal weather and hydrological outlooks as well as graphical displays of statewide temperature, precipitation and the other weather highlights in each month can be found later in this issue.

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

NDAWN Station in Sabin, MN. By Ritchison

Weather Highlights

Seasonal Summary:

by Daryl Ritchison

June 2014

The state average precipitation was 4.73 inches which is above the 1981-2010 normal of 3.34 inches. June 2014 state average precipitation ranked as the 19th wettest in the last 120 years with a maximum of 7.01 inches in 2005 and a minimum of 1.11 inches in 1974.

The US Drought Monitor July 1, 2014 report had no drought conditions reported for North Dakota. (http://droughtmonitor.unl.edu/)

The USDA, National Agricultural Statistics Service, North Dakota Field Office reported a topsoil moisture of 0% very short, 2% short, 64% adequate, and 34% surplus with a subsoil moisture reported as 0% very short, 1% short, 69% adequate, and 30% surplus. (Weekly Weather and Crop Bulletin Vol. 101, No. 26).

According to the preliminary reports of the National Weather Service's Storm Prediction Center (SPC), severe weather reports for June had 15 reports of high wind, 27 hail reports, and 9 reported tornadoes.

The top five June daily maximum wind speeds recorded from NDAWN were Baker with 55.5 mph, Michigan with 54.8 mph, Turtle Lake with 50.5 mph, Minot with 49.8 mph and Oakes with 49.0 mph. NDAWN wind speeds are measured at a height of 10 feet (3 m).

The state average air temperature was 62.5 °F which is below the 1981-2010 normal of 63.3 °F. June 2014 state average air temperature was the 58th coolest in the past 120 years with a maximum of 74.1 °F in 1988 and a minimum of 56.8 °F in 1915.

NDAWN's highest recorded daily air temperature for June was 91.5 °F at Britton, SD on the 21st. The lowest recorded daily air temperature was 35.1 °F at Plaza, ND, on the 12th.

July 2014

The state average precipitation was 1.56 inches which is below the 1981-2010 normal state average of 2.87 inches. July 2014 state average precipitation ranked the 16th driest in the past 120 years with a maximum of 3.86 inches in 1958 and a minimum of 1.79 inches in 1930.

The National Weather Service (NWS) reported record rainfall of 2.79 inches at the Grand Forks Airport on the 21st, and a record rainfall of 2.71 at the National Weather Service office (UND) of 2.71 on the 21st as well. A complete list of record events can be found in the "Storms and Record Events" section later in this bulletin.

The US Drought Monitor July 29, 2014 reported less than 1% of North Dakota in Abnormally Dry Conditions (D0) with no areas in Moderate or above drought conditions. (http://droughtmonitor.unl.edu/).

The USDA, National Agricultural Statistics Service, North Dakota Field Office reported a topsoil moisture of 1% very short, 11% short, 75% adequate, and 13% surplus with a subsoil moisture reported as 1% very short, 6% short, 79% adequate, and 14% surplus. (Weekly Weather and Crop Bulletin Vol. 101, No. 30).

According to the preliminary reports of the National Weather Service's Storm Prediction Center (SPC), severe weather reports for July had 71 reports of high wind, 44 hail reports, and 5 reported tornadoes.

The top five April daily maximum wind speeds recorded from NDAWN were 54.8 mph on the 23rd at Linton, 54.4 mph on the 27th at Britton, SD, 53.7 mph on the 26th at Britton, SD, 53.7 mph on the 19th at Leonard and 53.3 mph on the 9th at Hettinger. NDAWN wind speeds are measured at a height of 10 feet (3 m).

The state average air temperature was 66.8 °F which is below the 1981-2010 normal of 69.1 °F. July 2014 state average air temperature ranked the 25th coolest in the past 120 years with a maximum of 80.1 °F in 1936 and a minimum of 61.8 °F in 1992.

The National Weather Service (NWS) reported a record daily low maximum temperature of 68 degrees at Jamestown. That tied the old record of 68 degrees set in 1937. A complete list of record events can be found in the "Storms and Record Events" section later in this bulletin.

NDAWN's highest recorded daily air temperature for April was 96.0 °F at Marion, ND on the 5th. The lowest recorded daily air temperature was 38 °F at Hazen, ND on the 2nd.

August 2014

The state average precipitation was 4.32 inches which is well above the 1981-2010 normal of 2.12 inches. August 2014 state average precipitation ranked as the 4th wettest with 120 years of records with a maximum of 5.96 inches in 1927 and a minimum of 0.23 inches in 1905.

The National Weather Service (NWS) reported record rainfall of 1.15 inches at the Grand Forks Int'l Airport and 1.83 inches at the National Weather Service (UND) in Grand Forks on August 3 with the previous record being 0.98 inches in 1981 for the Grand Forks Airport and for the UND site the old record was 1.48 inches also previously set in 1981. The Dickinson airport recorded a record daily rainfall on August 3 with 0.42 inches being recorded. That broke the previous record of 0.38 inches set in 2013. The Dickinson airport set a daily maximum rainfall record on August 4 with 1.28 inches being recorded. This surpassed the previous record of 0.59 inches set in 1981. The Dickinson Airport set a new daily rainfall record of 1.85 inches on August 15, the previous record was 0.87 inches in 1981. With several daily rainfall records being broken at the Dickinson Airport, it is no surprise that the Dickinson airport recorded a total of 6.79 inches of rain in August which smashed the previous August month record precipitation of 5.55 inches set in 1954. A complete list of record events can be found in the "Storms and Record Events" section later in this bulletin.

The US Drought Monitor August 26, 2014 report had no drought conditions listed for the state (http://droughtmonitor.unl.edu/).

The USDA, National Agricultural Statistics Service, North Dakota Field Office reported a topsoil moisture of 0% very short, 4% short, 76% adequate, and 20% surplus with a subsoil

moisture reported as 0% very short, 4% short, 82% adequate, and 14% surplus. (Weekly Weather and Crop Bulletin Vol. 101, No. 35).

According to the preliminary reports of the National Weather Service's Storm Prediction Center (SPC), severe weather reports for August had 9 reports of high wind, 8 hail reports, and No reported tornadoes.

The top five August daily maximum wind speeds recorded from NDAWN were from Mott on the 20th with 48.0 mph, McHenry on the 17th with 47.6 mph, Linton on the 17th with 39.7 mph, Dazey on the 18th with 39.6 mph and Jamestown on the 16th with 37.2 mph. NDAWN wind speeds are measured at a height of 10 feet (3 m).

The state average air temperature was 67.0 °F which is slightly below the 1981-2010 average of 67.6 °F. That would place August 2014 state average as the 59th warmest in the past 120 years with a maximum of 73.8 °F in 1983 and a minimum of 61.2 °F in 1977.

NDAWN's highest recorded daily air temperature for August was 95.5 °F at Sidney, MT on the 12th. The lowest recorded daily air temperature was 38.4 °F at Harvey, ND, on the 30th.

Summer 2014

Using analysis from the National Climatic Data Center (NCDC), the average North Dakota precipitation for the summer season (June 1 through August 31) was 10.61 inches which is 2.31 inches above average. That would rank the summer of 2014 as the 9th wettest summer since such records began in 1895. The summer was especially wet in the southwestern and north central portions of North Dakota.

According to statistics compiled by the NCDC the three southwestern climate zones of North Dakota all experienced the wettest August of record. Many locations in that part of the state exceeded the previous August record by over one inch. Much of that excess rain came in the form of two thunderstorm complexes that dumped in excess of three inches in several locations in southwestern North Dakota.

Not only was it a wet summer for many area across the state it was also a cool summer. There were each month at least a small portion of the state that recorded average or above average temperatures, but taken as a whole, all three summer months finished below the current 30 year average. The North Dakota summer 2014 average temperature was 65.4 degrees, which is 1.3 degrees below average. That would rank as the 36th coldest summer of record.

