North Dakota Climate Bulletin

Summer 2020 Volume: 14 No: 3

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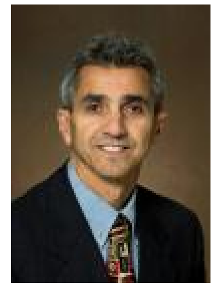
From the State Climatologist



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, Fargo, N.D.

The overall summer average temperature was 2.2 degrees warmer than average, which would make it the 10th warmest summer on record. Precipitation-wise, the statewide accumulation was 0.09 inch wetter than average, which would make it the 58th wettest (69th driest) summer on record. A severe drought category was introduced as a result of progressive dryness in Burleigh and Morton counties. Earlier in the summer season, Bismarck was experiencing the driest year-to-date period on record since 1875. Eastern North Dakota remained wet throughout the season, causing the Red River of the North to run well above its usual stages. A summary of the statewide drought and flood concerns can be found in the Hydro-Talk portion of this bulletin.

Overall, 143 records, including temperature- and precipitation-related occurrences across the state, were tied or broken, and 493 significant storm reports were recorded.

Detailed monthly climate summaries for June, July and August, along with several other local resources for climate and weather information, can be accessed at www.ndsu.edu/ndsco.

Adnan Akyüz, Ph.D., North Dakota State Climatologist

Double rainbow at sunrise by Tanya Akyüz, Fargo, N.D.

Weather Highlights

Seasonal Weather Summary: By Adnan Akyüz

Precipitation

Using analysis from the National Centers for Environmental Information (NCEI), the average North Dakota precipitation for the summer season (June 1 through Aug. 31, 2020) was 8.39 inches, which was 5.97 inches greater than the last season (spring 2020), but 0.93 inch less than last summer (2019 season), but 0.09 inch more than the 1981-2010 average summer precipitation (Table 1). This would rank the summer of 2020 as the 58th wettest (69th driest) summer since such records began in 1895.

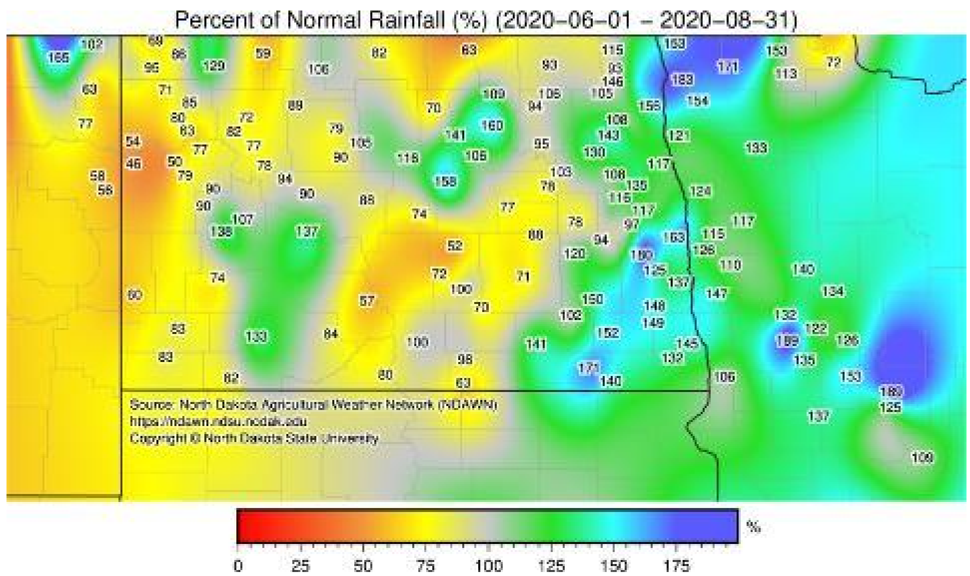


Figure 1. Precipitation percent of normal in summer 2020 for North Dakota. (North Dakota Agricultural Weather Network, NDAWN)

The numbers less than 100 in Figure 1 are shaded in yellow and red to depict the region with below-average rainfall. In contrast, the numbers greater than 100 in the same figure are shaded in green, blue and purple to depict the region with above-average rainfall. The greatest seasonal precipitation accumulation of the season was 16.81 inches, recorded in Enderlin, Ransom County. Based on historical records, the state average summer precipitation showed a positive long-term trend of 0.21 inch per century during this period of record since 1895. The lowest and highest seasonal summer precipitation for the state ranged from 3.32 inches in 1929 to 15.65 inches in 1993. The Historical Summer Precipitation for North Dakota time series (Figure 2) shows a graphical depiction of these statistics.

