North Dakota Climate Bulletin

Autumn 2015

Volume: 9 No: 4

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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 autumn was the 2nd warmest and 54th wettest on record statewide since 1895.

The state average autumn temperatures increased a mere 0.17 °F per decade during the last 121 years while the state average precipitation only increased 0.07 inches per decade (the steepest seasonal trend in the state) on the average during that period. By the end of the season only a 9% of the state was in moderate drought. The most notable extreme highlight of the season (and the year) is the record high temperature of 97°F on October 11 in Fargo which surpassed the previous record held for 73 years by 12°F and became the warmest day of the year. Fifteen other record high temperatures were broken across the state on the same day.

Weather highlights in each month as well as graphical displays of statewide temperature and precipitation, plus seasonal hydrologic and climate outlooks can be found later in this bulletin.

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

Beach NDAWN location by Vern Whitten

Weather Highlights

Seasonal Summary:

by Daryl Ritchison

September 2015 Summary and Statistics

From September 4-6, 2015 several waves of rain moved across the northern portion of North Dakota. Some locations recorded over four inches of rain during that three day period which pushed the monthly average rainfall to over 300% of normal. Although the northern portion of the state, especially from near US Highway 2 and northward were quite wet, the rest of North Dakota recorded a very dry September (see page 6). Therefore, the statewide average finished near normal, yet, very few locations were actually near that mark. Temperatures were consistently above average for most of the month with September 2015 finishing as one of the warmest Septembers on record.

The statewide average precipitation was 1.55 inches which is below the 1981-2010 normal of 1.71 inches. September 2015 average precipitation ranked tied for the 54th wettest in the last 121 years with a maximum of 4.68 inches in 1941 and a minimum of 0.20 inches in 2012.

The US Drought Monitor September 29, 2015 reported 20% of North Dakota in D0 (abnormally dry) conditions which was confined to portions of southeastern North Dakota. (http://droughtmonitor.unl.edu/)

The USDA, National Agricultural Statistics Service, North Dakota Field Office reported a topsoil moisture of 35% short to very short, and 4% surplus with a subsoil moisture reported as 31% short to very short and 3% surplus. (Weekly Weather and Crop Bulletin Vol. 102, No. 39).

The statewide average air temperature was 62.1 °F which is above the 1981-2010 normal of 56.9 °F. September 2015 average air temperature ranked 6th warmest in the past 121 years with a maximum of 63.5 °F in 1897 and a minimum of 45.5 °F in 1965.

NDAWN's highest recorded daily air temperature for September was 103.9 °F at Fort Yates on September 3. The lowest recorded daily air temperature was 25.5 °F at Warren, MN, on September 29.

According to the preliminary reports of the National Weather Service's Storm Prediction Center (SPC), severe weather reports for September had 6 reports of high wind, 11 hail reports, and 0 reported tornadoes.

The top five September daily maximum wind speeds recorded from NDAWN were 56.4 mph at Garrison on September 16. Dickinson with 52.4 mph on September 5, Karlsruhe with 49.4 mph on September 16, Hofflund with 49.0 mph on September 6 and Hazen with 46.4 mph on September 6. NDAWN wind speeds are measured at a height of 10 feet (3 m).

October 2015 Summary and Statistics

October 2015, like the previous month of September, finished with well above average temperatures. Although there were some portions of the state with above normal precipitation, a high percent of North Dakota recorded below average precipitation (see page 7). The most significant event of the month was the record high maximum temperatures that occurred on October 11. On that day, many locations in southeastern North Dakota recorded maximums in the 90s. In fact, on that day the Fargo airport (KFAR) recorded a high of 97° (nearby Fargo NDAWN was 95°) which was not only a record for the day by 12°, it was also a record for the highest temperature recorded during the month of October and the warmest temperature in 2015. Other stations near Fargo also recorded similar historic statistics on that day.

The state average precipitation was 1.30 inches which is below the 1981-2010 normal state average of 1.46 inches. October 2015 state average precipitation ranked the 37th wettest in the past 121 years with a maximum of 4.61 inches in 1982 and a minimum of 0.09 inches in 1952.

The US Drought Monitor July 28, 2015 reported 27% of North Dakota in D0 (abnormally dry) conditions and 10% in D1 (Moderate Drought). Those areas were confined to the eastern and southeastern portion of North Dakota. (http://droughtmonitor.unl.edu/)

The USDA, National Agricultural Statistics Service, North Dakota Field Office reported a topsoil moisture of 32% short to very short and 2% surplus with a subsoil moisture reported as 33% short to very short and 2% surplus. (Weekly Weather and Crop Bulletin Vol. 102, No. 43).

The state average air temperature was 47.8 °F which is above the 1981-2010 normal of 43.4 °F. October 2015 state average air temperature ranked the 16th warmest in the past 121 years with a maximum of 54.8 °F in 1963 and a minimum of 32.6 °F in 1925.

NDAWN's highest recorded daily air temperature for October was 98.5 °F at Wyndmere on October 11. The lowest recorded daily air temperature was 14.7 °F at Bowman on October 29.

According to the preliminary reports from the Storm Prediction Center (SPC), severe weather reports for October had 0 reports of high wind, 0 hail reports, and 0 reported tornadoes.

The top five October daily maximum wind speeds recorded from NDAWN were 63.9 mph at Watford City on October 11, 63.7 mph at Robinson on October 12, 62.0 mph at Hazen on October 11, 61.0 mph gust was reported at Turtle Lake on October 11 and Hazen 59.0 on 12. All those strong wind reports were recorded along a cold front that pushed in much colder air into the region after the extreme warmth previously noted on October 11. NDAWN wind speeds are measured at a height of 10 feet (3 m).

November 2015 Summary and Statistics

November completed climatological autumn the way it started. Warm. Temperatures ranged from 5 to 8 degrees above average across much of eastern North Dakota. Some parts of eastern and northeastern North Dakota recorded rainfall on November 6 then again on November 15-16 that missed much of the rest of the state. Although those locations recorded above average precipitation for the month, most other reporting sites across the state were on the dry side meaning overall the average precipitation was slightly below the 30 year normal.

The state average precipitation was 0.56 inches which is below the 1981-2010 normal of 0.68 inches. November 2015 state average precipitation ranked 53rd wettest in the past 121 years with a maximum of 2.33 inches in 2000 and a minimum of 0.03 inches in 1939.

The US Drought Monitor December 1, 2015 reported 34% of North Dakota in D0 (abnormally dry) conditions and 9 % in D1 (moderate drought) which was all confined to the southern and eastern portions of the state. (http://droughtmonitor.unl.edu/)

The USDA, National Agricultural Statistics Service, North Dakota Field Office reported a topsoil moisture of 24% short to very short and 4% surplus with a subsoil moisture reported as 28% short or very short and 3% surplus. (Weekly Weather and Crop Bulletin Vol. 102, No. 48).

The state average air temperature was 32.7 °F which is above the 1981-2010 average of 27.3 °F. November 2015 state average air temperature ranked the 17th warmest in the past 121 years with a maximum of 37.3 °F in 1999 and a minimum of 6.1 °F in 1896.

NDAWN's highest recorded daily air temperature for November was 70.1 degrees at Campbell, MN on November 2. The lowest recorded daily air temperature was -9.0 °F at Froid, MT, on November 26. That -9.0 °F was also the coldest temperature in the lower 48 states that day.

According to the preliminary reports of the National Weather Service's Storm Prediction Center (SPC), severe weather reports for November had 0 reports of high wind, 0 hail reports, and 0 reported tornadoes.

The top five November daily maximum wind speeds recorded from NDAWN were all on November 18. These include Mandan at 63.5 mph, McHenry with 61.8 mph, Berthold with 60.0 mph, Robinson with 59.1 mph and Linton with 58.9 mph. NDAWN wind speeds are measured at a height of 10 feet (3 m). These strong wind gusts were associated with a strong mid-latitude cyclone and corresponding tight pressure gradient and rapidly descending air as high pressure moved in behind the departing low pressure system.

Autumn 2015 Summary

According to the National Centers for Environmental Information (NCEI), climatological autumn 2015 had a statewide average temperature of 47.5 degrees. That is 4.9 degrees above the 1981-2010 average temperature 42.6 degrees. That would rank the season as tied for the 2nd warmest in the past 121 years.

The three month statewide average rainfall according to NCEI was 3.41 inches. That is 0.44 inches below the 1981-2019 average of 3.85 inches. That would rank as the 54th wettest since such records started to be calculated in 1895.

Autumn 2015 will be remember for the persistent warmth. All three months finished well above average with September finishing as the 6th warmest, October the 16th warmest and November the 17th warmest. All areas of the state recorded above average temperatures for the season, but the highest anomalies from normal were in the east where some locations were as much 6 to 7 degrees above averages.

Although all parts of the state finished above average for temperatures, precipitation amounts in more typical fashion were highly variable. Overall, the state finished a bit below average, but that was not evenly distributed across the state. The northern one-third of North Dakota recorded excess precipitation whereas the southern two-thirds were mostly in a deficit situation for the season. The drier than average autumn in combination with fairly dry conditions in July and August as well are reasons why abnormally dry or moderate drought conditions were prevalent in southern and east-central North Dakota as the winter season began.