Season in Graphics

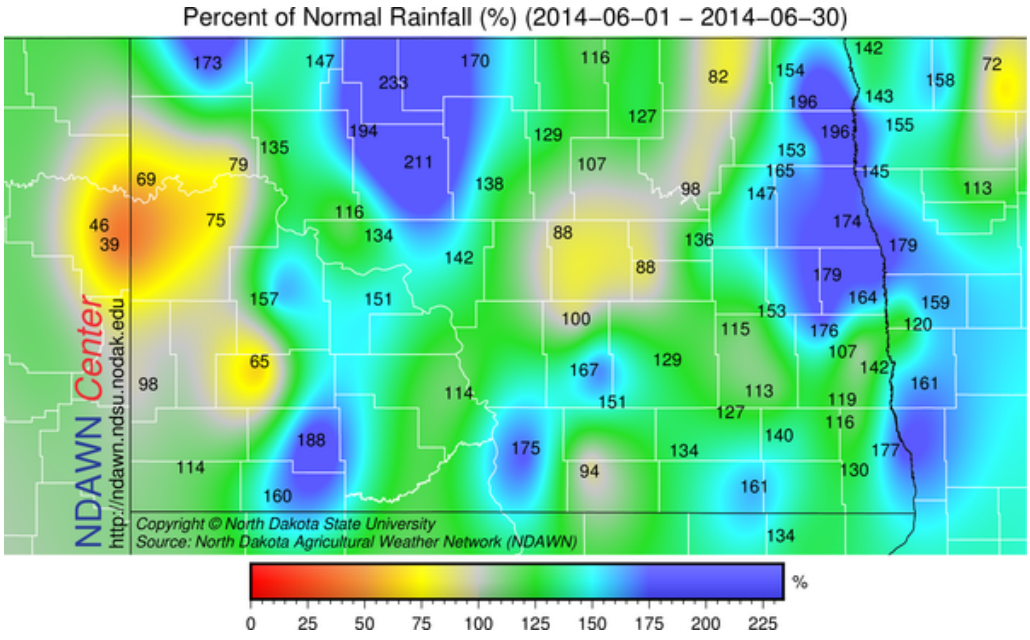
Summer 2014 Weather in North Dakota:

June 2014

Total Precipitation percent of mean (1981-2010)

Precipitation Percent of Normal

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

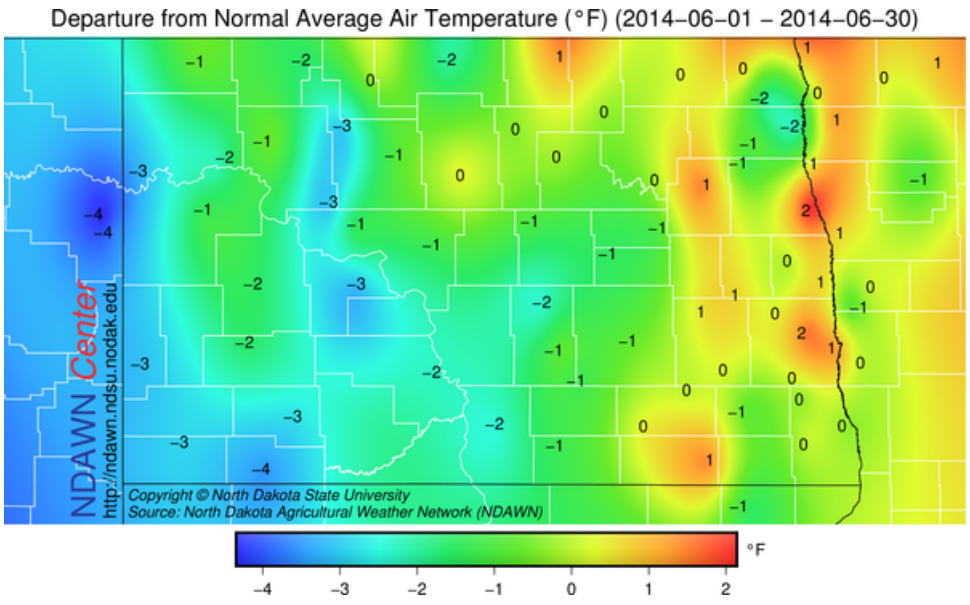


North Dakota State Climate Office

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

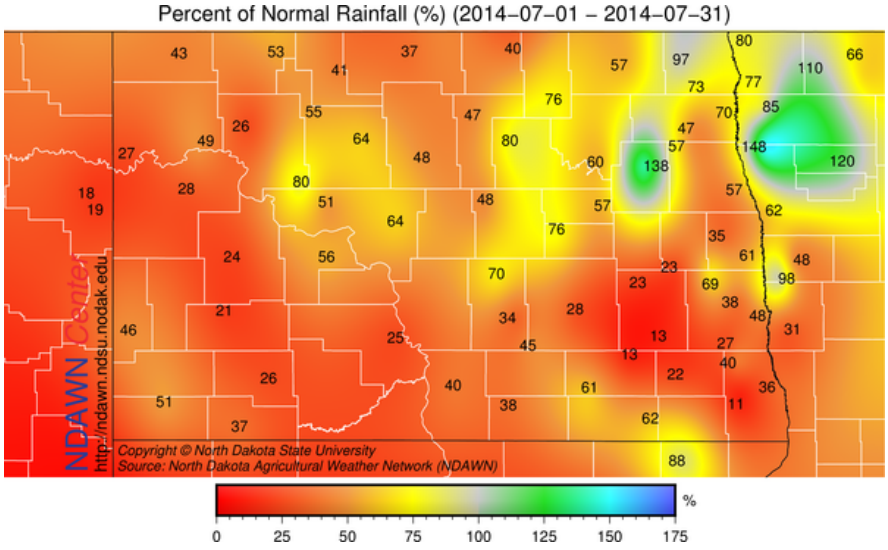
July 2014

Summer 2014 Weather in North Dakota:

Total Precipitation percent of mean (1981-2010)

Precipitation Percent of Normal

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



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Departure From Normal Monthly
Average Air Temperature in degrees F

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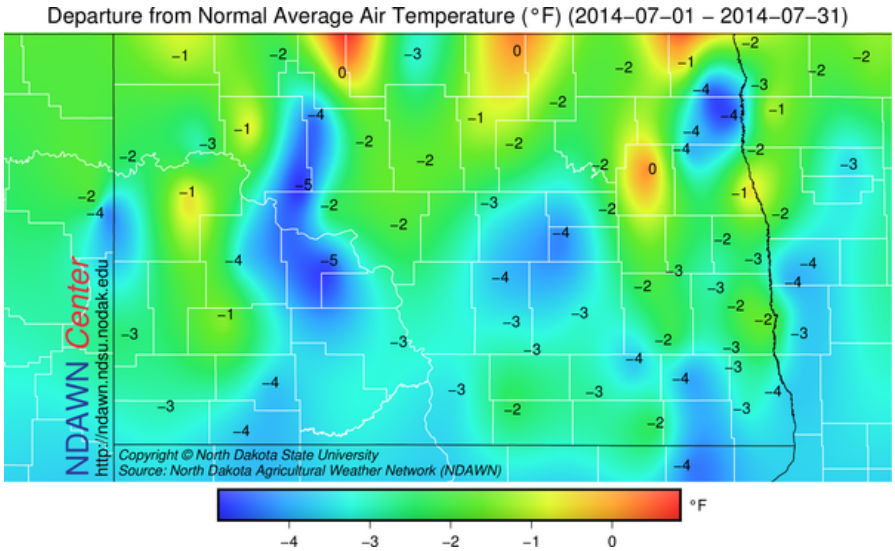


North Dakota State Climate Office

Season in Graphics

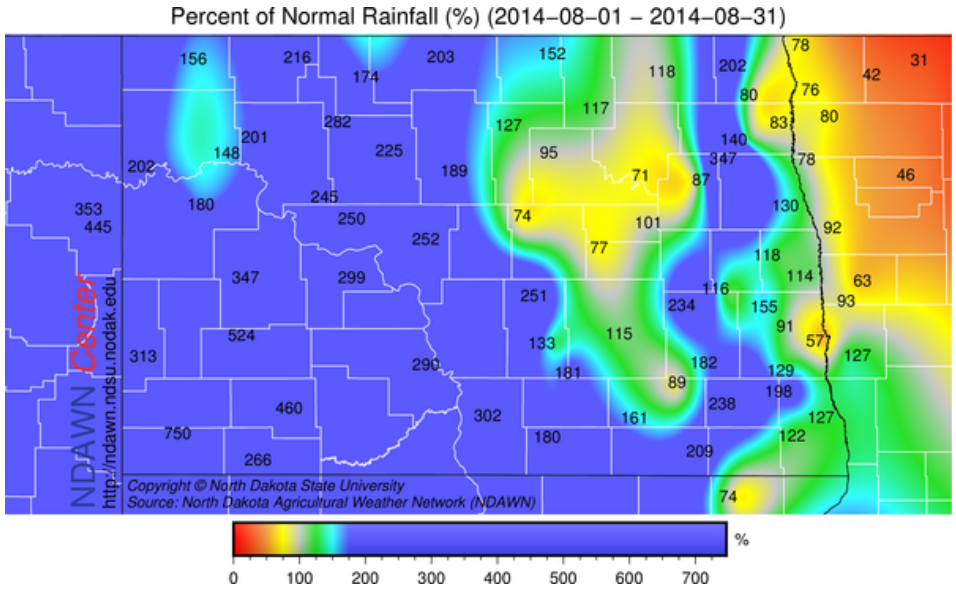
August 2014

Summer 2014 Weather in North Dakota:

