NORTH DAKOTA STATE CLIMATE OFFICE ndsco

North Dakota Climate Bulletin

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In This Issue

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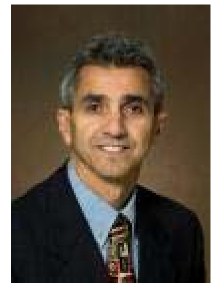
From the State Climatologist



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 spring was the 38th warmest and the ninth driest (the driest spring since 1980) on record since 1895 statewide in ND. Overall in the spring season, there were 46 highest daily and 41 lowest daily temperature records either broken or tied. There were also 41 highest daily precipitation and snowfall records either broken or tied. A total of 128 records were either tied or broken including temperature and precipitation related occurrences across the state. Drought conditions intensified throughout the spring. By the end of the season, the state was experiencing the worse drought since April 2013 based on an index that takes into account drought intensity (D-level) and coverage (%).

Detailed monthly climate summaries for March, April and May can be individually accessed via https://www.ndsu.edu/ndsco/climatesummaries/monthlyclimatesummary/2017/

The bulletin will contain graphical displays of statewide seasonal temperature, precipitation, and other weather highlights.

This bulletin can be found at http://www.ndsu.edu/ndsco/, along with several other local resources for climate and weather information.

Adnan Akyüz, Ph.D.
North Dakota State Climatologist

Fargo, ND *by Vern Whitten*

Seasonal Weather Summary: By Adnan Akyüz

Precipitation

Using analysis from the National Centers for Environmental Information (NCEI), the average North Dakota precipitation for the spring season (March 1, through May 31, 2017) was 2.45 inches, which was 2.92” less than last year, 2.15” less than the 1981-2010 average spring precipitation and was the driest Spring since 1980. This would rank spring 2017 as the 9th driest spring since such records began in 1895. Figure 1 shows the percent of normal precipitation distribution geographically.

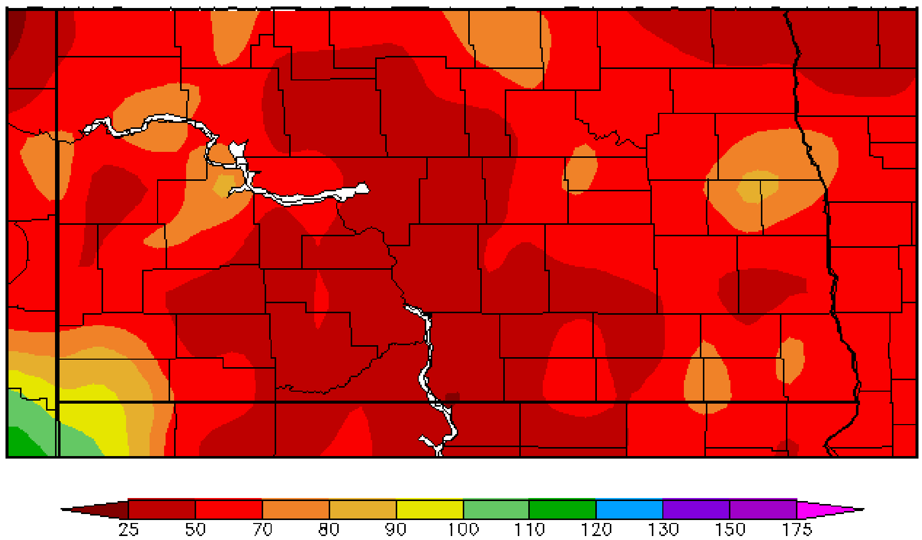


Figure 1. Precipitation % of Normal in Spring 2017 for North Dakota (HPRCC)

Based on historical records, the state average spring precipitation showed a positive average long-term trend of 0.04” per decade since 1895. The highest and the lowest seasonal spring average precipitation for the state ranged from the highest amount of 9.64” in 1896 to the lowest amount of 1.30” in 1934. The “Historical Spring Precipitation For North Dakota” time series on page 5 shows a graphical depiction of these statistics.

Flood: There were several locations along the major river systems in North Dakota where the river stages reached above the NWS flood stage. The table below shows select flood stages of locations that were subject to flooding.

Table 1. Major River Systems and their Peak Stages in Spring 2017 in North Dakota.

Gauge	Peak Stage (ft)	Date	NWS Flood Stage (ft)
Red River at Pembina	44.81	4/5/2017	39
Red River at Drayton	35.7	4/3/2017	32
Red River at Oslo	27.7	3/1/2017	26
Red River at North Grand Forks	34.81	5/3/2017	28
Red River at Fargo	22.26	2/24/2017	18
Pembina River at Neche	22.41	4/1/2017	18

Temperature

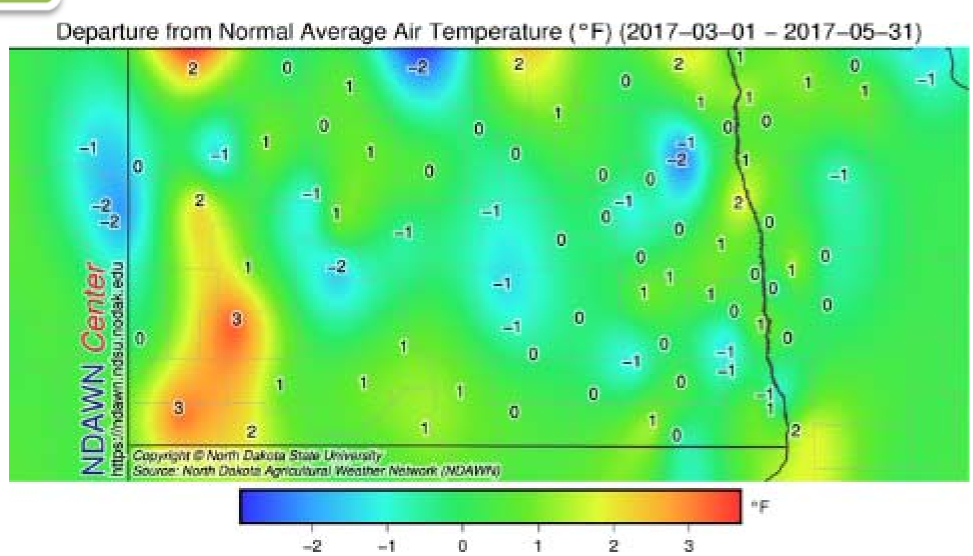


Figure 2. Temperature Departure from Normal in Spring 2017 for North Dakota (NDAWN)