Season in Graphics

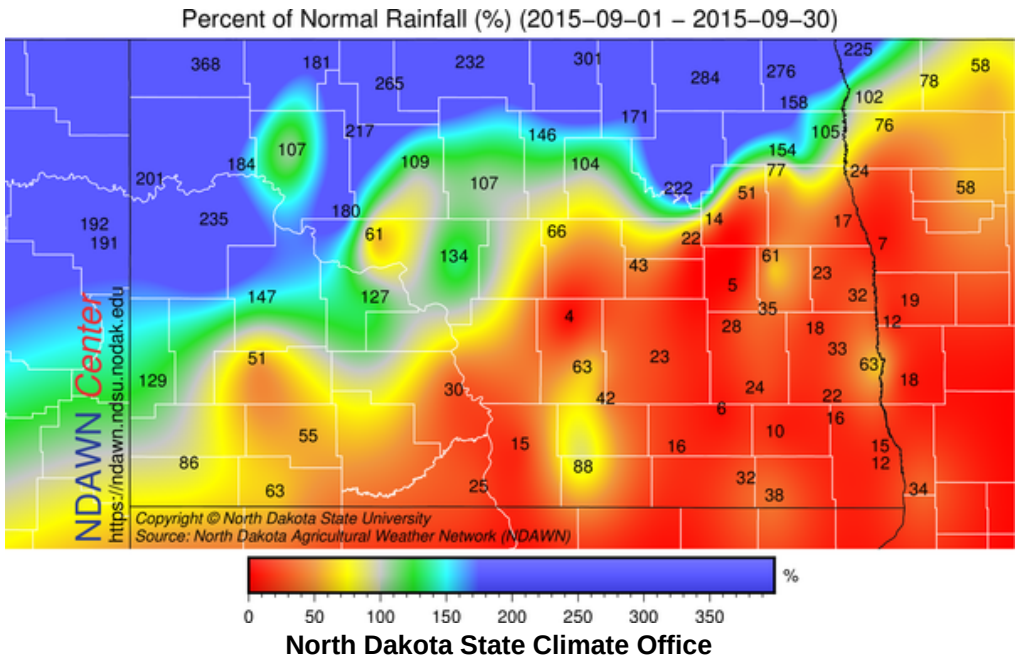
September 2015

Autumn 2015 Weather in North Dakota:

Total Precipitation percent of mean (1981-2010)

Precipitation Percent of Normal

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

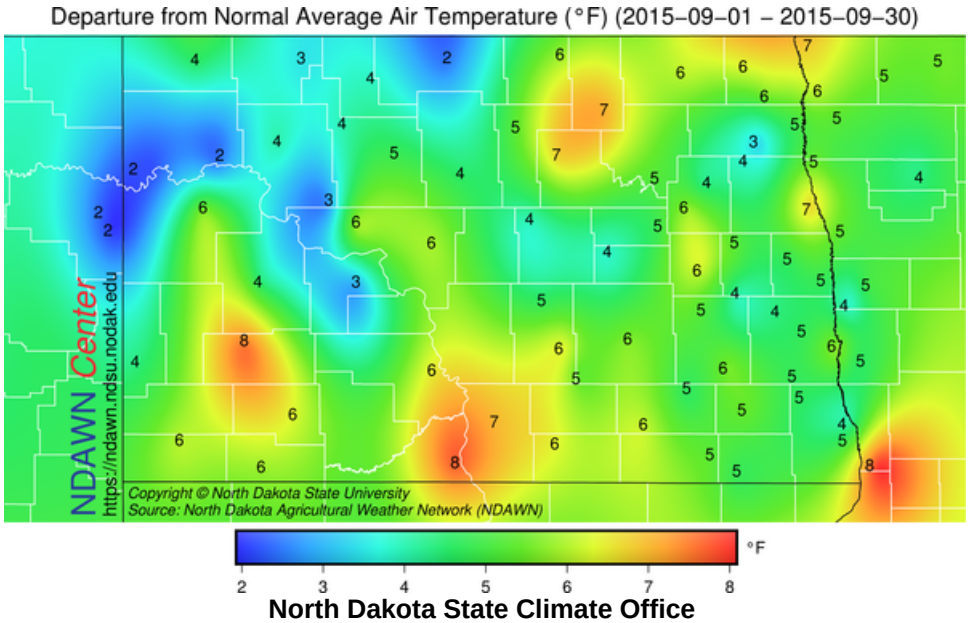


North Dakota State Climate Office

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

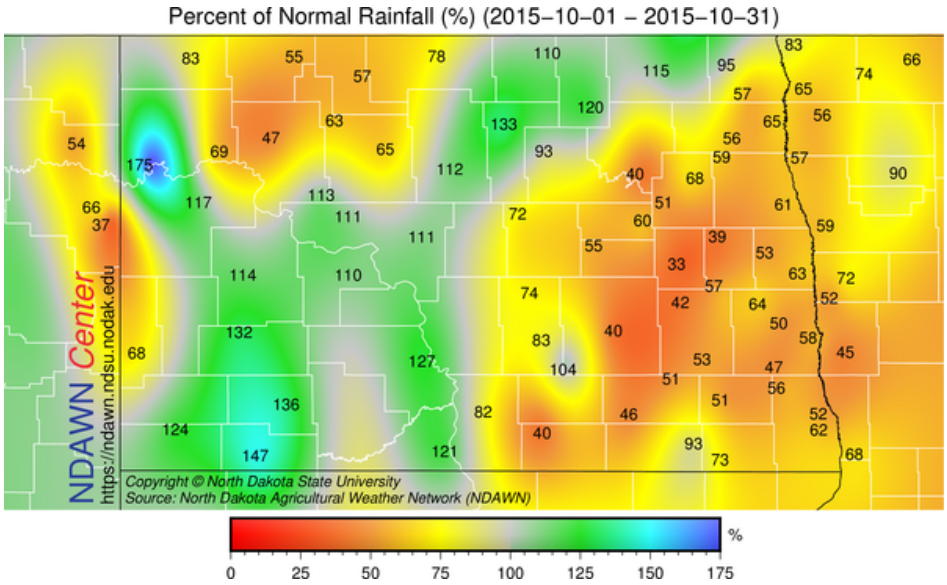
October 2015

Autumn 2015 Weather in North Dakota:

Total Precipitation percent of mean (1981-2010)

Precipitation Percent of Normal

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

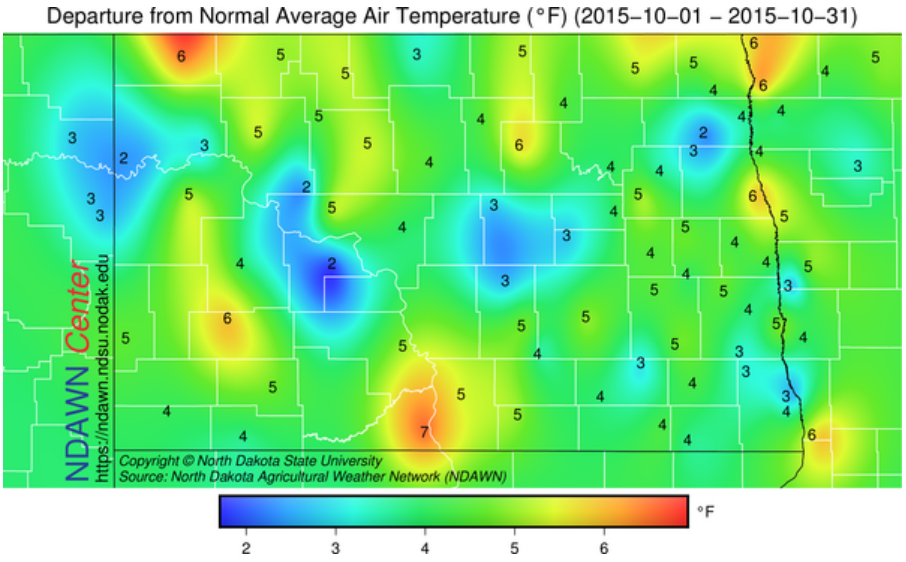


North Dakota State Climate Office

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

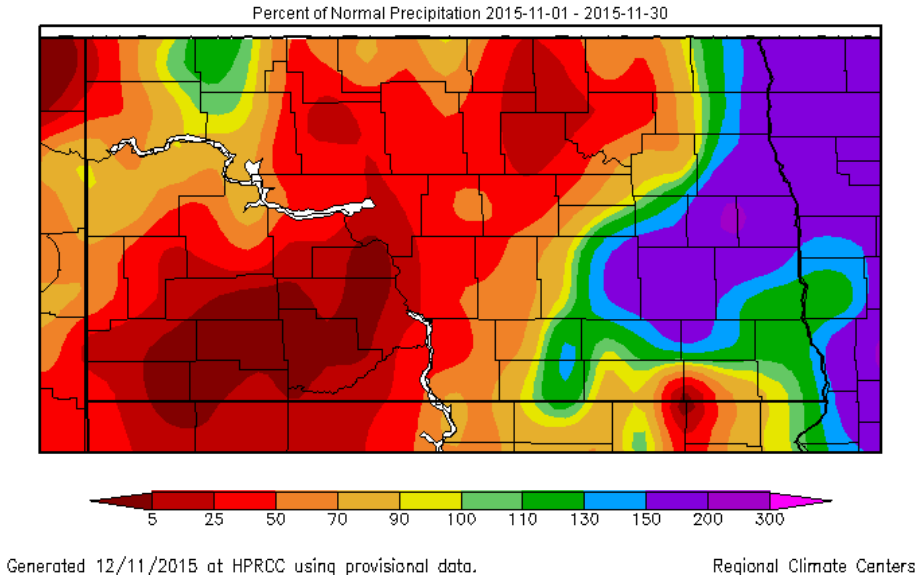
Autumn 2015 Weather in North Dakota:

November 2015

Total Precipitation percent of mean (1981-2010)