Total Precipitation percent of mean (1981-2010)

Precipitation Percent of Normal

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



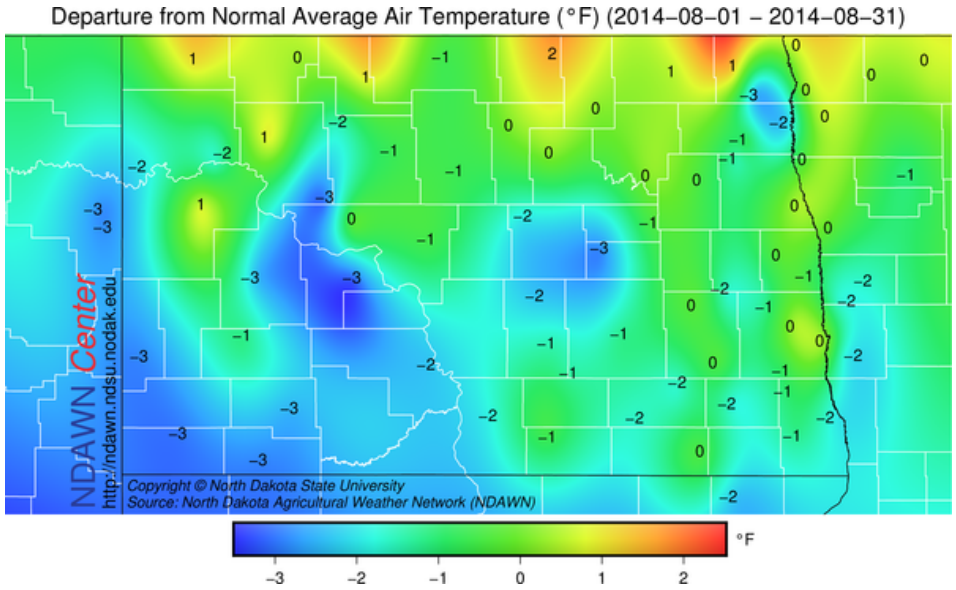
North Dakota State Climate Office

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

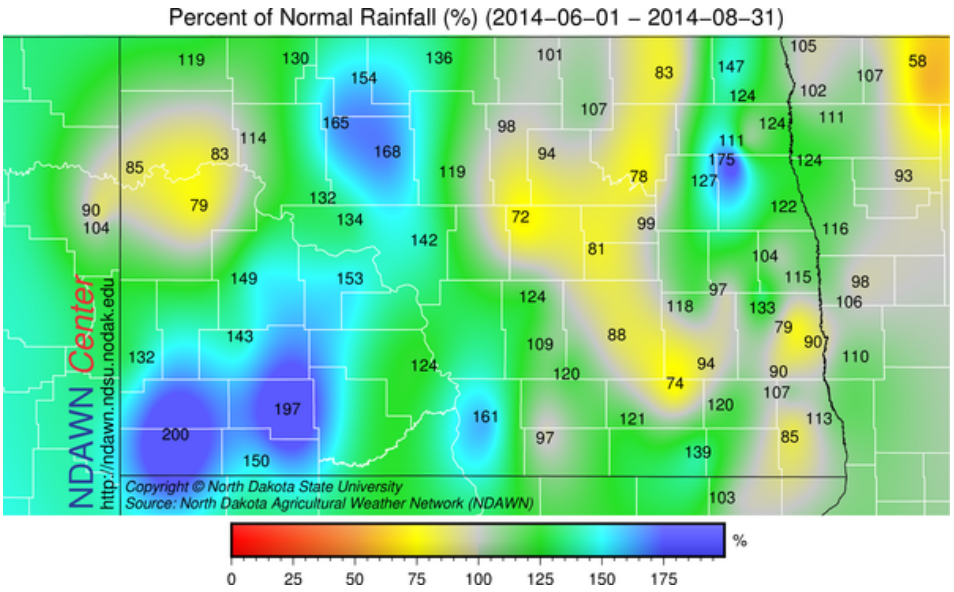
Summer 2014

Summer 2014 Weather in North Dakota:

Total Precipitation percent of mean (1981-2010)

Precipitation Percent of Normal

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



North Dakota State Climate Office

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

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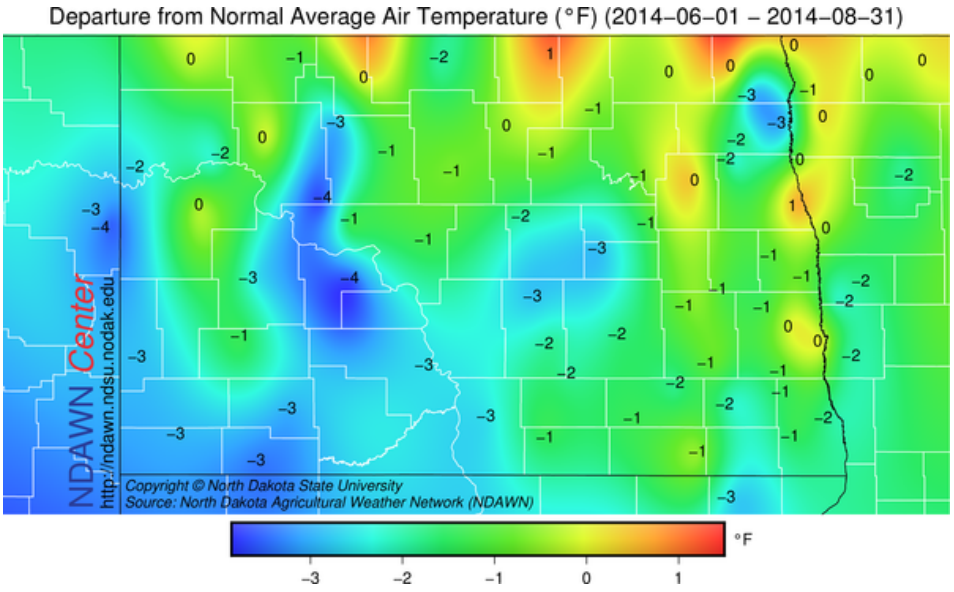
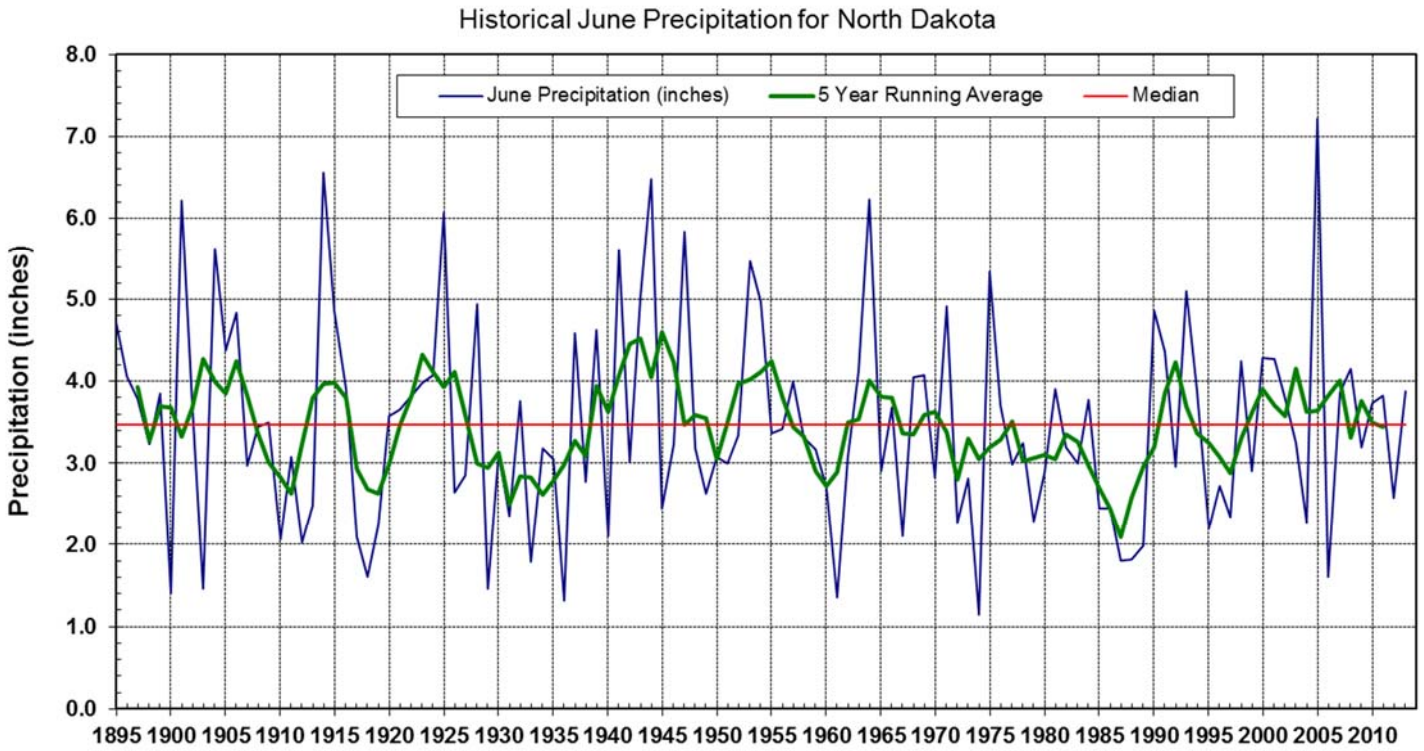
Average Air Temperature in degrees F