The average North Dakota temperature for the spring season (March 1 through May 31, 2017) was 41.6°F, which was 3.3°F colder than last year, but 0.3°F warmer than the 1981-2010 average spring temperature and was the coldest spring since 2014. This would rank spring 2017 as the 38th warmest spring since such records began in 1895. Figure 2 shows the departure from normal temperature distribution geographically. Based on historical records, the state average spring temperature showed a positive trend of 0.21°F per decade since 1895. The highest and the lowest seasonal spring average temperatures for the state ranged from the highest amount of 48.1° in 1977 to the lowest amount of 31.5° in 1899. The "Historical Spring Temperature For North Dakota" time series on page 6 shows a graphical depiction of these statistics.

Drought: Following the 9th wettest consecutive six-month period from September through February in ND, this spring was the 9th driest. Even though the precipitation pattern changed as early as March, there was plentiful moisture trapped in the soil from the previous two seasons for spring planting. A cool start prevented planting and the other early season agricultural activities. It also slowed down the onset of the drought. However, after the temperatures bounced back to their normal range and even above normal in some periods, evapotranspiration rates increased. Persistently dry conditions with increased evaporation demand intensified drought conditions rather rapidly by the end of the season. High wind, high evaporative demand, and intense heat hampered germination. Locations in the drought-stricken areas started reporting blowing dust. The graphics below show a comparison of the drought conditions across the state between the beginning and the end of the season.

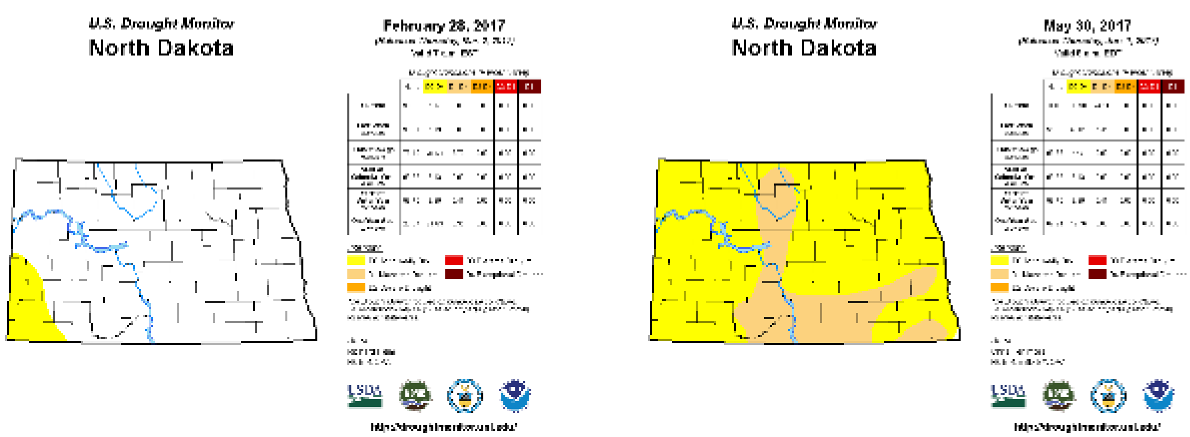


Figure 3. Drought Monitor map Comparison for North Dakota in the Beginning (on the left) and at the end (on the right) of Spring 2017.

Figure 4 below shows the statewide drought coverage in % and intensity (i.e. DO, D1, etc…) in time scale representing the state from the beginning to the end of the month with one-week resolution. Notice the steep increase in coverage and intensity observed during the last week of May.

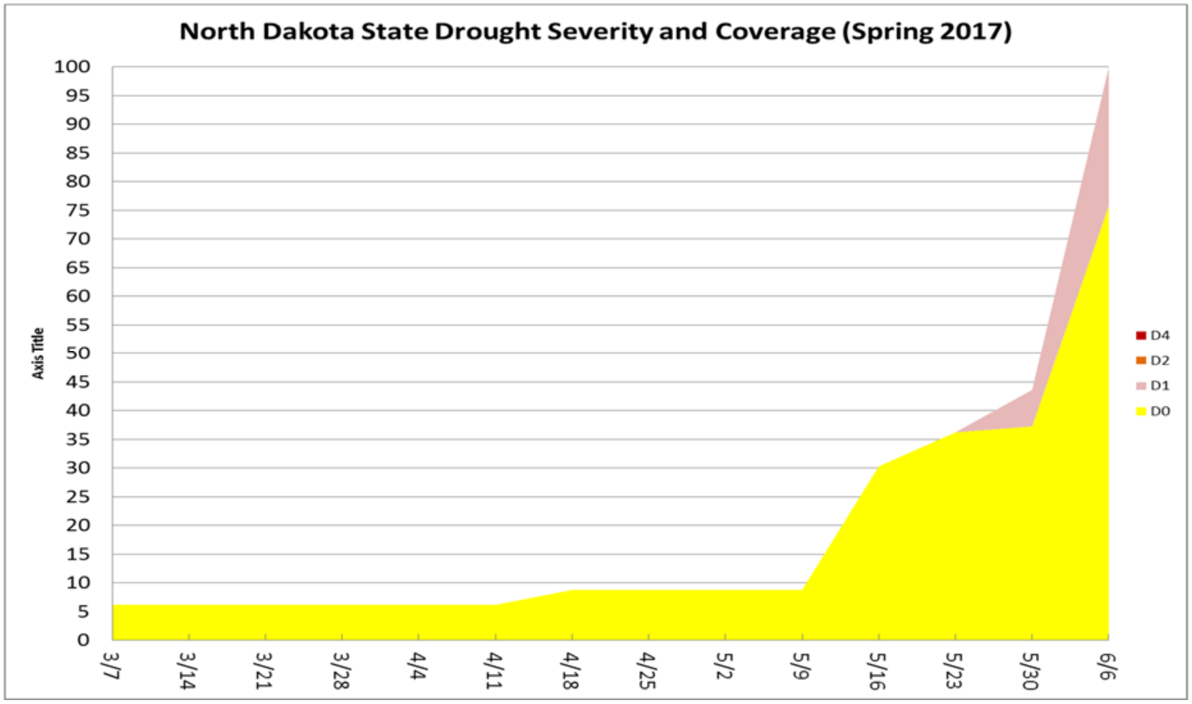


Figure 4. Statewide Drought Coverage (%) and Intensity (Dx) in Spring 2017.