Precipitation Percent of Normal

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

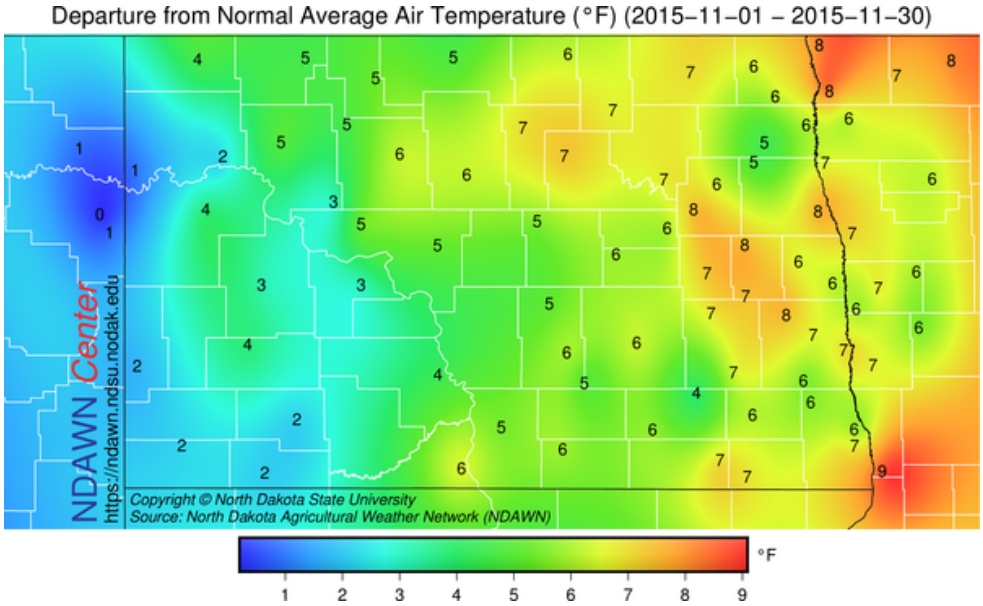


High Plains Regional Climate Center

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

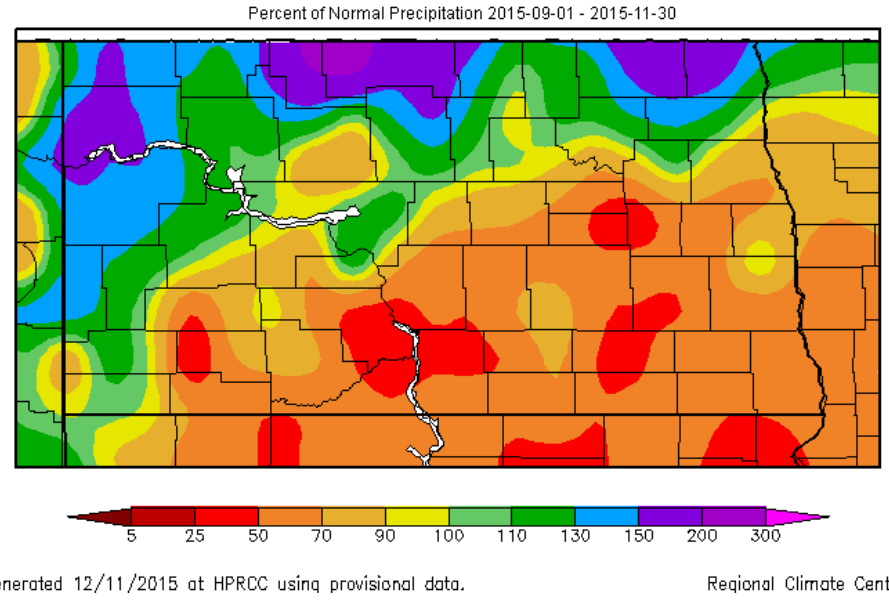
Autumn 2015 Weather in North Dakota:

Autumn 2015

Total Precipitation percent of mean (1981-2010)

Precipitation Percent of Normal

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

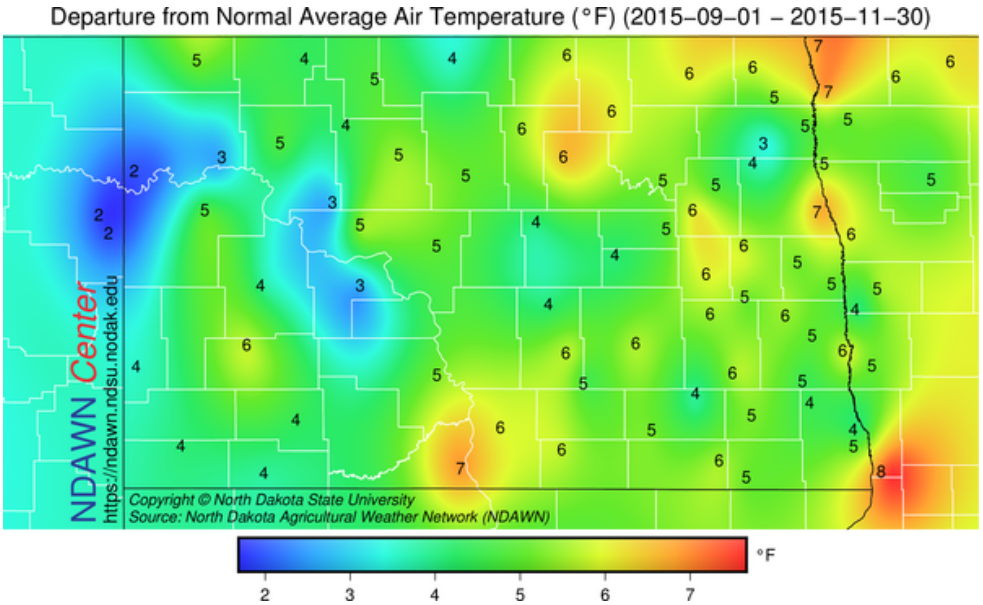


High Plains Regional Climate Center

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

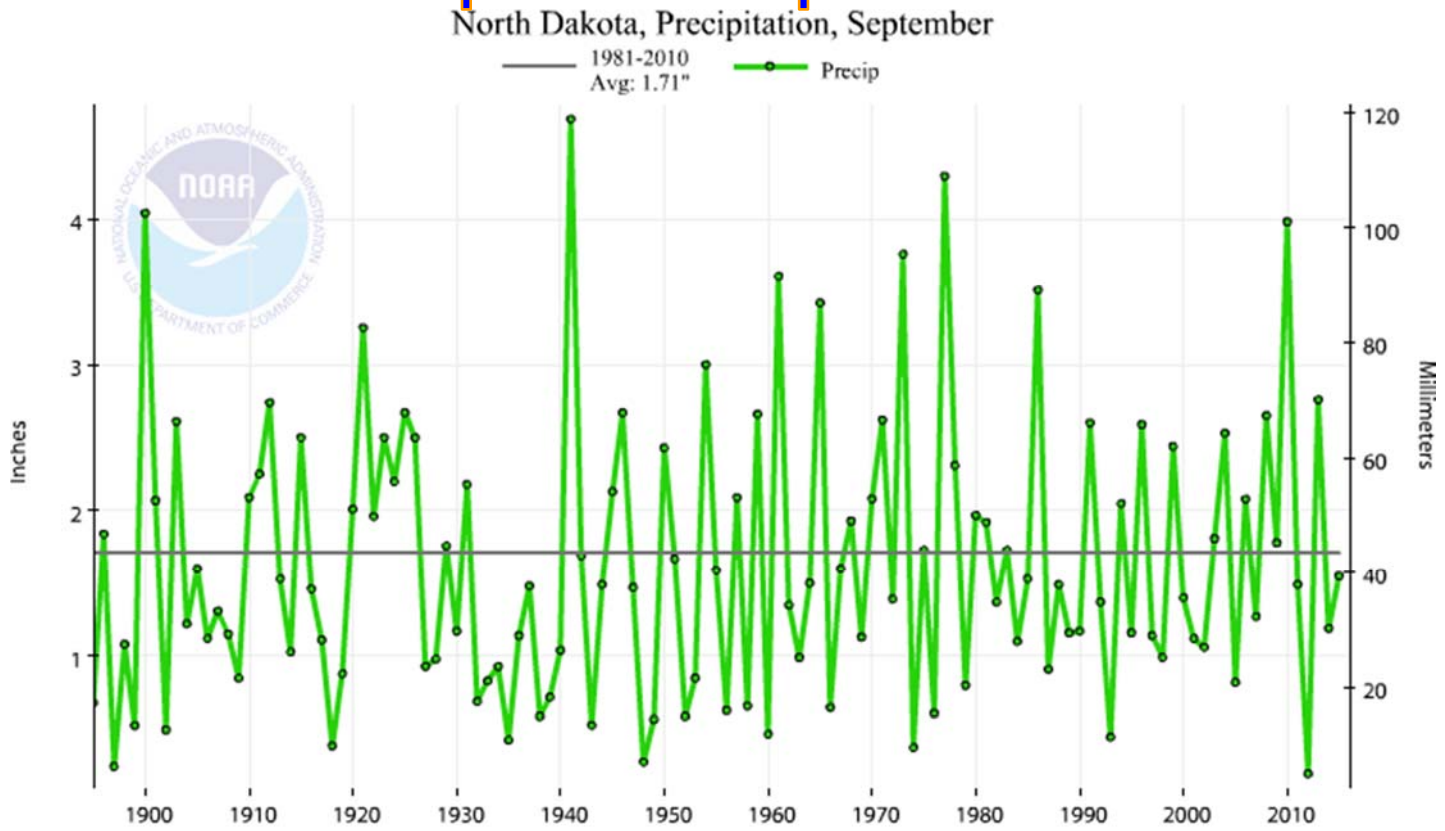
Departure From Normal Monthly
Average Air Temperature in degrees F