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



North Dakota State Climate Office

Historical June Precipitation for North Dakota

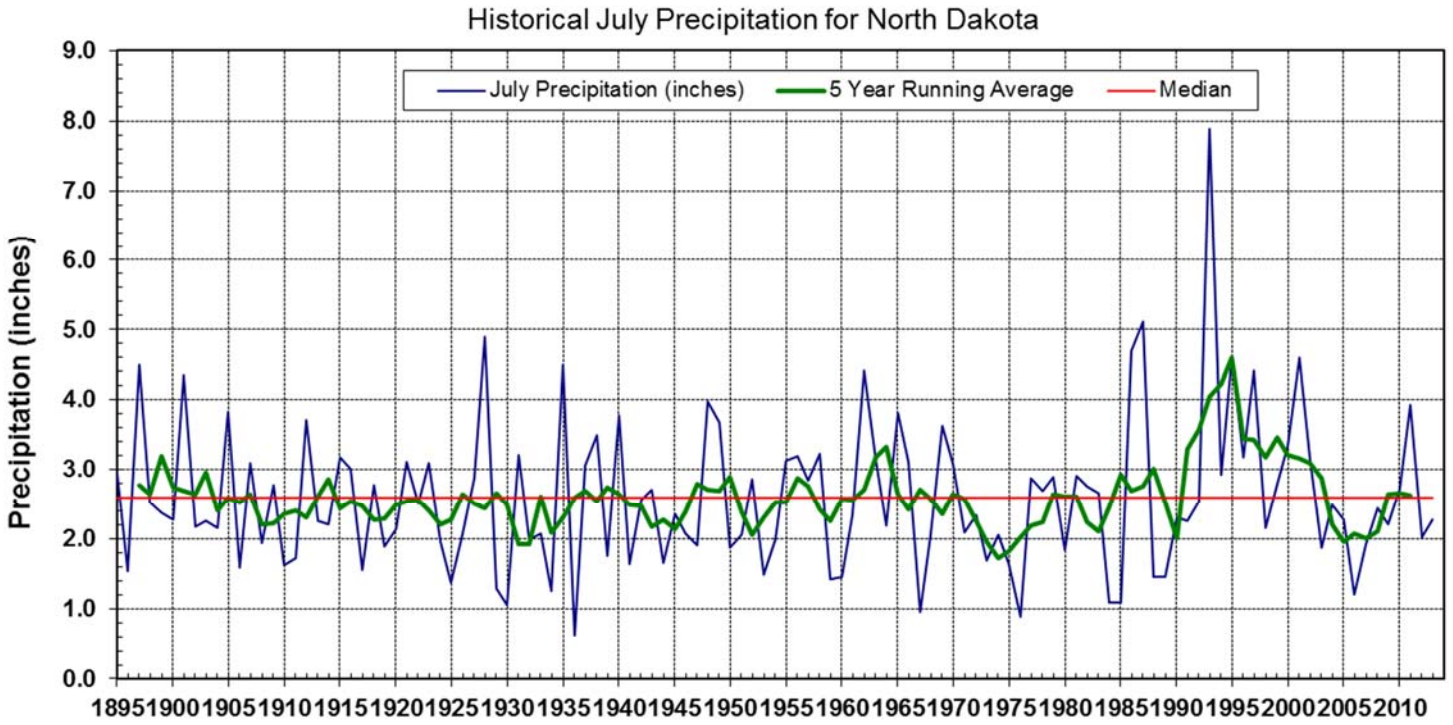


June Precipitation Statistics

2014 Amount: **4.73 inches**
Maximum: 7.01 inches in 2005
State Normal: 3.34” (1981-2010)

Monthly Ranking: 19th wettest in 120 years
Minimum: 1.11 inches in 1974
Years in Record: 120

Historical July Precipitation for North Dakota

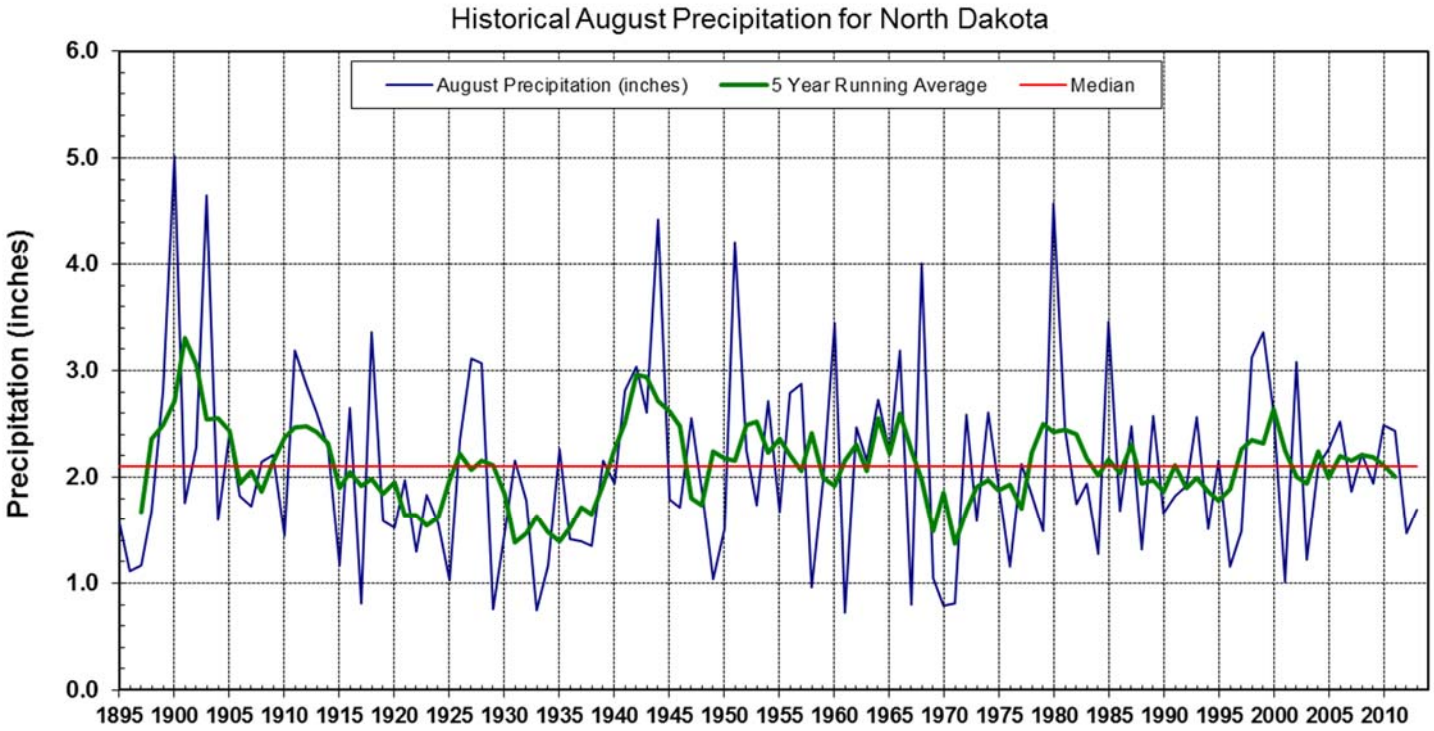


July Precipitation Statistics

2014 Amount: **1.56 inches**
Maximum: 7.97 inches in 1993
State Normal: 2.87” (1981-2010)

Monthly Ranking: 16th driest in 120 years
Minimum: 0.64 inches in 1936
Years in Record: 120