Based on the index that takes into account intensity (D-level) and coverage (%) called Drought Intensity and Coverage Index (Figure 5), the index by the end of the season was 124 which indicates that the state was experiencing the worse drought since April 2013 when it was last exceeded the current index.

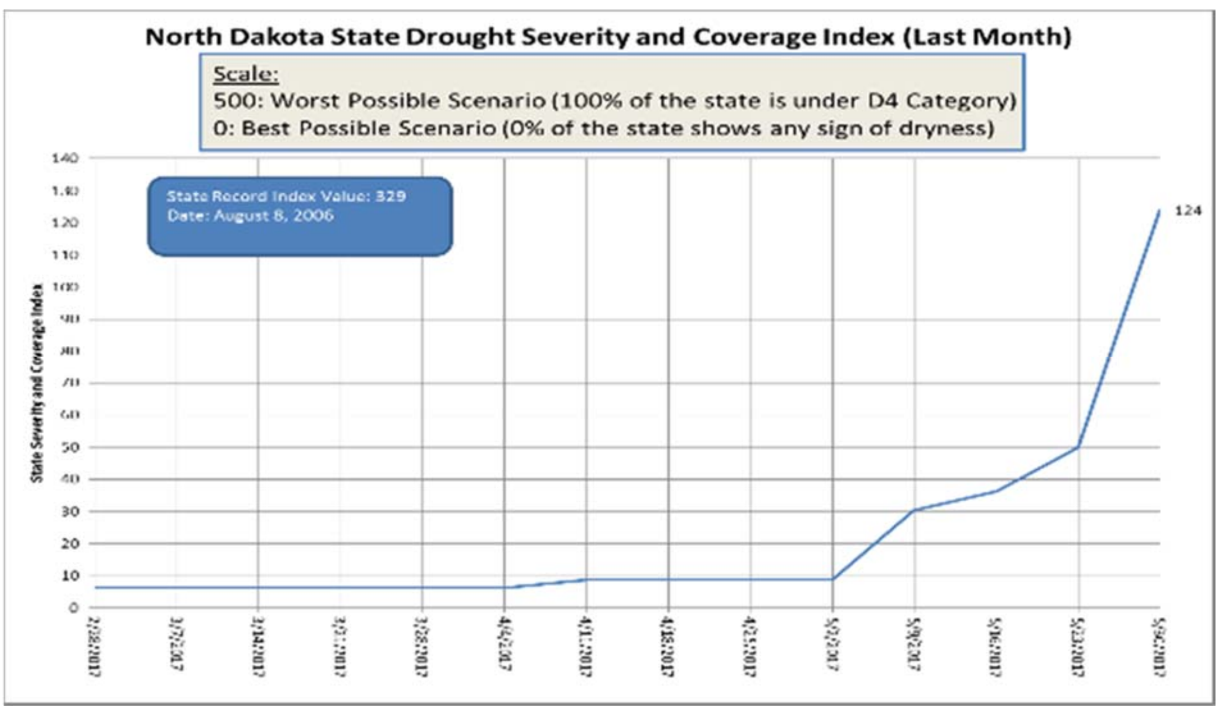
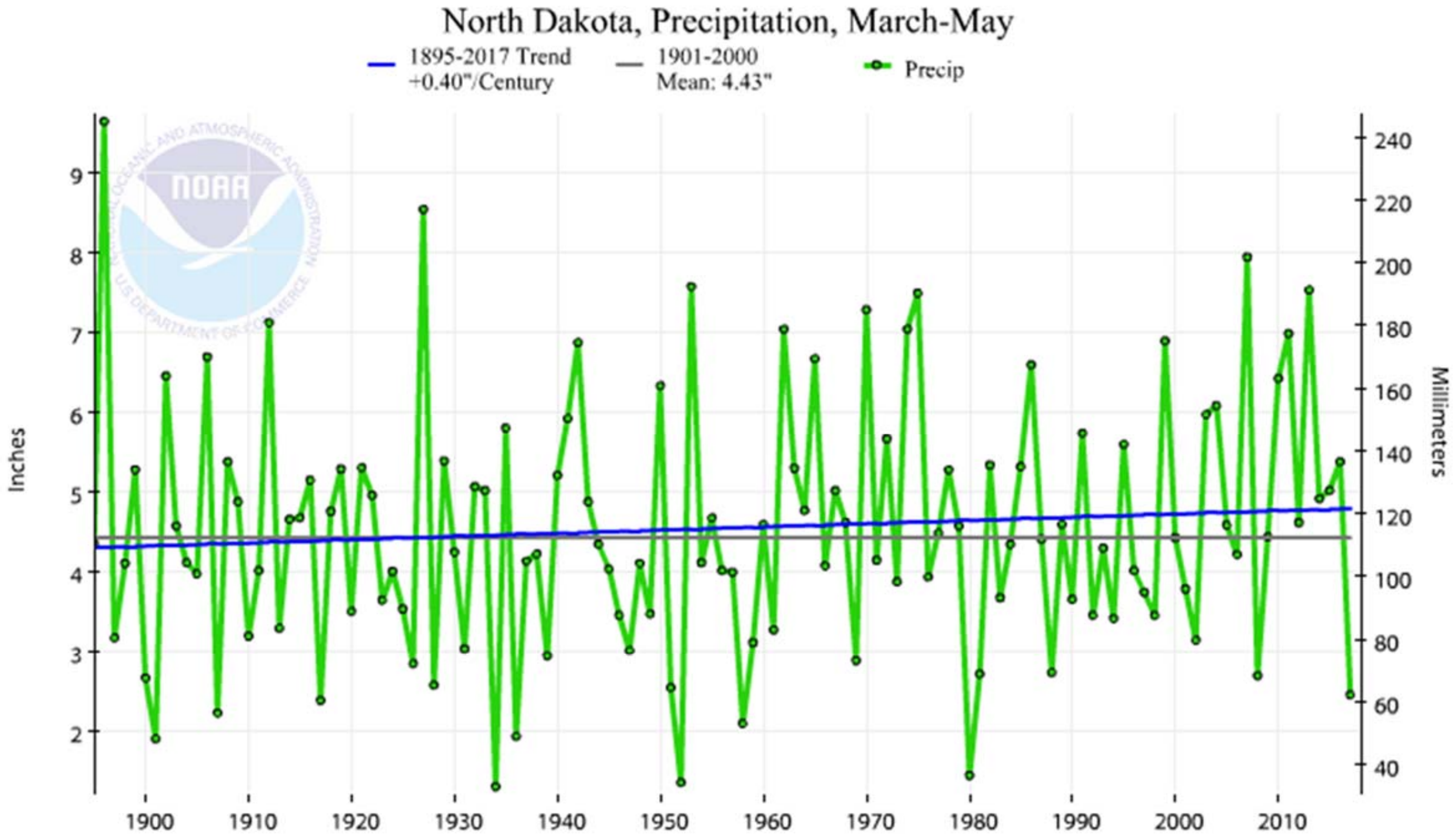