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



North Dakota State Climate Office

Historical September Precipitation for North Dakota

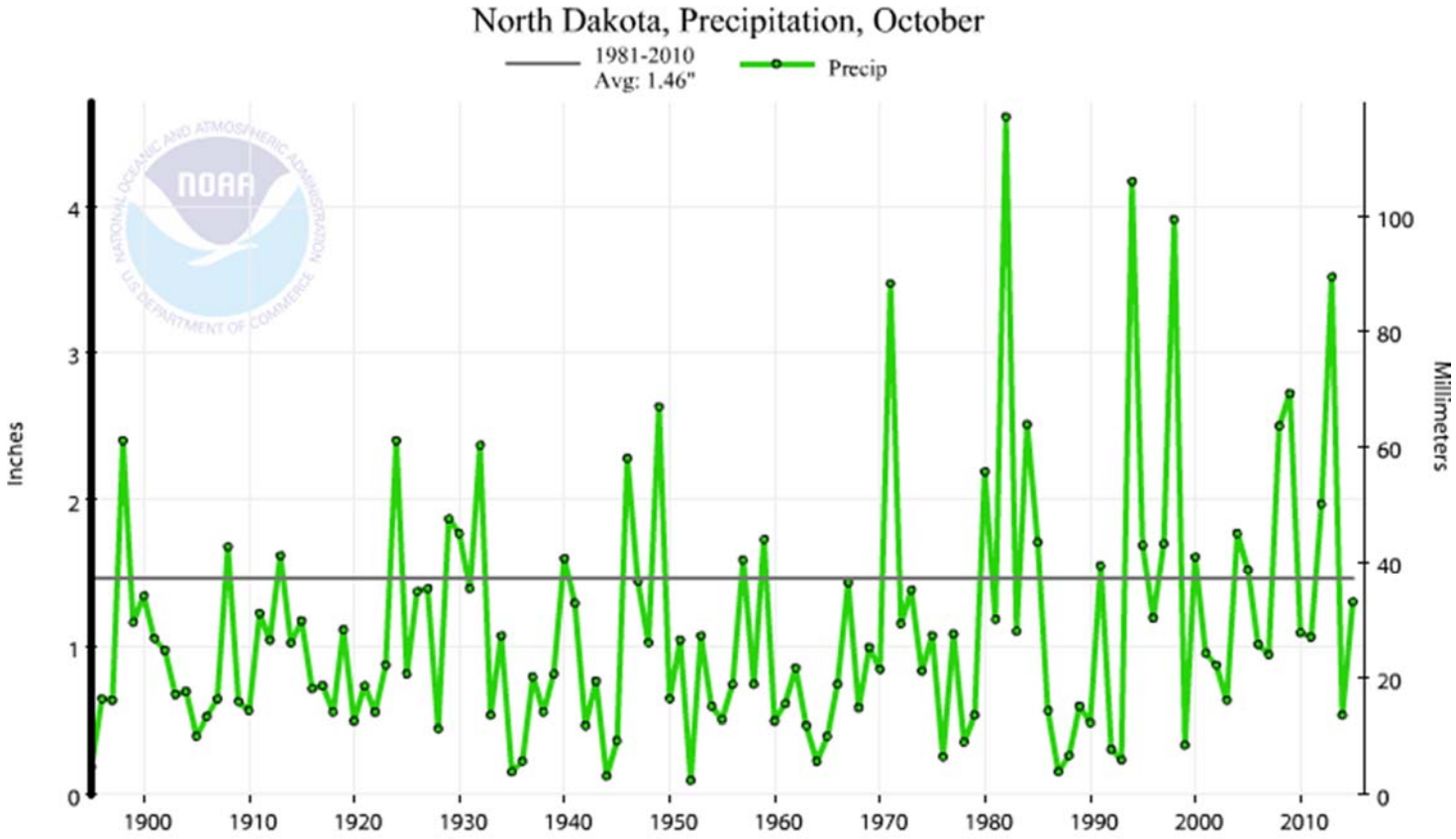


September Precipitation Statistics

2015 Amount: **1.55 inches**
Maximum: 4.68 inches in 1941
State Normal: 1.71 inches (1981-2010)

Monthly Ranking: 54th wettest
Minimum: 0.20 inches in 2012
Years in Record: 121

Historical October Precipitation for North Dakota

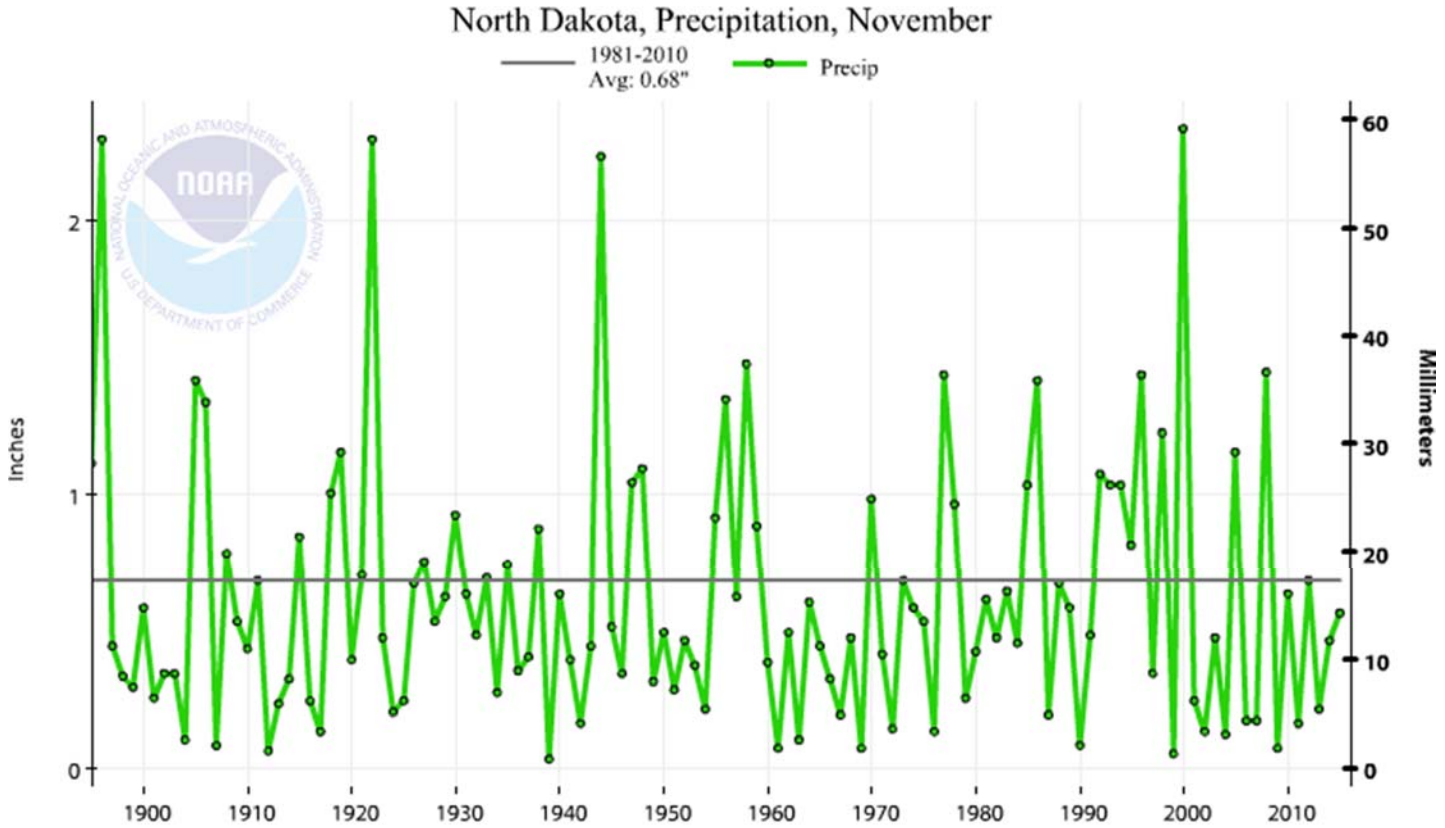


October Precipitation Statistics

2015 Amount: 1.30 inches
Maximum: 4.61 inches in 1982
State Normal: 1.46 inches (1981-2010)

Monthly Ranking: 37th wettest
Minimum: 0.09 inches in 1952
Years in Record: 121

Historical November Precipitation for North Dakota

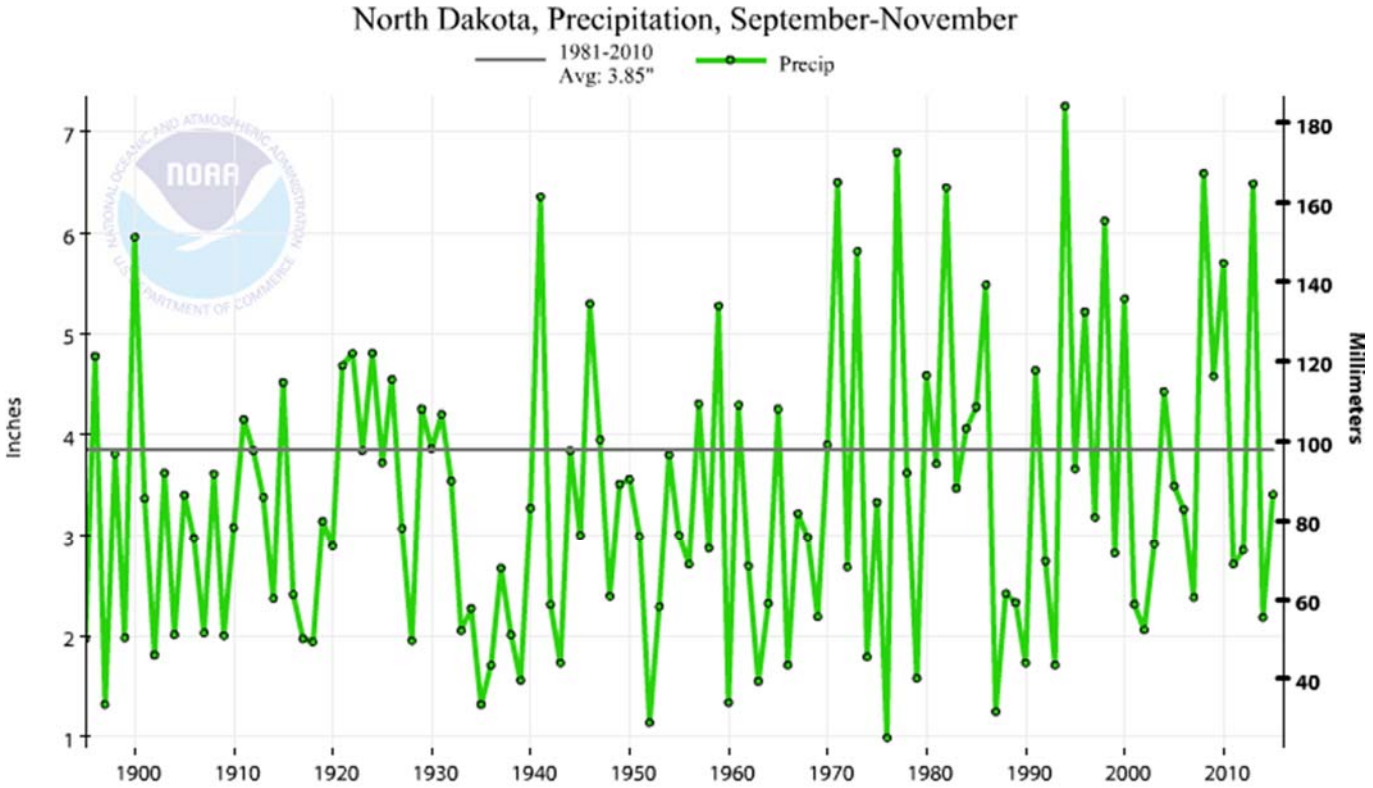


November Precipitation Statistics

2015 Amount: 0.56 **inches**
Maximum: 2.33 inches in 2000
State Normal: 0.68 inches (1981-2010)

Monthly Ranking: 53rd wettest
Minimum: 0.03 inches in 1939
Years in Record: 121

Historical Autumn Precipitation for North Dakota

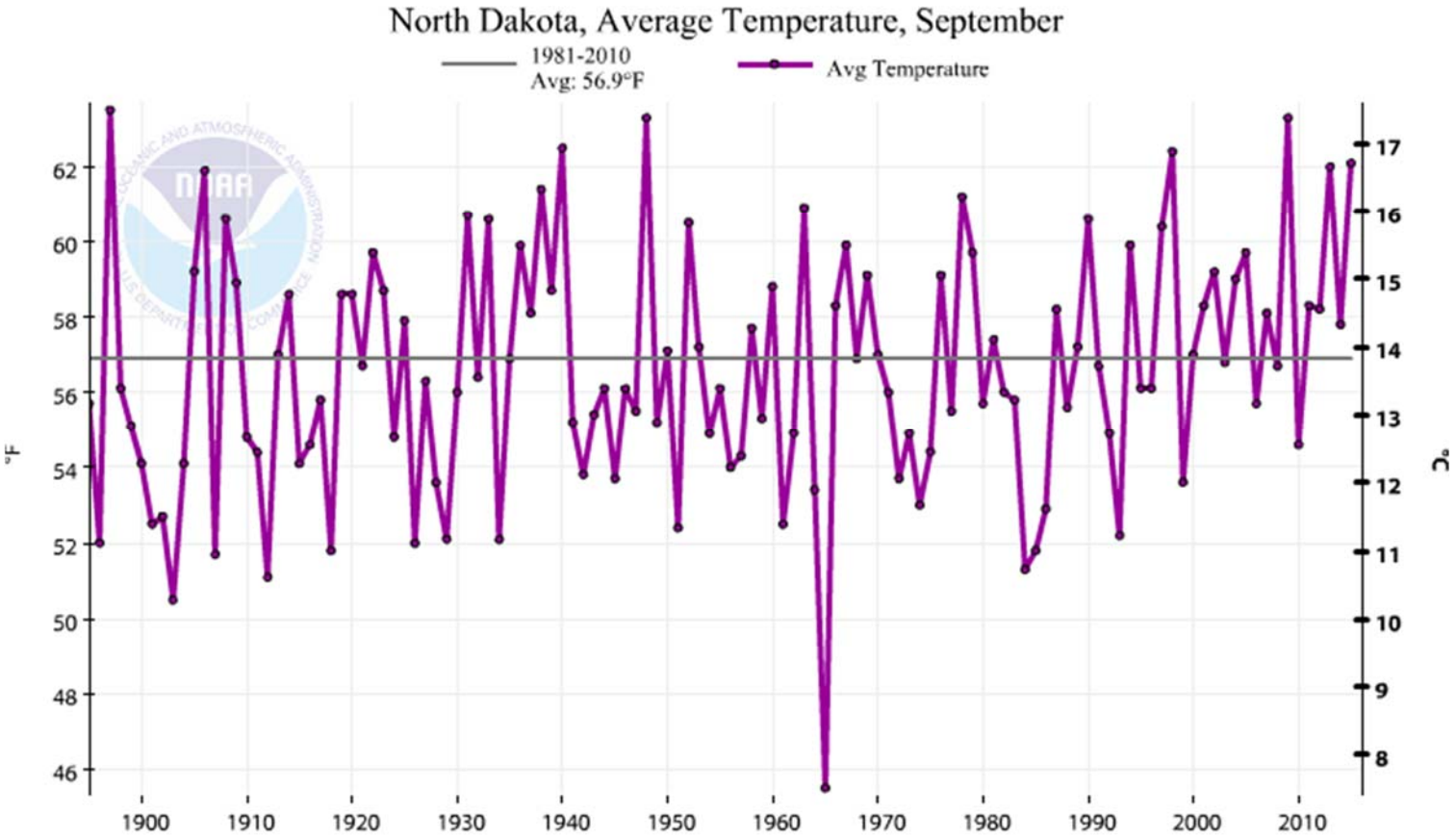


Autumn Precipitation Statistics

2015 Amount: 3.41 **inches**
Maximum: 7.25 inches in 1994
State Normal: 3.85 inches (1981-2010)

Monthly Ranking: 54rd wettest
Minimum: 0.99 inches in 1976
Years in Record: 121

Historical September Temperature for North Dakota

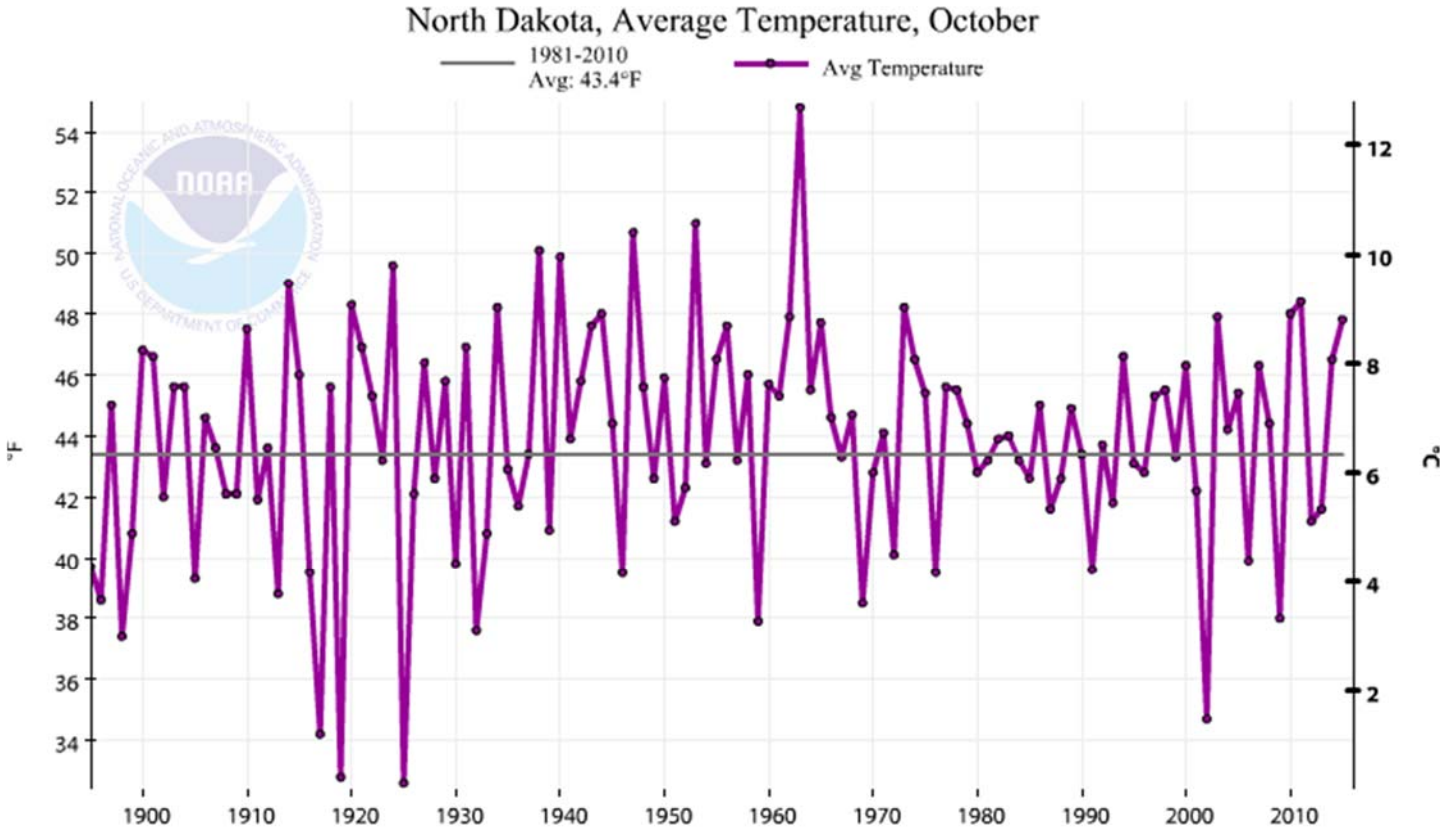


September Temperature Statistics

2015 Average: **62.1** °F
Maximum: 63.5 °F in 1897
State Normal: 56.8 °F (1981-2010)

Monthly Ranking: 6th warmest
Minimum: 45.5 °F in 1965
Years in Record: 121

Historical October Temperature for North Dakota

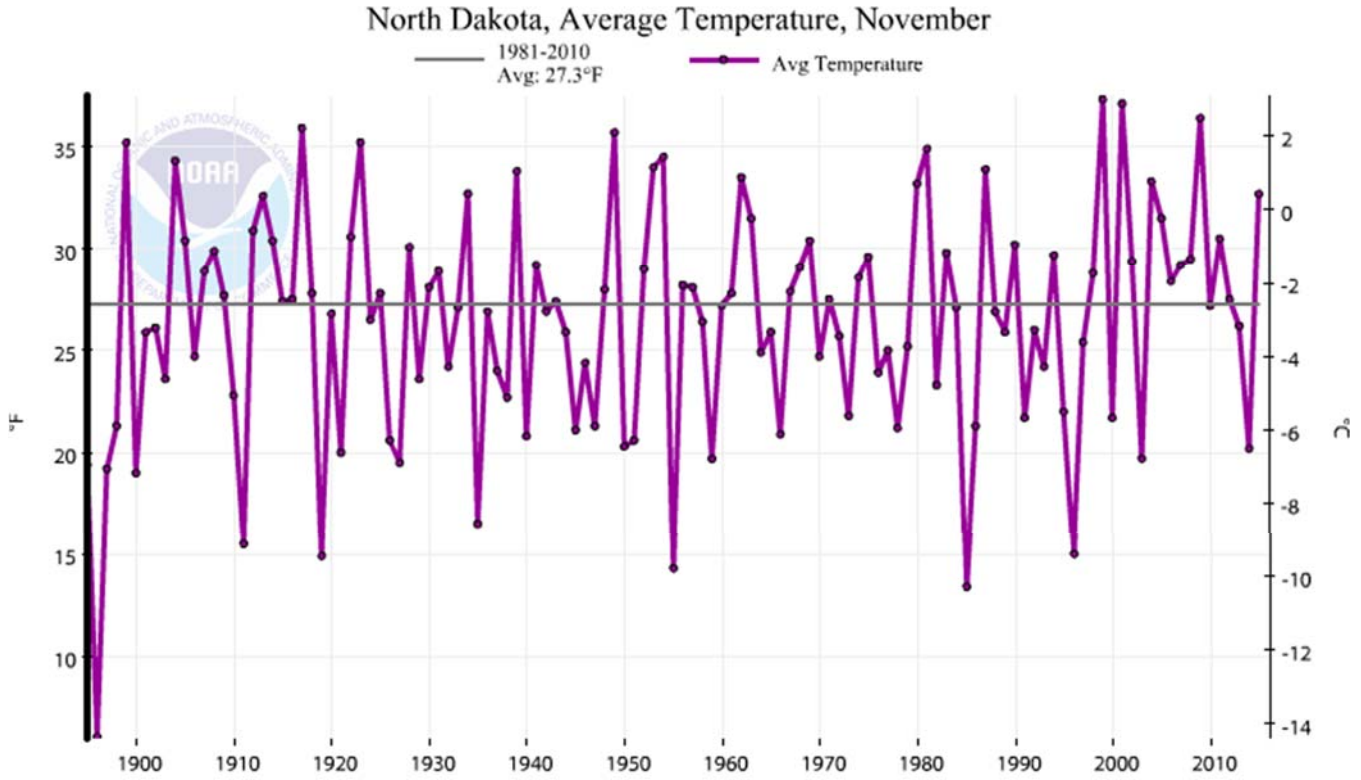