Historical August Precipitation for North Dakota

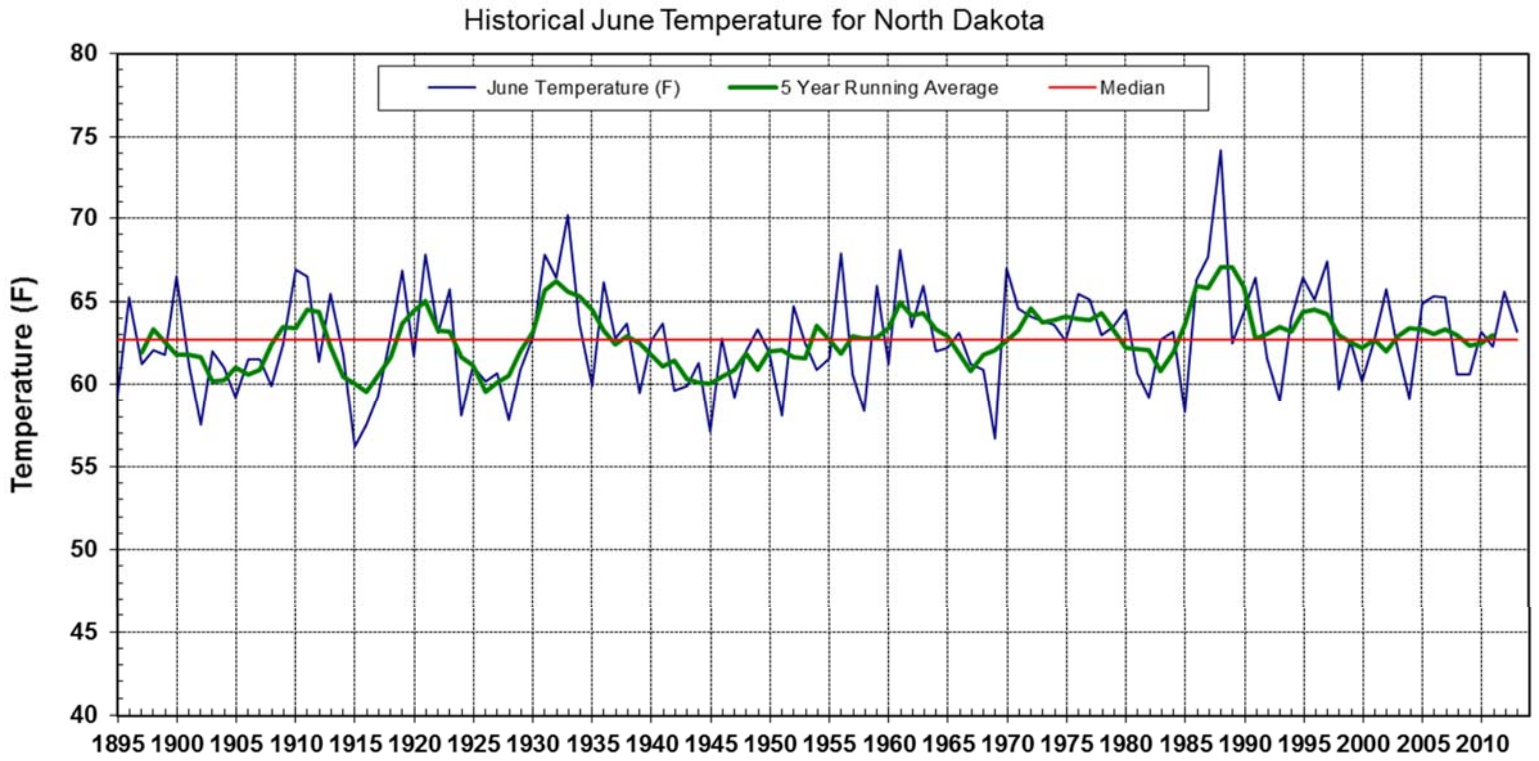


August Precipitation Statistics

2014 Amount: 4.32 inches
Maximum: 4.54 inches in 1900
State Normal: 2.12” (1981-2010)

Monthly Ranking: 4th wettest in 120 years
Minimum: 0.73 inches in 1929, 1933
Years in Record: 120

Historical June Temperature for North Dakota

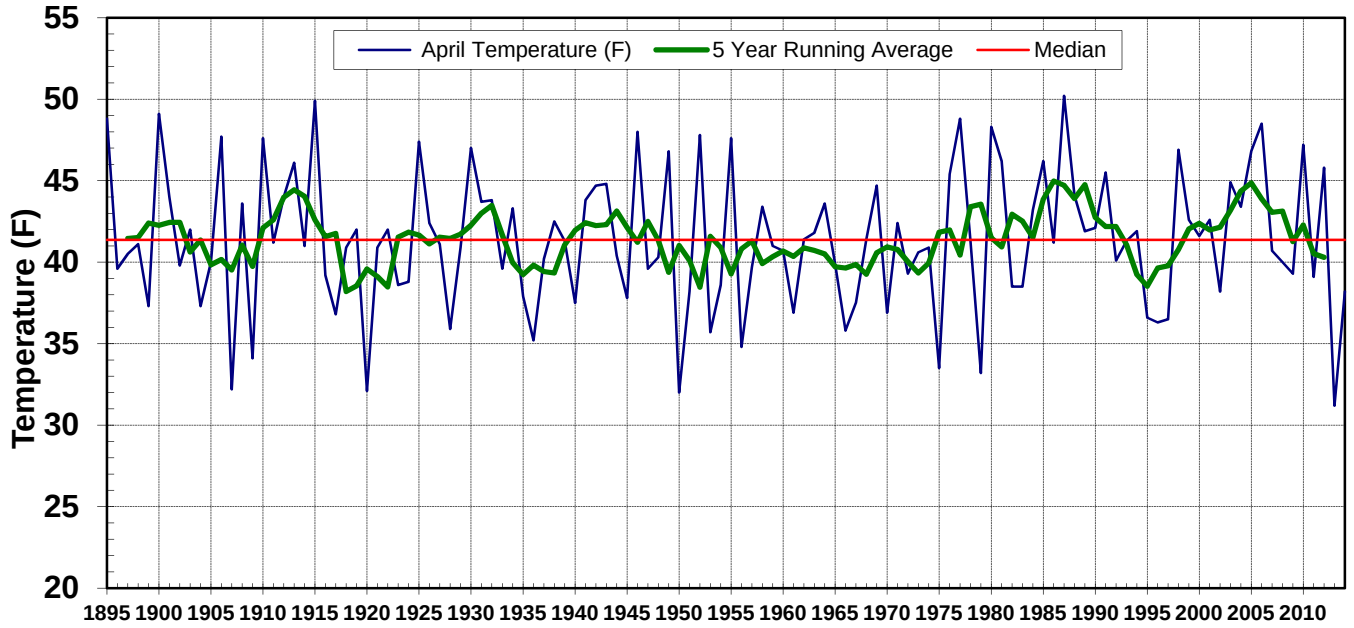


June Temperature Statistics

2014 Average: **62.5** °F
Maximum: 74.1 °F in 1988
State Normal: 63.3 °F (1981-2010)

Monthly Ranking: 58th Coolest in 120 years
Minimum: 56.8 °F in 1915
Years in Record: 120