Figure 5. Statewide Drought Coverage and Intensity Index in Spring 2017.

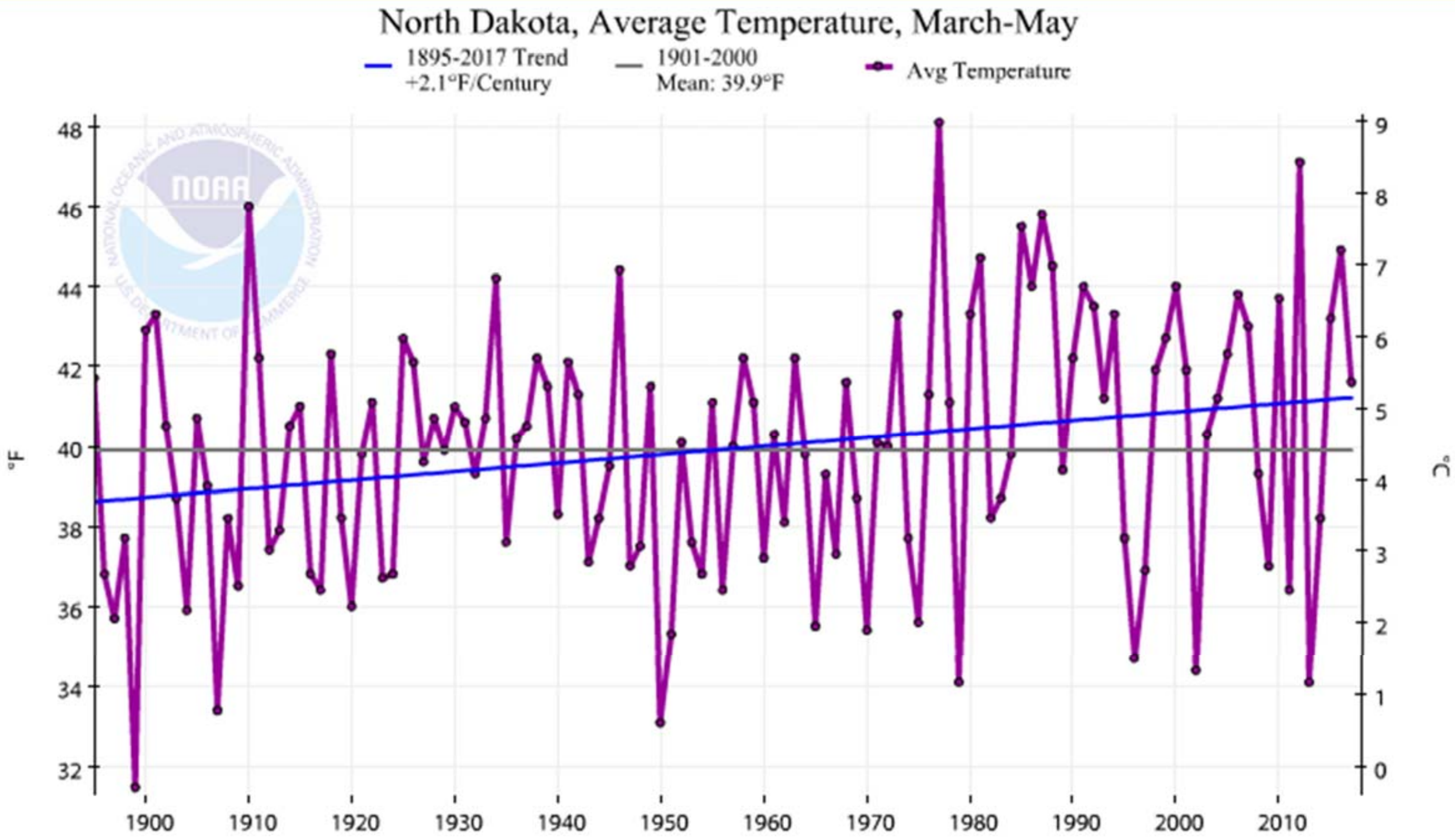
HISTORICAL SPRING PRECIPITATION FOR NORTH DAKOTA



Record High Value: 9.69" in 1896
Record Low Value: 1.3" in 1934
Seasonal Trend: 0.04" per Decade

Spring 2017 Value: 2.45"
1981-2010 Average: 4.58"
Seasonal Ranking: 9th Driest Spring
Record Length: 123 years

HISTORICAL SPRING TEMPERATURE FOR NORTH DAKOTA



Record High Value: 48.1°F in 1977
Record Low Value: 31.5°F in 1899
Seasonal Trend: 0.21°F per Decade

Spring 2017 Value: 41.6°F
1981-2010 Average: 41.3°F
Seasonal Ranking: 38th Warmest Spring
Record Length: 123 years

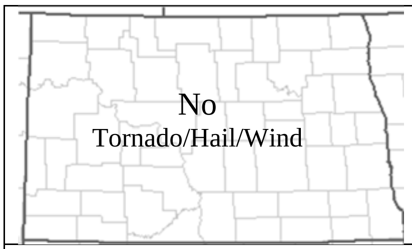
Storms & Record Events

State Tornado, Hail, and Wind Events for Spring 2016-17

Table 2. Numbers in the table below represent the number of tornado, hail and wind events accumulated monthly and seasonally.