October Temperature Statistics

2015 Average: 47.8 °F
Maximum: 54.8 °F in 1963
State Normal: 43.4 °F (1981-2010)

Monthly Ranking: 16th Warmest
Minimum: 32.5 °F in 1925
Years in Record: 121

Historical November Temperature for North Dakota

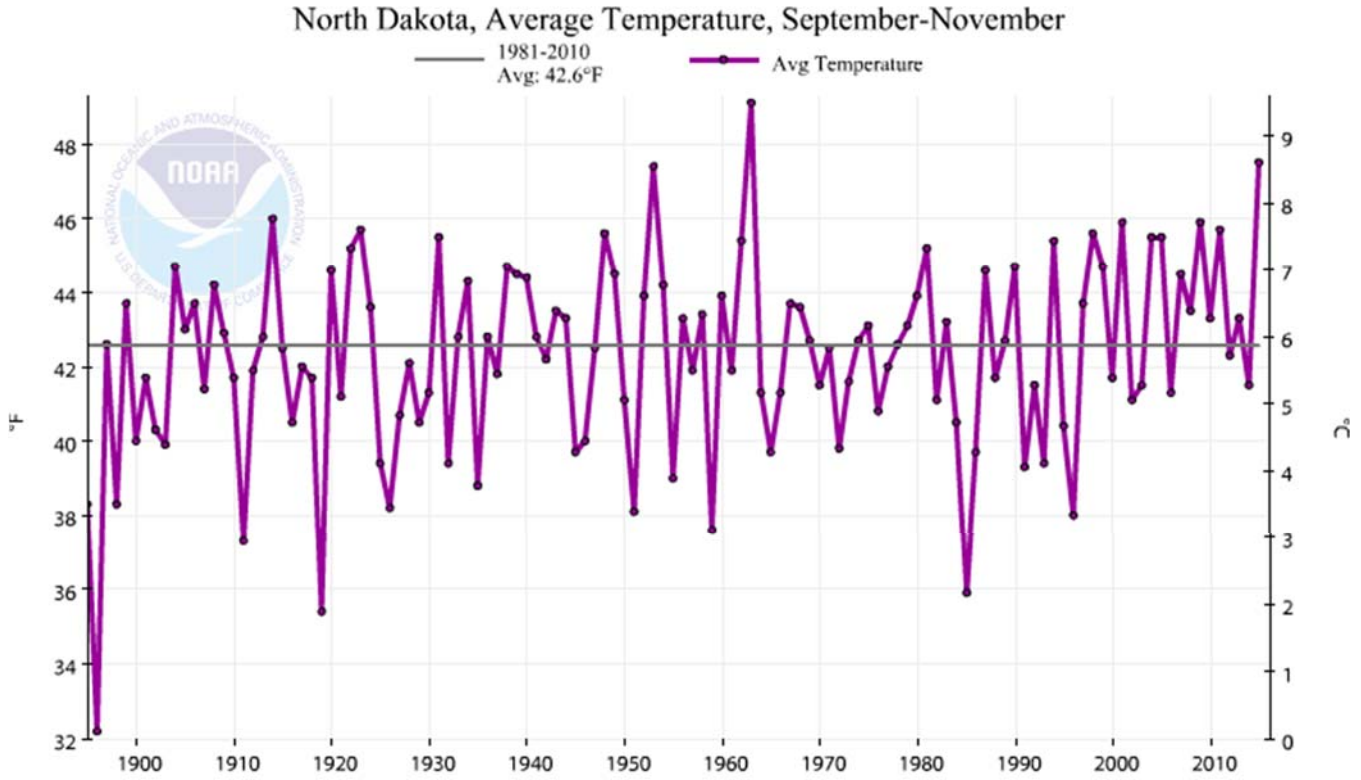


November Temperature Statistics

2015 Average: **32.7 °F**
Maximum: 37.3 °F in 1999
State Normal: 27.3 °F (1981-2010)

Monthly Ranking: 17th warmest
Minimum: 6.1 °F in 1896
Years in Record: 121

Historical Autumn Temperature for North Dakota



Autumn Temperature Statistics

2015 Average: **47.5 °F**
Maximum: 49.1 °F in 1963
State Normal: 42.6 °F (1981-2010)

Monthly Ranking: 2nd warmest
Minimum: 32.2 °F in 1896
Years in Record: 121

Storms & Record Events

State Tornado, Hail, and Wind Reports for Autumn 2015

by D. Ritchison

North Dakota 3 Month Total	Wind 6	Hail 11	Tornado 0
Reports by Month			
Month	**Wind**	**Hail**	**Tornado**
Total September	6	11	0
Total October	0	0	0
Total November	0	0	0

North Dakota Record Event Reports for Autumn 2015

Date	Location	Type of Record	Previous Record
09/02/15	Williston Airport	100° F highest maximum temperature	99° in 1901
09/13/15	Bismarck Airport	97° F highest maximum temperature	93° in 1963
09/13/15	Minot Airport	91° F highest maximum temperature	Tied 91° in 1959
09/21/15	Fargo Airport	93° F highest maximum temperature	88° in 1984
09/21/15	Grand Forks Airport	91° F highest maximum temperature	88° in 1984
09/21/15	Jamestown Airport	90° F highest maximum temperature	Tied 90° in 1984
09/21/15	Bismarck	90° F highest maximum temperature	89° set in 1984
09/21/15	Dickinson Airport	84° F highest maximum temperature	81° set in 1948