Historical July Temperature for North Dakota

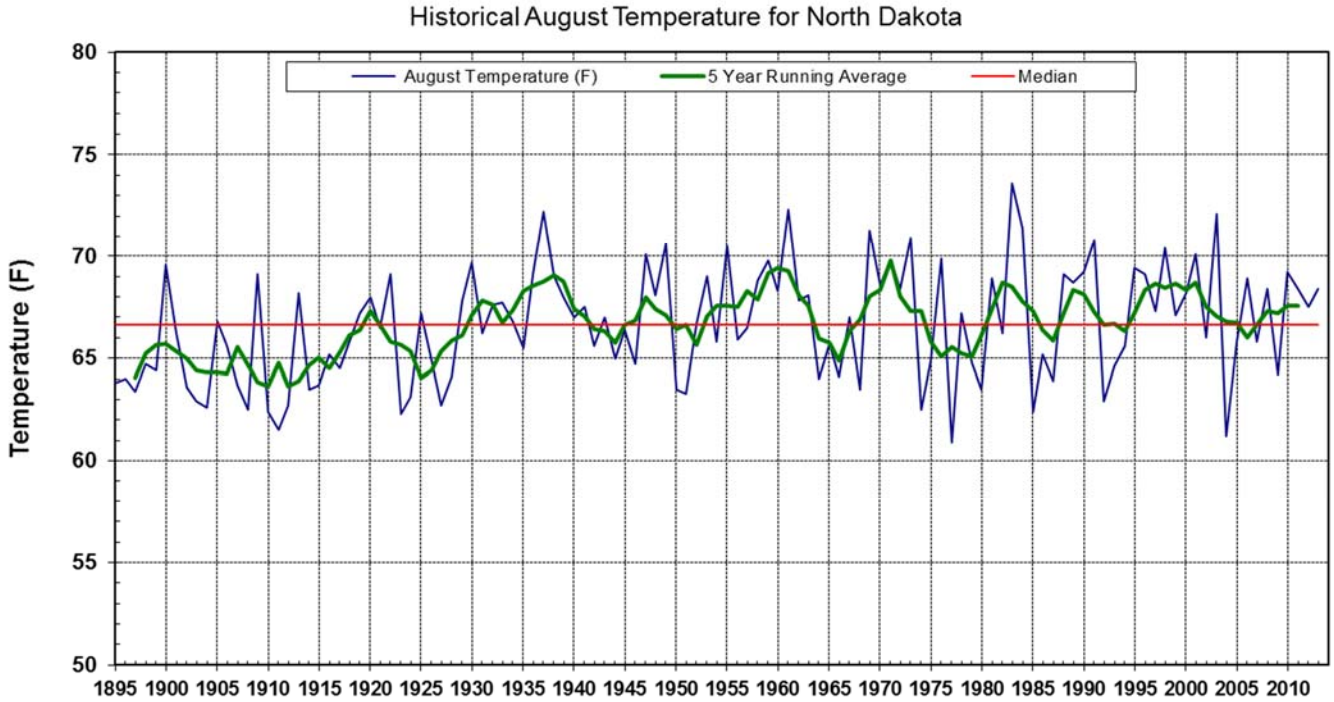


July Temperature Statistics

2014 Average: **66.8** °F
Maximum: 80.1 °F in 1936
State Normal: 69.1 °F (1981-2010)

Monthly Ranking: 25th Coolest in 120 years
Minimum: 61.8 °F in 1992
Years in Record: 120

Historical August Temperature for North Dakota



August Temperature Statistics

2014 Average: **67.0 °F**
Maximum: 73.8 °F in 1983
State Normal: 67.6 °F (1981-2010)

Monthly Ranking: 59th coolest in 120 years
Minimum: 61.2 °F in 1977
Years in Record: 120

Storms & Record Events

State Tornado, Hail, and Wind Reports for Summer 2014

by D. Ritchison

North Dakota 3 Month Total	Wind	Hail	Tornado
	95	81	14

Reports by Month			
Month	**Wind**	**Hail**	**Tornado**
Total June	15	29	9
Total July	71	44	5
Total August	9	8	0

North Dakota Record Event Reports for Summer 2014

Date	Location	Type of Record	Previous Record
June 3	Grand Forks	Rainfall of 1.52	1.14 set in 1965
June 18	Jamestown	Rainfall 2.45 inches	2.01 inches set in 1964
June 19	Grand Forks	Rainfall 1.57 inches	1.16 inches set in1994
June 28	Minot	Rainfall 2.67 inches	2.14 inches set in 1952
July 14	Jamestown	Low Maximum of 68 degrees	Tie with 68 degrees in 1937
July 22	Grand Forks (UND)	Rainfall 2.71	2.03 set in 1966
August 3	Dickinson	Rainfall of 0.42 inches	0.38 inches set in 2013
August 4	Dickinson	Rainfall of 1.28 inches	0.59 inches set in 1981
August 15	Dickinson	Rainfall of 1.85 inches	0.87 inches set in 1981
August 24	Grand Forks	Rainfall 1.15 inches	0.98 inches in 1981
August 24	Grand Forks (UND)	Rainfall 1.83 inches	1.48 inches in 1981
August	Dickinson	Monthly Rainfall 6.79 inches	5.55 inches in 1954

Seasonal Outlook

Fall 2014 Climate Outlooks: El Niño or El Nana?

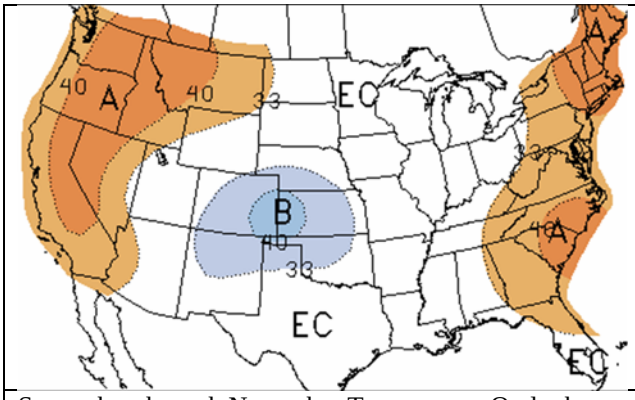
by . M. Ewens[1]

The Climate Prediction Center (CPC) continues to monitor the progress of a gradual warming in the Equatorial Pacific. This warming may herald an El Niño, which typically results in warmer and somewhat less snowy winters for our region. However, there have been inconsistencies in the Ocean /Atmosphere signals that support a definite El Niño.

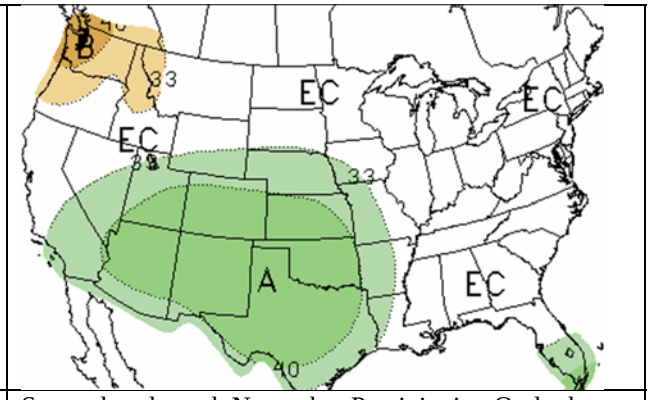
As a result the CPC has assigned "Equal Chances" (EC) for both the temperature and precipitation outlook for the September – November period (See the figures below). Looking farther into the future, the CPC assumes that a weak El Niño will form by the Boreal Winter, resulting in an increased likelihood of warmer than median temperatures this winter. The EC nomenclature has been assigned to the precipitation forecast, as the signal is particularly weak when El Niño does not reach the moderate or strong category.

The CPC will continue to monitor the Pacific and updates to the seasonal outlooks will reflect changes as they occur. For now the best scientific assessment is a weak El Niño, resulting in a predominance of warmer than median weather this upcoming winter. That would be a welcome relief for many as the past few winters have been quite cold!

The latest outlook from the Climate Prediction Center (CPC) for the next three months can be seen below. The CPC is forecasting equal chances of above, below or normal precipitation a slightly higher than average chance of below normal temperatures. You can find their current and future outlooks at http://www.cpc.ncep.noaa.gov/products/predictions/90day.



September through November Temperature Outlook



September through November Precipitation Outlook

Also, the North Dakota State Climate Office has links to the National Weather Service's local 3-month temperature outlooks for the upcoming year. Those forecasts can be found at: http://www.ndsu.edu/ndsco/outlook/L3MTO.html . The readers will also 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 at the NOAA's National Weather Service, Weather Forecast Office in Grand Forks, ND. E-Mail: Mark.Ewens@noaa.gov.

Hydro-Talk

Hydrologic Outlook

by A. Schlag[2]

As the summer winds down and we enter fall, now is a good time to reflect on the hydrologic summer across North Dakota. In general, it has been relatively cooler than normal with normal to above normal moisture across most of the state. This has kept soil moisture levels above normal during the summer for most of the state and brings us into early fall with something above normal soil moisture even as the growing season begins to wind down. This is generally a primer for next year's flood spring flood season, but for now there remains more than enough time for soil moisture levels to fall back to more normal conditions prior to the onset of frozen ground in late November or early December.

So let's look forward into what is generally being advertised about the upcoming fall and winter. An El Niño watch has been issued by the Climate Prediction Center as conditions are favorable for a weak El Niño. The effect of an El Niño across North Dakota can be observed in the generalized graphic below.