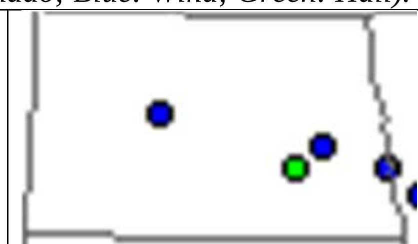
Month	Tornado	Hail	Wind	Total
March Total	0	0	0	**0**
April Total	0	0	0	**0**
May Total	0	1	4	**5**
3-Month Total	**0**	**1**	**4**	**5**

The graphics below show the geographical distribution of the storm events in the table above in each month. The dots are color coded for each event (Red: Tornado; Blue: Wind; Green: Hail).



March 2017 North Dakota Storm Events

April 2017 North Dakota Storm Events.


May 2017 North Dakota Storm Events.

State Record Events for Spring 2017

Table 3. Numbers in the table below represent the number of select state record events (records broken or tied) accumulated monthly and seasonally.

Category	March	April	May	Seasonal Total
Highest Daily Max Temp.	0	1	4	**5**
Highest Daily Min Temp.	14	17	10	**41**
Lowest Daily Max Temp.	9	23	0	**32**
Lowest Daily Min Temp.	3	2	4	**9**
Highest Daily Precipitation	10	7	2	**19**
Highest Daily Snowfall	14	8	0	**22**
Total	**50**	**58**	**20**	**128**

Seasonal Outlook

Summer 2017 Outlook

By R. Kupec[1]

Spring 2017 saw slightly above average temperatures across North Dakota. Precipitation was near average for April and March, then well below average for May, bringing the season as whole to be drier than average. My spring outlook had forecasted temperatures to be near average and precipitation to be slightly above average. Clearly the precipitation portion of the forecast was incorrect. In the fall of 2016, I was asked to give an outlook through summer 2017 for an agriculture conference. At that time, my forecast for the summer was for drier and warmer conditions. My hope is that the spring forecast was incorrect, because dry conditions predicted in my summer forecast arrived early.

At the onset of summer, much of North Dakota is seeing abnormally dry to drought conditions. We are thus beginning the season with a moisture deficit, allowing temperatures to run well above average for the beginning of June. The neutral phase of the La Niña/El Niño sea surface temperature regime in the southern Pacific has firmly taken hold. Most computer models suggest that this will remain into the fall. These conditions tend toward average summer temperatures across the state. Precipitation is somewhat more varied, with western and southern North Dakota seeing slightly above average precipitation and north central and northeastern North Dakota seeing average to below average precipitation.

Despite the historical trends, I believe much of the state will see below average precipitation for the summer with the driest conditions across the south and not quite as dry across the north. Summer 2016 saw an excess of moisture across northern North Dakota while the southern portion of the state was in deficit for much of the season. I believe that pattern will redevelop this summer but will be even stronger, pushing excess moisture even further north into Canada. With drier conditions, expect temperatures across the state to run above average for summer 2017.

The current Climate Prediction Center (CPC) Summer Outlook has a slightly different view with an equal chance of above or below average temperatures for the season (Figure 6a). The CPC also has a 33% chance of above average precipitation across far western North Dakota to the south-central part of the state (Figure 6b). This forecast is more in line with historical observations during neutral La Niña/El Niño, while the forecast presented here is based more on trends over the last few summers. Come August, we will know which forecast was correct.

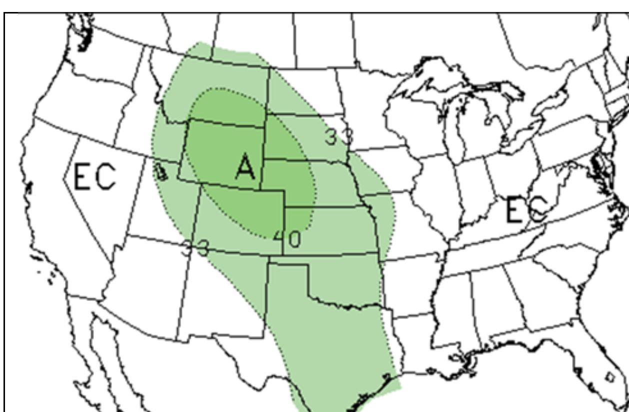


Figure 6a. June through August Temperature Outlook

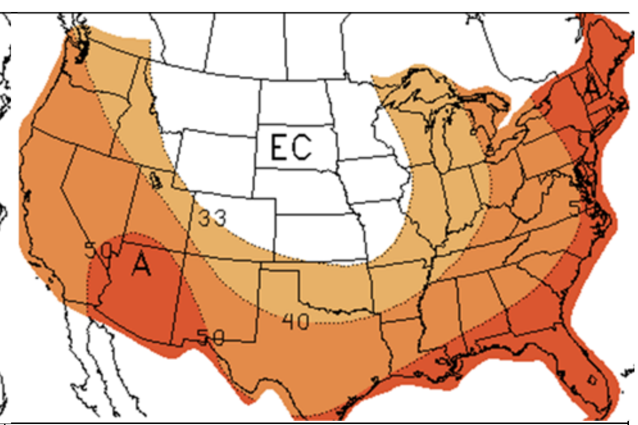


Figure 6b. June through August Precipitation Outlook

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

Hydro-Talk

Is Dry the New Normal?

By A. Schlag[2]

I sure hope not! However, despite the wet fall and early part of winter, the region has been fairly dry since March. In the table, deficits as inches of water tell the story of a worsening situation when it comes to precipitation over the past 180 days. Actually, since the values for the past 30 days tend to make up the bulk of the deficits, the fact is much of this dryness has manifested itself over the past 30-60 days.