10/10/15	Grand Forks (UND)	86° F highest maximum temperature	Tied 86° in 1934
10/10/15	Grand Forks Airport	85° F highest maximum temperature	83° in 1955
10/10/15	Bismarck Airport	90° F highest maximum temperature	88° in 1955
10/11/15	Fargo Airport	97° F highest maximum temperature	85° set in 1943
10/11/15	Grand Forks Airport	90° F highest maximum temperature	82° set in 1995
10/11/15	Jamestown Airport	93° F highest maximum temperature	80° set in 1997
10/18/15	Dickinson Airport	82° F highest maximum temperature	Tied 82° set in 2000
11/15/15	Grand Forks Airport	60° F highest maximum temperature	59° set in 1953
10/23/15	Fargo Airport	0.95 inches of rain	0.35 inches in 1947
10/23/15	Grand Forks Airport	0.56 inches of rain	0.33 inches in 2012
10/23/15	Dickinson Airport	0.53 inches of rain	0.29 inches in 1991
10/23/15	Minot Airport	0.35 inches of rain	0.33 inches in 2011
11/30/15	Fargo Airport	0.25 inches of rain	0.19 inches in 1996
11/30/15	Jamestown Airport	0.13 inches of rain	0.08 inches in 1972

Seasonal Outlook

Winter 2015-2016 Climate Outlooks

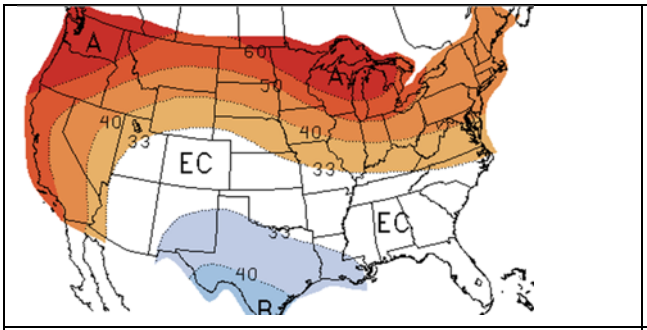
by . R. Kupec[1]

We have closed the record books on a very warm and generally dry autumn across all of North Dakota. Our fall outlook anticipated the warm, dry September and October but suggested a possible turn towards colder temperatures in November. While there was a brief cool down around Thanksgiving, the warm start to fall continued from start to finish. Precipitation came in below average for the season across the state, though the Red River Valley did see a slightly wetter than average November. With the strong El Niño on going in the southern Pacific Ocean, this mild and dry trend should continue into the winter.