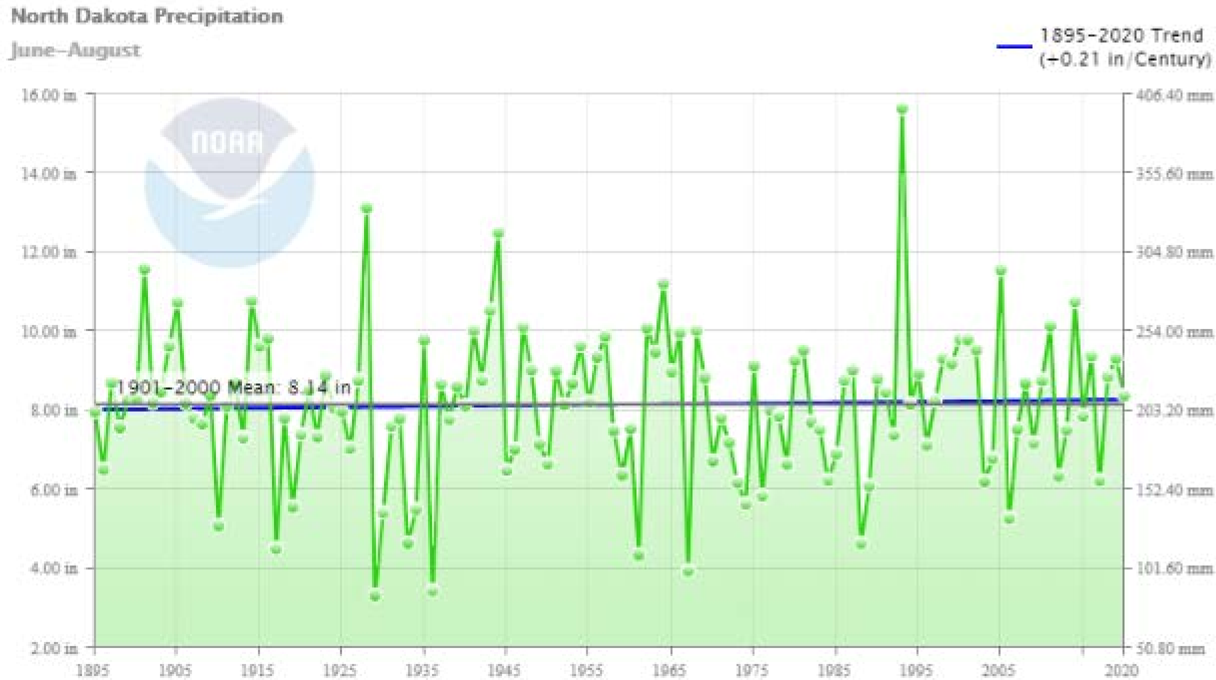


Figure 2. Historical summer precipitation time series for North Dakota.

Table 1. North Dakota Summer Precipitation Ranking Table[1].

Period	Value	Normal	Anomaly	Rank	Wettest/Driest Since	Record Year
Summer 2020	**8.39”**	**8.3”**	0.09”	**69th driest** **58th wettest**	**Driest since 1917** **Wettest since 2019**	**3.32” (1929)** **15.65” (1993)**

[1] NOAA National Centers for Environmental Information, Climate at a Glance: Statewide Time Series, published December 2019. Retrieved on Dec. 11, 2019, from www.ncdc.noaa.gov/cag.

Temperature

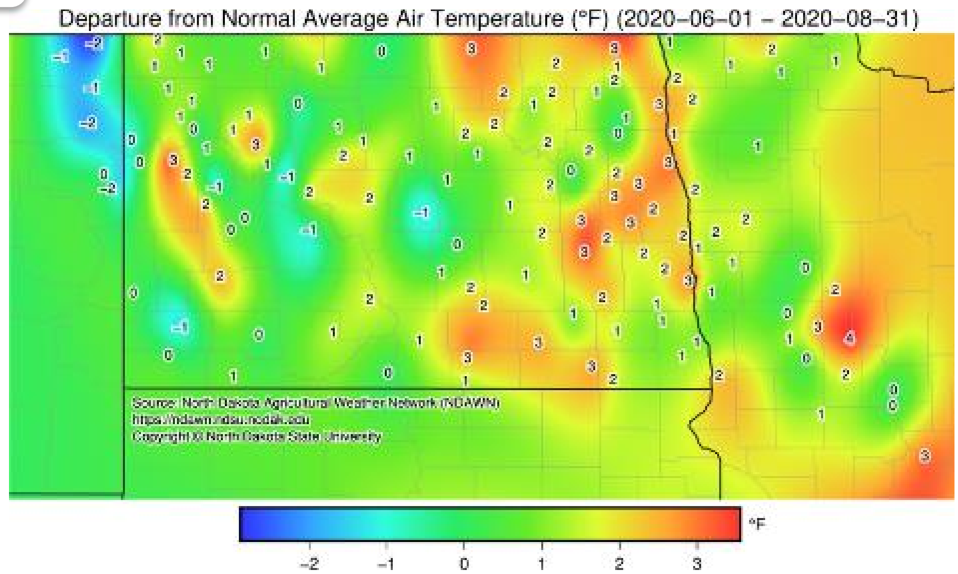


Figure 3. Temperature departure from normal in summer 2020 for North Dakota. (North Dakota Agricultural Weather Network)