Location	Last 30 Days	Last 60 Days	Last 90 Days	Last 180 Days
BISMARCK 5NNW	-2.21	-2.81	-3.14	-1.13
FLASHER	-1.65	-2.07	-2.93	-2.18
GARRISON 1 NNW	-1.78	-1.86	-1.79	Missing
GRAND FORKS UNIV (NWS)	-1.60	-1.21	-1.31	-0.37
HETTINGER EXP STN	-1.78	-1.90	-2.09	-0.25
LANSFORD	-1.52	-2.11	-2.40	0.31
LIDGERWOOD	-1.18	-0.75	-1.93	-1.81
MAYVILLE	-1.19	-0.54	-1.14	-0.19
MINOT EXP STN	-1.98	-2.86	-3.13	M
NEW SALEM 5NW	-1.76	-1.97	-2.53	-1.69
NORTHGATE 5 ESE	-1.01	-1.26	-1.41	0.3
STREETER 7 NW	-1.82	-2.02	-2.65	-0.85
UNDERWOOD	-2.00	-3.21	-3.76	-1.81
WILLOW CITY	-1.65	-1.90	-1.59	-0.74

In fact, Bismarck and Minot just recorded their 4th and 10th driest month of May on record with 143 and 111 years of data, respectively. The heavy snowpack across most of the state that simply disappeared into the soil has thus far been a literal lifesaver to the native vegetation and early crops. Without that reservoir of moisture in the soil, the region would be in far worse shape than what a windshield tour of the state would suggest. Drought designations tend to change very little during winter due to rivers and vegetation being generally inactive, yet conditions are now degrading rapidly with the lack of spring moisture.

While the above US Drought Monitor graphics certainly depict a rapidly worsening situation, the reality is that thus far the impacts are focused on agriculture. Hydrologically speaking, the region is still fairly healthy. Abundant shallow groundwater (not soil moisture) that came from the slow melting of our above normal snowpack this winter is still feeding our small rivers and streams. This is evidenced by the averaged streamflow figures to the right. There are not yet any sites in the Moderate to Severe Hydrologic Drought designation.

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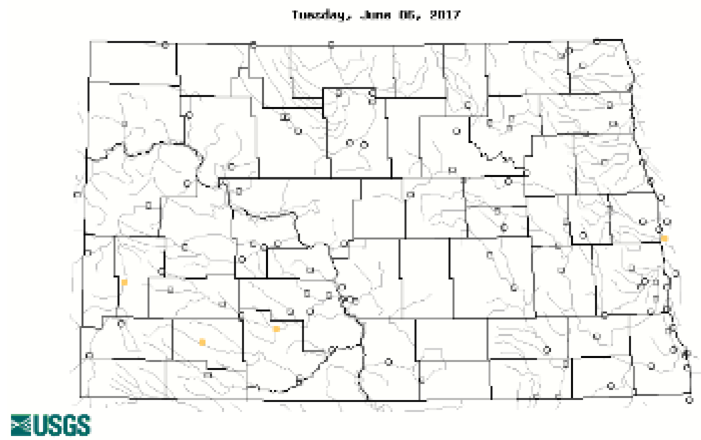
However, the slight increase in the number of sites that are added when looking at the 7-Day average compared to the 28-Day average does suggest there is a limit as to how long we should expect the rivers and streams to be relatively healthy.

Clearly, the western parts of North Dakota have been far drier than we would like. Agricultural impacts are mounting daily as reports of crops that have failed to germinate, pastures and hay land turning brown in the heat, and even my own struggles with getting new fruit trees to take off suggest we need rain and we need it soon to salvage the summer.

Map of below normal 28-day average streamflow compared to historical streamflow for the day of year (North Dakota)

North Dakota or Water-Resources Regions



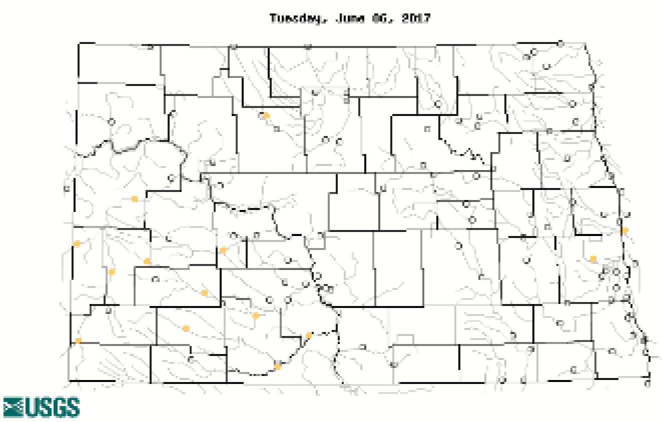
Search USGS streamgage

Choose a data retrieval option and select a location on the map
List of all stations · Single station · Nearest stations

Explanation - Percentile classes				
New low	<=5	6-9	10-24	Not ranked
Extreme hydrologic drought	Severe hydrologic drought	Moderate hydrologic drought	Below normal	

Map of below normal 7-day average streamflow compared to historical streamflow for the day of the year (North Dakota)

North Dakota or Water-Resources Regions All Days



Search USGS streamgage

Choose a data retrieval option and select a location on the map
List of all stations · Single station · Nearest stations

Explanation - Percentile classes				
New low	<=5	6-9	10-24	Not ranked
Extreme hydrologic drought	Severe hydrologic drought	Moderate hydrologic drought	Below normal	

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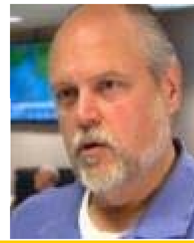
Science Bits



Trees vs. ND Weather and Climate Extremes

By G. Gust[3] and J. Zeleznik[4]

The Fargo Tornado of '57. This photo was taken in the spring of 2007, in preparation for the 50th Anniversary of the Fargo Tornado of 1957, looking south along 4th Street, south of 14th Ave north. Note the gaps beginning to show in the rows of older trees, and the interjection of a few newer homes (post 1957) in the row of older style homes. This marks the southern edge of the path of that Historic F5 Tornado, even to this day. [Photo by Gregory Gust]

When one thinks of trees in North Dakota, one quickly thinks of the essential protection they provide from our incessant wind, blinding blizzards, choking dust, driving rains, and from the blazing heat and sun of summer. Trees can also serve as a source of nutritious food (seeds and fruit), remarkable beauty, and at times, firewood.