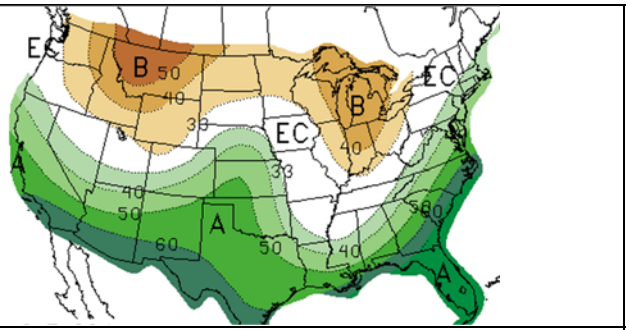
There are 14 winters in North Dakota weather records we can examine when similar El Niño conditions existed. Nine of these winters were generally warmer than average. A deeper examination finds 3 winters with a strong El Niño and warm water in the northern Pacific, conditions that also exist this winter. Those winters were 1997/98, 1986/87 and 1941/42 and all of these saw very warm winter months, with the exception of February 1942 which was colder than average. Given these trends, it seems likely that this winter will see above to very above average temperatures. The current Climate Prediction Center (CPC) outlook has a 40 to 60 percent chance of above average temperatures for the winter across North Dakota (See Figure 1).

The wild card in winter temperatures is snow. As we have seen over the first few days of December, snow pack can greatly reduce temperatures, acting as a refrigerator of the atmosphere and reflecting large amounts of sun light away from the surface. The El Niño signature with regards to precipitation is more mixed than the temperature signal. Nearly half of the winter months in El Niño years can be considered dryer than average, with the other half average or wet. The 3 analogous winters mentioned above had drier than average Decembers and Januarys but wetter than average Februarys. A possible explanation for this is that the strong southern jet stream that often occurs during El Niño begins to migrate north heading into spring bringing an increased chance of a large winter storm system to North Dakota. The current CPC outlook agrees with the idea of a generally dry trend. Their forecast is for a 33 percent chance of drier than average conditions across the state except the far northwest corner of that has 40 percent chance of drier conditions (See the figures below.)

It is likely that the warm weather we have experienced this fall will continue through December, January and February. This is not to say there will not be some cold periods within the time frame, but temperatures should be above average for the winter as a whole. Precipitation should be on the dry side, but given how little moisture we actually see on average over the winter months, one or two well placed storms can quickly change that especially heading into February. The next CPC outlook will be out on December 17th and is available at: http://www.cpc.ncep.noaa.gov/products/predictions/90day



December through February Temperature Outlook



December through February 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/data/enso/#c343262.

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

Hydro-Talk

North Dakota's Latest Hydrologic Status

by A. Schlag[2]

The longer I am with the National Weather Service, the less surprised I am with North Dakota's tendency to be at one extreme or the other with regard to weather. Just a couple years removed from some very cold and wet winters, we have just entered the meteorological winter of 2015-2016. Thus far, the El Nino is living up to all its pre-winter advertising. The Northern Great Plains has been a fairly enjoyable place to spend October through early December, so long as you aren't a really big fan of cold and snow. The welcome to winter snowfall of November 30 and December 1st is starting to look like it won't last more than a few days before melting/evaporating. Underneath that snow the soil is now widely frozen to a depth of 4-10 inches. However, below freezing temperature is probably a better way to describe the surface soils as they generally were fairly dry before the snow came. This would suggest that as the snow melts in the coming days the less than a quarter of an inch of meltwater will still find its way into the soil and produce little runoff. The somewhat less permeable nature of the soil post the melt due to water freezing into the pore space will indeed increase the risk of enhanced runoff in the spring, but at this point it would not appear to be a very large increase.

Thus far, I think most people would simply express positive feelings toward the current winter with little concern over the lack of moisture. Indeed, meteorologically speaking, one could lament a lack of moisture over the past couple of months across large areas of ND. However, with the region being well out of the growing season and now into the traditional snow accumulation season, there really are no significant impacts to lower than normal moisture until spring. In the coming spring a lack of snow could translate into inadequate runoff to fill water supply reservoirs. Just the same, this remains so far off into the forecast future that one would be best to merely keep this as a distinct possibility in the back of their mind rather than fear it.

A second topic that I would like to bring up is a modernization of the way the National Weather Service will be presenting data for the Souris (Mouse) River basin in North Dakota. For years the NWS and USGS have used a mixture of stages based on an arbitrary datum and stages based on feet above Mean Sea Level (MSL) and we have done so using the National Geodetic Vertical Datum of 1929 (NGVD 29). The Souris River Joint Board has requested that we convert all sites to the North American Vertical Datum of 1988 (NAVD 88) and present all river data as feet above MSL. For uniformity, both the USGS and NWS have begun to convert the river data in this format. For the NWS, this change becomes effective on January 1st, 2016.

As an example, here is how this change affects the Souris River gage location at Broadway Bridge in Minot, ND.

NWS Identifier: Flood stage	NGVD 29 above MSL	Conversion	NAVD 88 above MSL	New FS Definition as ft above MSL in NAVD 88
MION8	0 MSL	n/a	0 MSL	n/a
Action Stage	1548.0	+1.224	1549.224	1550.0
Minor Flood Stage	1549.0	+1.224	1550.224	1551.0
Moderate Flood Stage	1551.0	+1.224	1552.224	1553.0
Major Flood Stage	1555.0	+1.224	1556.224	1557.0

Note, as the NWS strongly prefers to represent the different levels of flooding in nice round numbers, this conversion process does raise the stage definition for ALL flood levels by about 9.3 inches (0.776') as measured on a stationary landmark. We have chosen to round all locations up, instead of to the nearest foot because of a general sense in flood stages already being very conservative which has resulted in over-warning the affected area during times of no to very minimal threat to life and/or property.

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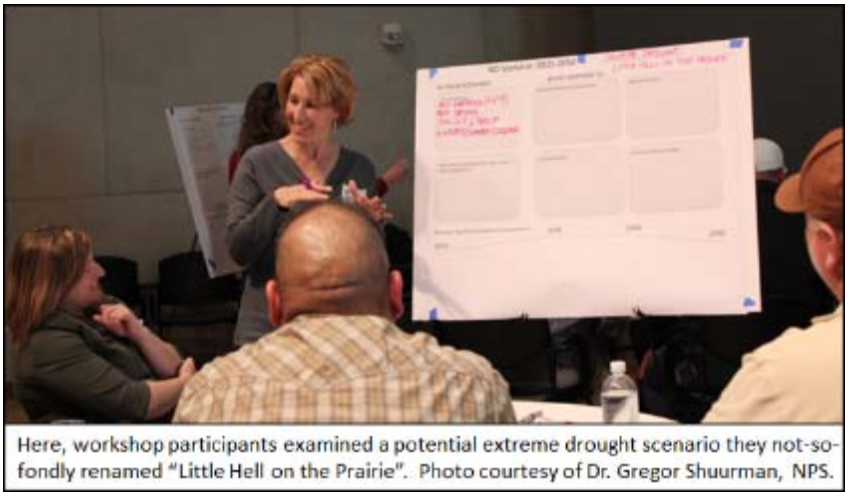
Science Bits

Using Scenarios to improve Climate Adaptation

by Greg Gust[3]

What Happened? On November 12-13, some 20 representatives from various state, tribal, and federal agencies met with climate change adaptation specialists from the U.S. National Park Service, USGS, NOAA, and Colorado State University to engage in scenario planning and explore a plausible range of future climatic conditions specific to central North Dakota - and to discuss some possible mitigation and adaptation measures such scenarios might evoke over the coming few decades.



Here, workshop participants examined a potential extreme drought scenario they not-so-fondly renamed "Little Hell on the Prairie". Photo courtesy of Dr. Gregor Shuurman, NPS.

Understanding ND's Climate Variability. To set the stage, USGS Statistician, Dr. **Karen Ryberg** (ND Water Science Center, Bismarck ND), reviewed trends in regional precipitation and runoff, as they relate to natural long-term climate variability and climate change, changing land-use and other potential causes. USGS Research Ecologist, Dr. **Amy Symstad** (Northern Prairie Wildlife Research Center, Hot Springs SD), discussed local rangeland ecology and habitat health, as patterns shift between wet "sweet clover infestation" years and dry "wildfire" years, often in back-to-back years.

NWS Warning Coordination Meteorologist, **Greg Gust** (Weather Forecast Office, Grand Forks ND), focused on local historic weather events, including the more recent episodes of extreme rain and snow melt flooding (2009, 2011) and extreme drought (2012). ND State Climatologist, Dr. **Adnan Akyüz** (ND State University, Fargo, ND), provided a succinct wrap-up as he showed statewide trends in precipitation and temperature, across a spectrum of daily, weekly, annual, and inter-annual averages and their extreme variability.

We are Extreme! North Dakota enjoys one of the most highly variable and extreme climates in the world, thanks in large part to our latitude and our geographic position at the center of the North American continent. And such intrinsic variability tends to persist even as our climate center shifts.

Shifting our Climate Center: Examining a different "Normal". North Dakota has already seen an average increase of 2.4 degrees Fahrenheit (the second steepest trend in the nation) or more in daily temperature, over the past century, along with our continued high degree of climate variability (Figure 1). Most long range climate modelling systems indicate that we will see ***additional warming*** over the course of this century.