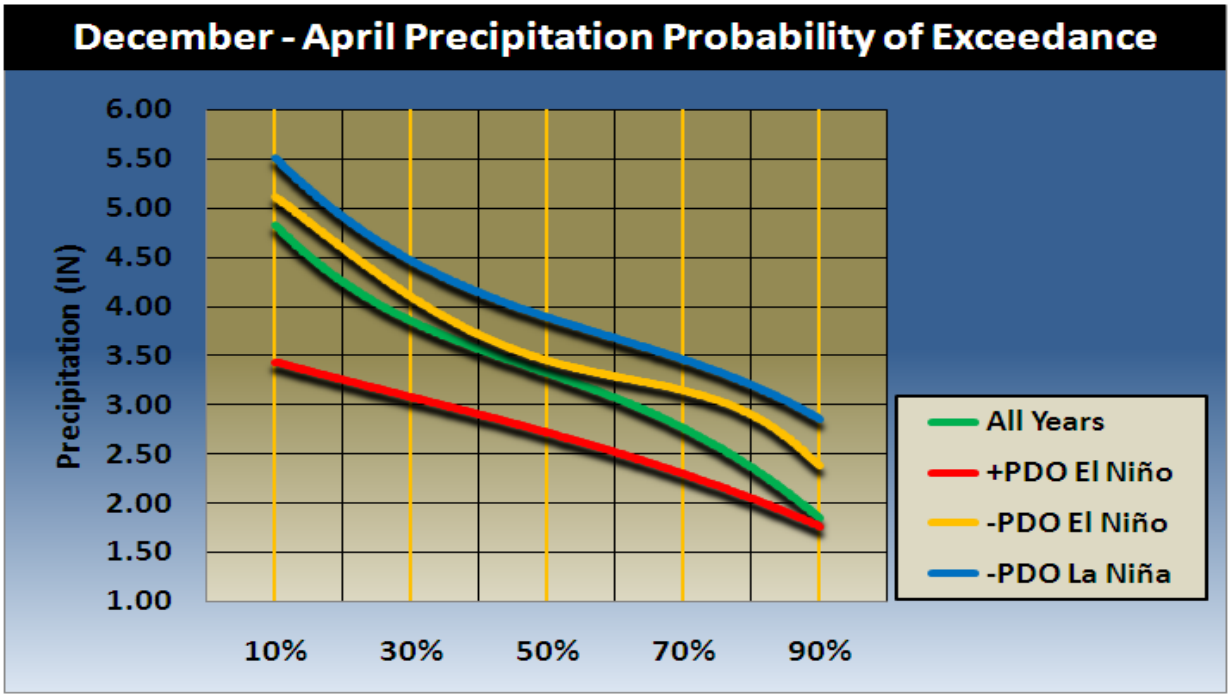


Figure 1 Bismarck, ND December-April Precipitation Probability of Exceedance for Various ENSO/PDO Conditions

While the data for the above graphic is specific to Bismarck, nearly identical trends were observed at all sites analyzed where there's a 50% probability for almost 3.5 inches of moisture during a –PDO and El Niño combination, and a 10% probability for just over 5 inches of

[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

moisture during these events. As is apparent in the graphic, El Niño winters tend to be on the drier side, with the state of the Pacific Decadal Oscillation being just one more key climate driver in our area. Note: the PDO signal is currently defined as negative (-).

Similarly, one can also look at the probability of exceedance for streamflow at various points across the state. In the below example, we note that the Souris (Mouse) River near Minot tends to have its greatest peak flows during a –PDO and La Niña year, while the El Niño years fall well below and into the more "normal" category.

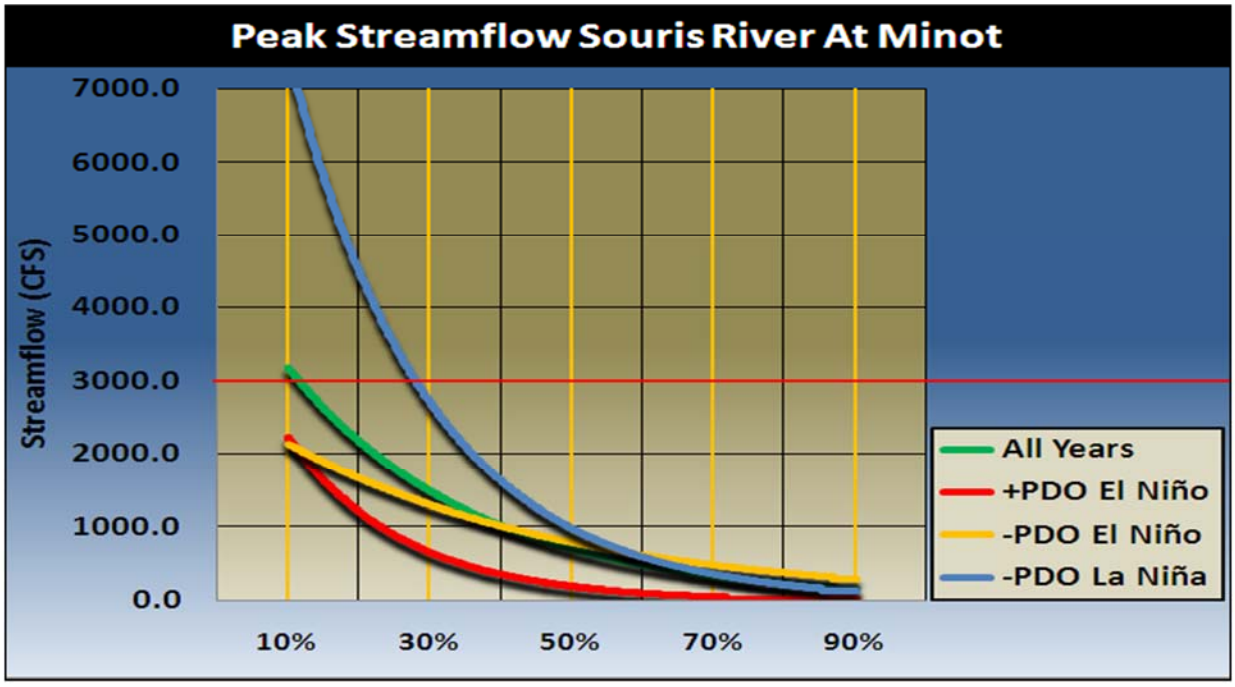


Figure 2 Peak Streamflow at Souris River, Minot for Various ENSO/PDO Conditions.

Clearly, all of this is just a statistical look at previous years where things are much clearer in hindsight, but the trends are remarkable. So if the prospect of an El Niño winter does indeed come to fruition, history would suggest a relatively good chance of an unremarkable spring flood season in 2015. Then again, there are still those few outliers in the data to which we have not yet discovered why they don't fit into this otherwise neat little statistical description of long-term flood risk probabilities.

Science Bits

How Does the NWS Issue Radar-Indicated Tornado Warnings

by Greg Gust[3]

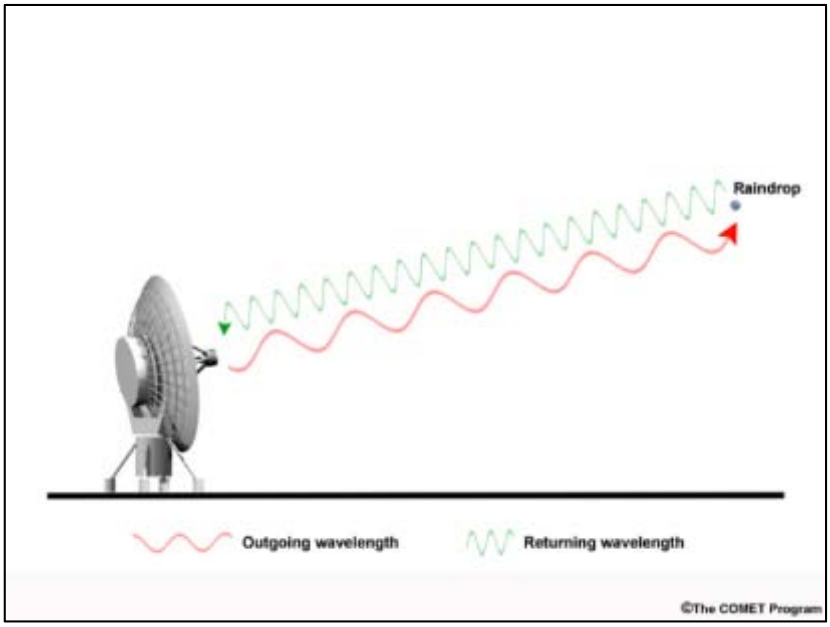
Under the right conditions… the National Weather Service usually employs a two-out-of-three principle in determining when and if to issue a Tornado Warning.

1. ***Atmospheric Conditions*** - the NWS observes and forecast these conditions, so we generally know when and where the conditions will be most favorable for the initiation of strong to severe thunderstorms and the generation of internal storm rotations that can produce tornados.
2. ***Radar Signatures*** - as these storm develop the NWS closely monitors these storms with our network of weather radars. As we see certain features develop, in that right environment, we may begin to issue warnings.
3. ***Spotter Reports*** - we may have trained SkyWarn (http://www.nws.noaa.gov/skywarn/) Spotters out and about that are reporting to us on what they are observing, at their locations, near these storms.

All three conditions will make for a great episode of storm warnings, but two-out-of-three may be just enough to get the ball rolling.

Basic Radars: *In very simple terms…* Radars operate on the principle that energy of certain wavelengths is more likely to bounce off of objects of a certain size, than to be absorbed and/or reradiated. A standard radar system will transmit a pulse of energy at a certain frequency (wavelength is the inverse of frequency) and then "listen" for any reflection of that energy. If the radar "hears" a reflection, the time that has elapsed and the strength of the returned signal will tell the radar about the objects distance and relative number of reflectors. All of these pulses are traveling very near the speed of light, so that radar can pulse and then listen, repeatedly, over a very broad area in a matter of a few minutes.