My earliest thoughts on trees recall the challenges I had as a youngster, attempting to plant and nurture young trees on our family farm. They increased the diversity, beauty, flowers, and fruit among the existing mix of cottonwood, ash, and boxelder shelterbelts which were planted by my father and grandfather long before me.

As a weather guy, I often see the story of our Northern Plains weather and our climate written in our treescape. From the semiarid High Plains in the west, across the rolling shortgrass prairies and intensely farmed open valleys of the Dakotas, into the boreal forest interface of Minnesota, presence or their absence of trees tell us stories about of the extremes of weather and climate in our region. They provide clues about what this region has experienced in recent generations.

More often now I'm drawn to the damage inflicted on trees by winter and summertime storms that can bring damaging downburst winds. They can lay mile upon mile of shelterbelts to the ground, or a tornado can carve a more narrow path through elegant rows of trees in countryside and city alike. Heavy ice covered branches can give way under the force of the wind. Today I can still drive through a city like Fargo and see the path of the Historic Tornado of '57 showing in the trees of North Fargo, where older elms give way to a younger, more diverse stock.

The Role of Wind: Among factors which may limit a tree's ability to thrive and survive, the wind and storm-related tree damage are perhaps the most readily discernible. Broken branches and limbs often cover our streets and roads following the passage of massive summertime downburst winds, and even a

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[4] Dr. Joseph Zeleznik is an Extension Forester with the Natural Resources Management Program of NDSU. Email: joseph.zeleznik@ndsu.edu

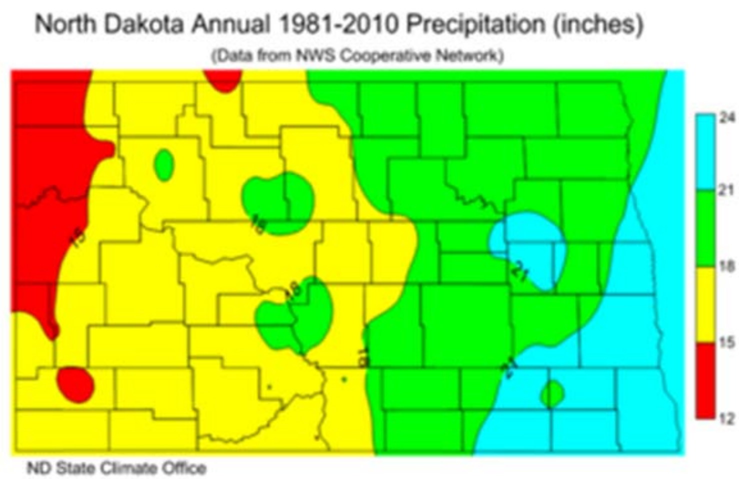
Ice and Wind. The November 25th 2005 (Thanksgiving Weekend) Ice Storm coated trees and powers lines across southern Richland County with an inch or more of ice. The next day, over a foot of snow and blizzard force winds tore many of those ice coated tree branches and powers lines down to the ground. [Photo courtesy of Brett Lambrecht, Richland Co. Emergency Management]

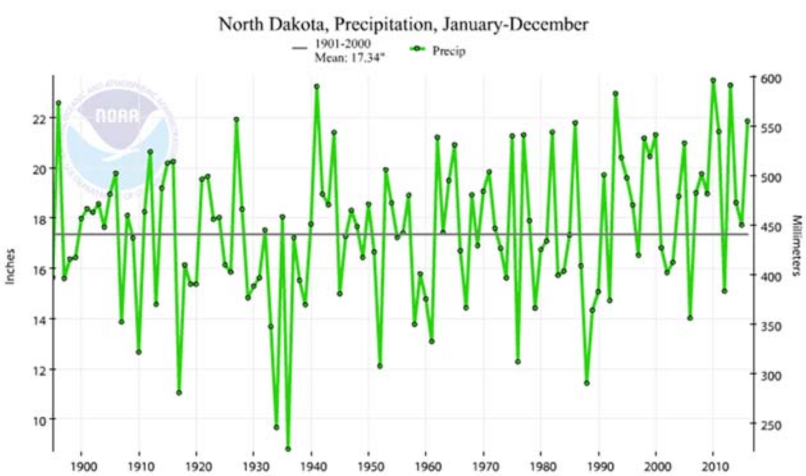
rare tornado. In such a way, wind can also be a limiting factor, as repeated exposure to extreme wind damage could make it impossible for a tree to become established.

Well-established trees may also be damaged by wind extremes and become susceptible to a range of disease or insect infestation which it would have otherwise fended off. Singular trees and shelterbelts alike can be very resilient on their own, but most will benefit from careful trimming and removal of damage.

In winter the brutal combination of ice and winds can wreak havoc on tree branches as well as power lines. Yet a quick response with careful trimming can often save the basic tree. In a few years' time, heavily damaged areas can fill back in again, with added character, of course!

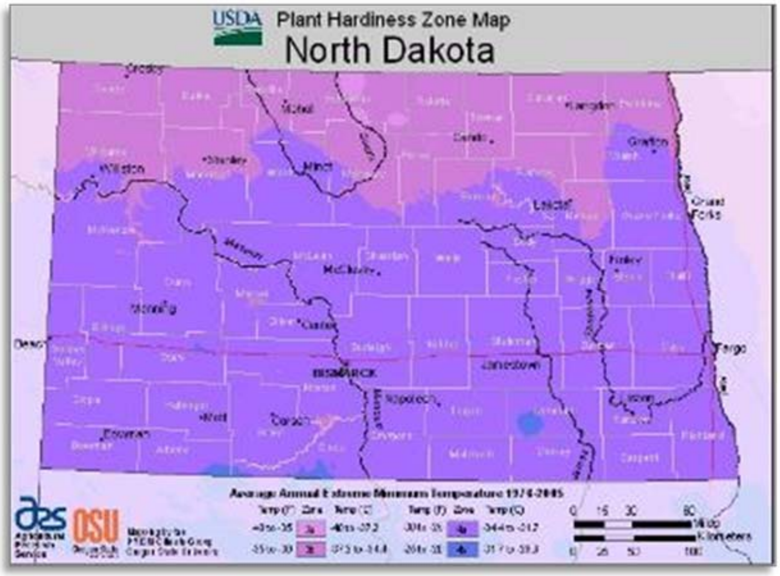
The Role of Precipitation:
Precipitation is probably the primary limiting factor to the growth and expansion of trees across the area. North Dakota sees a wide range in average annual precipitation from <15 inches in the northwest to >21 inches in the southeast (See the figure on the right). There is a sizable increase in the amount of vegetation (including trees) in the natural landscape in wetter areas.