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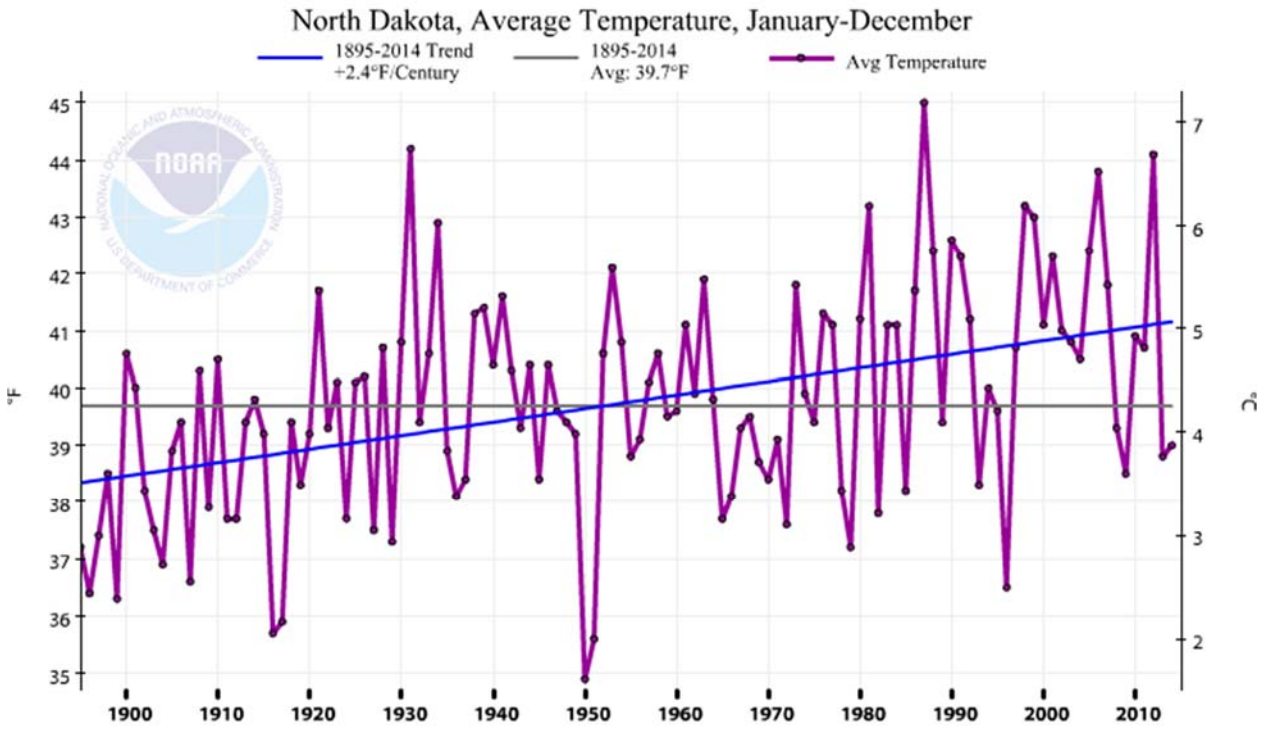

Figure 1. North Dakota Annual Average Temperature Time Series (1895-2014)

Scenarios Examined. Workshop coordinators Dr. **Nick Fisichelli** (NPS Climate Change Response Program, Ft. Collins CO) and Dr. **Andrea Ray** (NOAA Earth Systems Research Lab, Boulder CO) previewed four scenarios (Figure 2) derived from the WCRP/CMIP3 A2 emissions scenario, and as downscaled and available at http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/.

*Caveat: These climate scenarios are **not** official forecasts of future climate! They are narratives describing plausible futures selected from range of projections, each produced by somewhat different climate models.*

Scenarios are alternate stories about the future. As with most stories, they are created so that their participants can be informed, inspired, challenged, and stretched. These scenarios only looked at potential climate changes and their impacts through the middle of this current century, but they had fascinating implications through mid-century and beyond (Figure 3).

#32. Warm Wet Summers = Least Change. This scenario had only a subtle increase in warming (1 to 1.5F) and in precipitation (1 inch), so is at the low end of projections. In general, the slight increase in moisture is offset by increased heat so that average soil moisture, runoff, and riverine hydrology remain similar to today. Imagine this as a subtle nudge along the path to scenario #29.

#29. Hot Summer, Soggy Spring. This scenario gets a little more than twice the rate of warming and moisture increase as #32, but more moisture comes in late winter and early spring, while more heat comes in mid to late summer. As a result spring snowmelt floods tend to increase while a hot and dry summer leads to earlier brown out.

#3. Hot Flood See-Saw. The scenario adds even more moisture than #29 (3+ inches), but spreads it more evenly into the summer, which then contributes more to spring snowmelt floods and summer flash floods. Meanwhile more heat (3F+) is added, more to the winter months than summer, so summer has a somewhat steamy and soggy feel - much like having a 2009 or 2011 style year as the new normal.

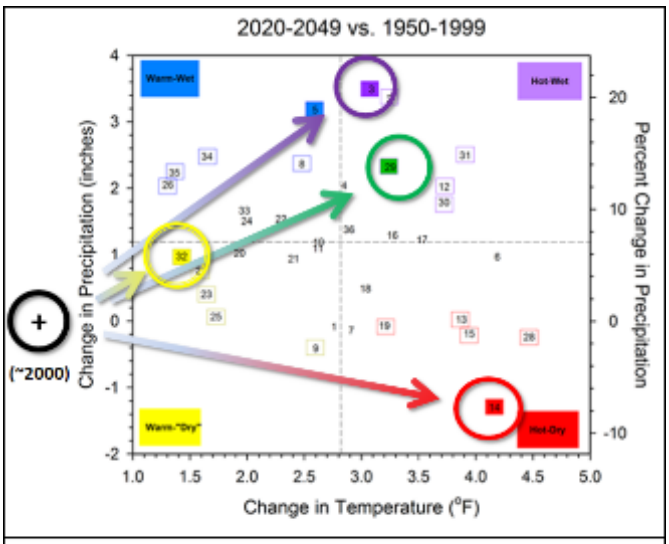

Fig 2. A sampling of projections in the Bureau of Reclamation's CMIP3 hydrology dataset (http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html#Welcome) for 1/8 degree area near KNRI headquarters (47.34°N, 101.27°W). Source graph courtesy Amy Symstad (USGS/NPWRC), Nick Fisichelli (NPS/CCRP), and Andrea Ray, (NOAA/ESRL).

#14. Severe Sustained Drought. This scenario adds even more heat (4F+) so that the growing season is lengthened considerably, but it also reduces our overall moisture (-1 inches) while it increases our risk for frost in the long shoulder seasons. Soil moisture would start to show a deficit much earlier in the season, and both plant growth and riverine flow would suffer - like 2012 again, and again, and again…

In each scenario, participants listed select features of each new climate regime (hotter, wetter, snowier, etc.), identified other types of sociopolitical or economic features which may develop (population, tourism, traffic, etc.), and then looked at the resultant impacts which could occur at a setting like the ***Knife River Indian Villages*** National Historical Site. Each scenario was then integrated into a larger planning framework where participants were invited to test their options, by examining different adaptation strategies, and cross-checking for any recurrent themes.

Why such an Exercise? The use of exercises or scenarios in order to test our abilities to respond to some type of emergency or a disaster is something with which most government agencies, businesses, and individuals are acquainted. Who hasn't heard a test of their neighborhood siren system, in preparation for Severe Summer Weather season? Or engaged in a continuity-of-operations plan within their place of work… maybe even a phone-tree or emergency notification system through their school system? BTW…is your Winter Weather Survival kit up-to-date, and safely stowed in your vehicle?

So even though we may not want calamity or disaster to strike, we know we should prepare for those things which are at least somewhat likely to occur, somewhere near us, during some particular period in time. In the weather business we often refer to those things which require a very quick response capability as short-fuse (like a tornado, see my Spring 2015 Science Bits article), and those that will unfold over time as long-fuse (like a winter storm or a spring flood).

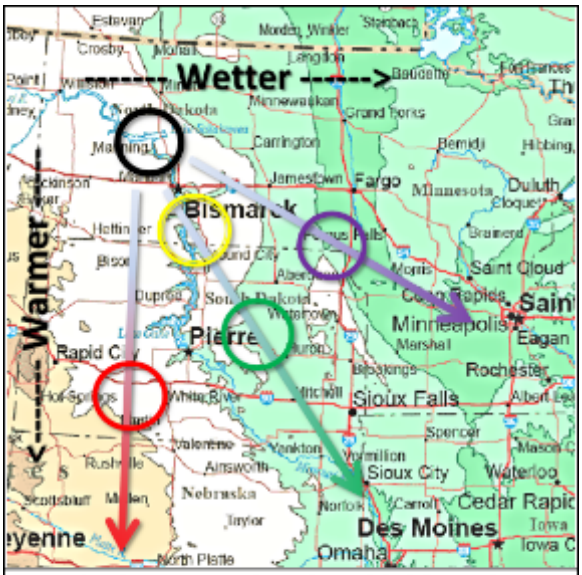

Fig 3. Select climate scenarios depicted as a subtle shift in ND climate normals to a new warmer and either wetter or slightly drier climate regime - more like our neighbors to the south and east. In the Hot Flood See-Saw scenario, central ND climate could resemble that of southeast ND by mid century, and southern Minnesota by the end of the century.

Like weather, our climate is something that is also continually in flux, but with changes that are evident over much longer time periods of time such as seasons, years, decades, centuries, and millenia. A review of such scenarios with various agency partners helps each of us to better understand our past and present weather/climate conditions, and to better understand how we may help each other to improve our decisions and our corporate resiliency as we deal with climate changes yet to come.

For more information… about the project and to track related workshop activities, check out the project description on the Colorado State University/North Central Climate Science Center page at: http://nccsc.colostate.edu/revamp/project/scenario-planning-in-the-great-plains

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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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