Weather Radars: They are most often designed to interrogate clouds for water droplets, water drops, and hail stones, ranging in size from a few millimeters to several centimeters in size. These radars most often transmit at energy wavelengths of either 3cm, 5cm, or 10cm… with the Weather Surveillance Radar-88Doppler (WSR-88D), used by the NWS for severe convective storms and large hail, being of the 10cm variety. At many large airports in the country, the FAA employs a 5cm Terminal Doppler Weather Radar (TDWR) which is especially useful at detecting wind related issues nearer those airports. Smaller, lighter, and more mobile radars will often be the 3cm variety and are best for the very close analysis of a storm.

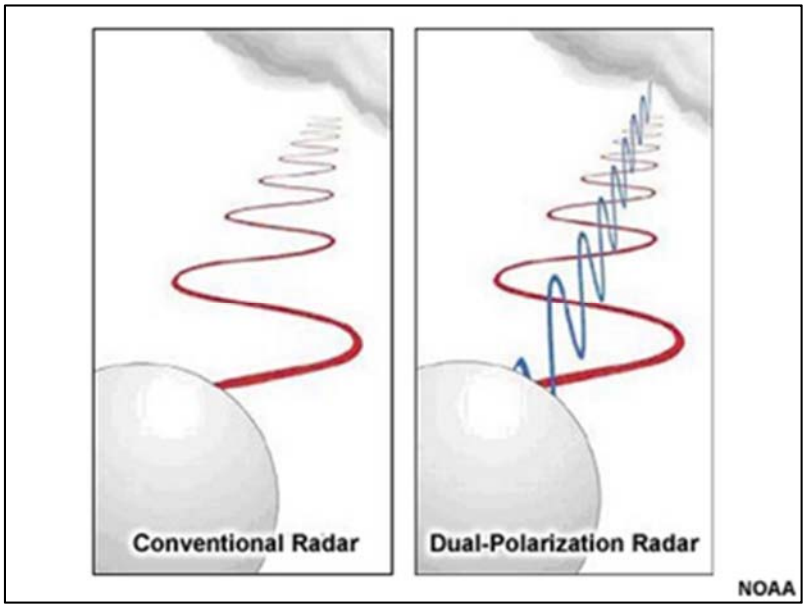


[3] The corresponding author: Greg Gust is the Warning Coordination Meteorologist at the NOAA's National Weather Service, Weather Forecast Office in Grand Forks, ND. E-Mail: gregory.gust@noaa.gov .

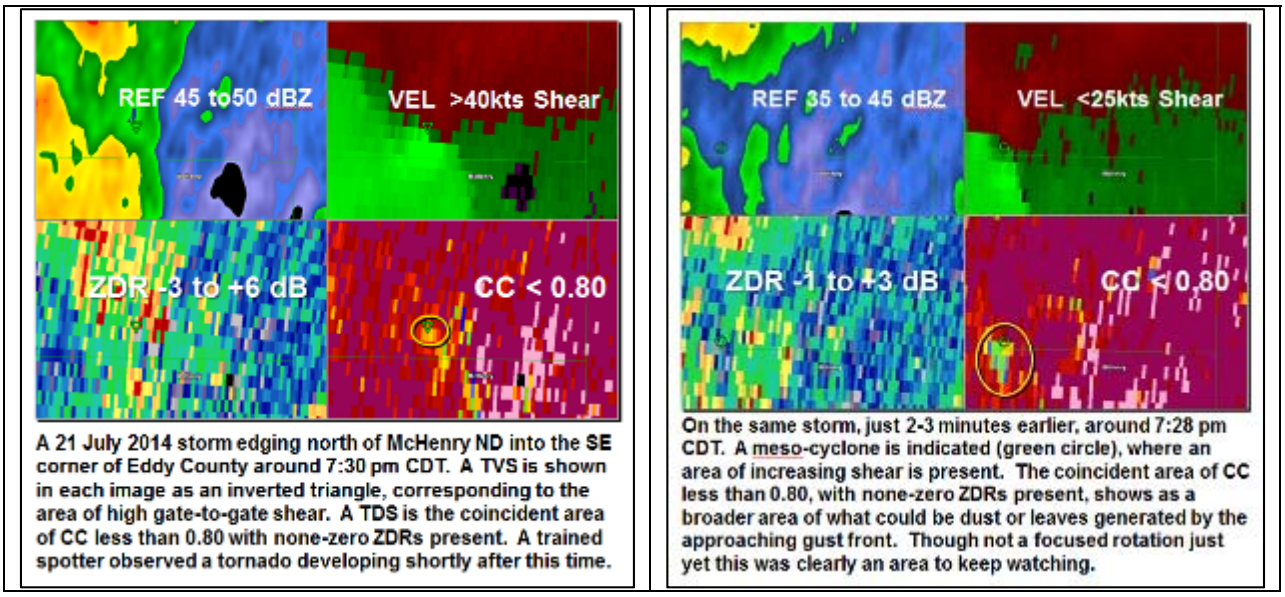
Doppler Radars: They refer to a type of radar system which can detect the strength of a return pulse (reflectivity) and whether that reflected energy has had a subtle shift in its frequency. These subtle shifts will occur if an object is moving either towards the radar or away, thus a Doppler Weather Radar can help to map the internal cloud winds by noting the relative motions of all the droplets, drops, and hailstones in an area of storms… and in fair weather it may even be able to detect dust, smoke plumes, and bugs! Doppler Weather Radars are especially helpful in identifying both large areas of potential downburst (straight-line) winds and any small wind features within storms that could be signs of either a potential microburst or an intense meso-cyclone (future tornado) within the cloud structures.

Tornado Vortex Signature (TVS): TVS is one of the key benefits of our Doppler Radar network and its attendant suite of analytical tools and algorithms. In brief, the radar is able to track developing areas of rotation within a storm, and as these areas increase in horizontal and vertical continuity the radar will indicate a developing meso-cyclone (mini-rotation), and when it reaches an even greater strength, that a nascent tornado vortex exists within the cloud… and subsequent funnel cloud or tornado formation is possible.

Dual Polarized Radar (Dual-Pole): A basic radar will use one waveguide and produce a pulse with either a horizontally or vertically polarized wave, resulting in a one-dimensional view of any reflectors it detects. A dual-pole radar will typically split each pulse and use two waveguides to produce both horizontally and vertically polarized waves, thus getting a better concept of the cross-sectional dimension of each reflector. In just the last few years, the NWS has upgraded its network of WSR-88D radars to this dual pole status. The Summer 2012 edition of the North Dakota Climate Bulletin has an in-depth article explaining the fielding of this system upgrade and the expected benefits. One key benefit is to be able to detect debris stirred in the air that may be associated by a tornado (polarimetric tornado debris signature or simply Tornado Debris Signature).



Tornado Debris Signature (TDS): TDS is one of the many new and exciting features we are beginning to glean from these upgraded dual-pole radars. In brief, the two-dimensional view of cloud particles allows us to see areas where materials within the cloud may have strange Differential Reflectivity (ZDR), indicating flattened objects, or targets with anomalously low Correlation Coefficient (CC), indicating a mix of many oddly shaped targets. The graphics below show comparison of four Dual-Polarization Radar products during the July 21, 2014 storm near McHenry all of which were utilized in Tornado Detection Algorithm to assist meteorologists making correct interpretation in real time.



Comparison of four Dual-Polarization Radar Product during the July 21, 2014 Storm near McHenry, ND. Top left: Reflectivity, Top-Right: Storm Relative Velocity, Bottom-left: Differential Reflectivity, Bottom-right: Correlation Coefficient.

Volume Coverage and **Scan Strategy**… will determine how much of an area is covered by radar and how often. A typical volume coverage area for an NWS radar extends to a 240nm radius from the radar location and in storm surveillance mode is completely updated about once every 4 to 5 minutes.

Newest addition:

Supplemental Adaptive Intra-Volume Low-Level Scan (SAILS): Just this summer, the NWS WSR-88D network received its latest upgrade, one that allows for an additional radar sweep at the lowest levels, about midway through its volume coverage patterns 12 and 212. For example, in VCP-212, the 88D can produce its lowest elevation radar sweep about once every 2 minutes, instead of every 4 to 5 minutes as before.

For more information… check out the NWS Warning Decision Training Branch online radar courses at: http://www.wdtb.noaa.gov/courses/dloc/topic3/lesson1/index.html

CONTACTING THE NORTH DAKOTA STATE CLIMATE OFFICE

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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