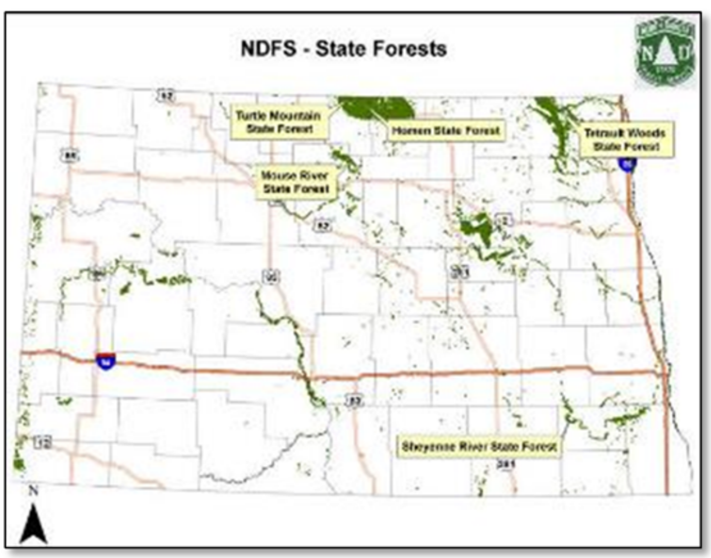
Yet the interannual rainfall across the state is also quite variable, with it being quite common for any area of the state to receive half the normal rainfall in one year and nearly twice the normal rainfall in the next (see the figure on the left). Thus annual and perennial grasses and plants show a better overall resiliency to such dramatic changes in precipitation and overall moisture availability.

The Role of Temperature:
Temperature is another primary limiting factor to the growth and survivability of trees. Once again, North Dakota has temperature extremes: both in regards to magnitude and variability.



Certain trees can be more vulnerable to the low extreme temperatures. The USDA Plant Hardiness Zones Map for North Dakota shows a range of average annual extreme minimum temperatures of from -40F in far northern ND to -25F in the far south. Most of the state vacillates somewhere between Zones 3a and 4b. However, record minimum temperatures range from -60F in the northwest to around -40F in the southeast. Such extremely cold winter temperatures are more likely to impact the cambium layer of younger saplings, but prolonged exposure to such extremes of cold can harm mature trees as well.

Just where are our ND forests? In the semi-arid west, trees are usually evident on the landscape but are typically more compact than their eastern relatives, growing in ravines where a more regular source of ground water may sustain them during protracted periods of drought. Larger natural cottonwood groves are limited to the regularly flooded valley floors of the western rivers.



Meanwhile, the more humid east is home to larger and more numerous natural treescapes along its rivers and streams. Add to that the hundreds of miles of shelterbelts and landscape trees which have been planted around farmsteads and towns, or across fields, which easily survive on the more regular supply of rainwater and melting snow available there.

Somewhat unique in our treescape display are the mixed deciduous forests of the eastern and north-central portions of the state (see map on the left). These State Forests represent a fairly natural distribution of native trees as they may well have appeared to early pioneers.

For more information on ND forests, check out these links:

- ND Changing Landscapes/National Forest: http://ndstudies.gov/gr8/content/unit-iii-waves-development-1861-1920/lesson-1-changing-landscapes/topic-7-national-forest/section-1-forest
- North Dakota Forest Health: https://www.fs.fed.us/foresthealth/fhm/fhh/fhh-03/nd/nd_03.pdf

Trees and cold hardiness (J. Zeleznik): USDA Hardiness Zones are used to establish the cold tolerance of plant species. That is, a typical cold temperature that a plant might face during the winter. While the Hardiness Zones are not perfect, they give a great place to start when selecting new tree species or cultivars to plant.

One process involved in dormancy is called the “chilling requirement.” Each tree species or cultivar needs a certain number of hours below (about) 45°F before it can break dormancy in the spring. For example, one cultivar of American linden might need 1000 hours below 45°F while another cultivar might need 1500 hours before they can start growing in the spring. If a tree doesn’t get enough chilling hours, it will grow very poorly the following year and often will begin a slow decline until it dies. Insufficient chilling hours is rarely an issue in the northern Plains.

The challenge faced here is when trees’ chilling requirements are met early, and then we have a mid-winter warm up which is followed by colder temperatures. For example, in early January 2012, high temperatures were in the 40s and 50s for a week. Many hybrid maple trees broke bud and began flowering. Then it got cold again with minimum temperatures nearly -20°F in the following week. Many of these trees died back and had to be removed. Colorado blue spruce is another species that often suffers winter injury following those mid-winter warmup periods.

Often we see these big warmups in February or March; the problem is more common in the western part of the state. I call this type of event the “mid-winter fake out.” Springtime temperatures appear to have arrived yet it’s not really spring. Our native tree species don’t break bud and begin growth because their chilling requirements haven’t been met. They know better and don’t fall for the “fake.”

I’m not suggesting that people stop planting non-native tree species. Increasing the diversity of forests and tree resources is a good thing. However, keep in mind that “hardiness” goes beyond the concept of the extreme cold temperatures experienced during winter. Those maple trees could withstand 30 below temperatures, but they couldn’t withstand the cold-warm-cold fluctuation in temperature. So be prepared to replace those non-native trees, occasionally.

In Summary, our weather and climate are hard on trees and is probably the main reason North Dakota looks the way it does. A gently rolling grassland “prairie” with ribbons of trees marks our rivers and a smattering of shelterbelts mark our farms and towns. Our weather extremes challenge us to clean up after all our storms and do our best to maintain the trees we have.

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.

North Dakota State Climate Office

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