The average North Dakota temperature for the season (June 1 through Aug. 31) was 68.9 F, which was 29 degrees warmer than the last season (spring 2020), and 2.6 degrees warmer than last summer (2019 season). It was 2.2 degrees warmer than the 1981-2010 average summer temperature, which would rank summer 2020 as the 10th warmest summer since such records began in 1895 (Table 2). Figure 3 shows the departure from normal temperature distribution geographically. The negative numbers in Figure 3 are shaded in green and blue to depict the region with below-average temperatures. In contrast, numbers equal to or greater than zero in the same figure are shaded in orange and red to depict the region with average to above-average temperatures. Based on historical records, the average summer temperature showed a positive trend of 0.2 degree per decade since 1895. The lowest and highest seasonal summer temperatures for North Dakota ranged from 61.2 F in the 1915 season to 72 F in the 1936 season. The Historical Summer Temperature for North Dakota time series (Figure 4) shows a graphical depiction of these statistics.

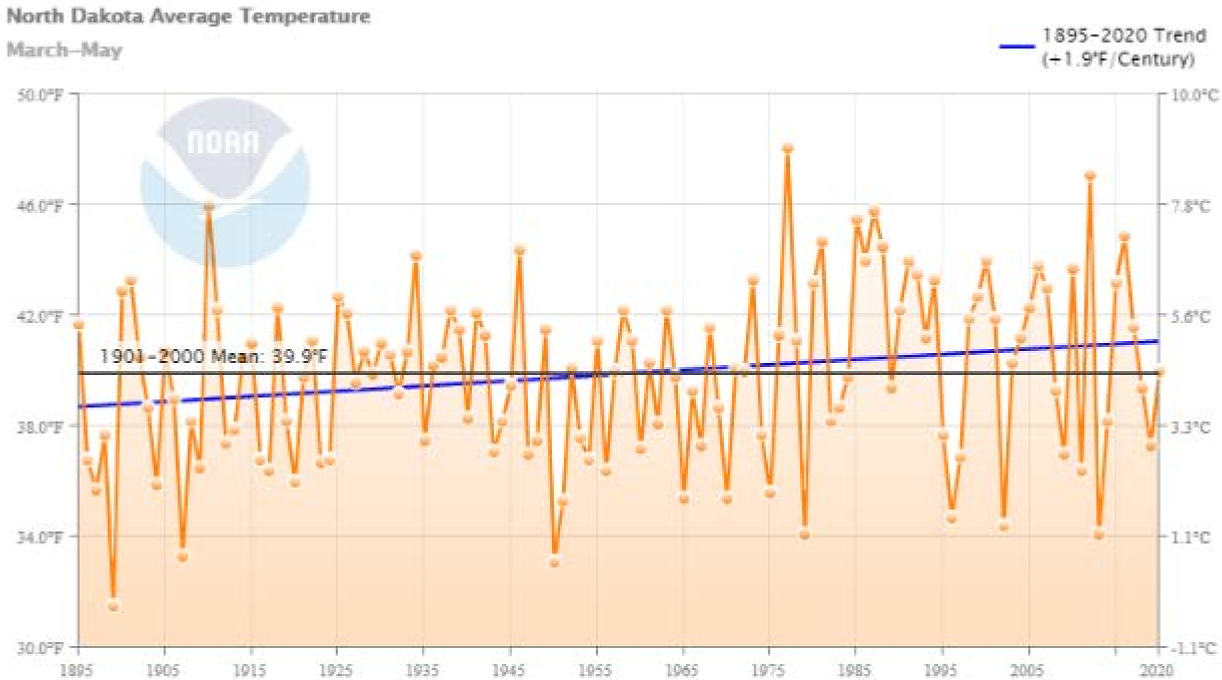


Figure 4. Historical summer temperature time series for North Dakota.

Table 2. North Dakota Summer Temperature Ranking Table[2].

Period	Value	Normal	Anomaly	Rank	Warmest/Coolest Since	Record Year
Summer 2020	68.9 F	66.7 F	2.2 F	117th coolest 10th warmest	Coolest since 2019 Warmest since 2012	61.2 F (1915) 72 F (1936)

[2] NOAA National Centers for Environmental Information, Climate at a Glance: Statewide Time Series, published December 2019. Retrieved on Dec. 11, 2019, from www.ncdc.noaa.gov/cag.

Drought: The drought conditions intensified throughout the season. By the end of the season, 17% of the state was in moderate drought, with 1.2% of it in the severe srought (D2) category. By this time, Bismarck had the lowest year-to-date precipitation on record. Figure 5 below shows the drought conditions in the beginning and the end of summer. Figure 6 shows the drought intensity and coverage in a time scale. Both of the figures show no drought conditions spatially and temporally.

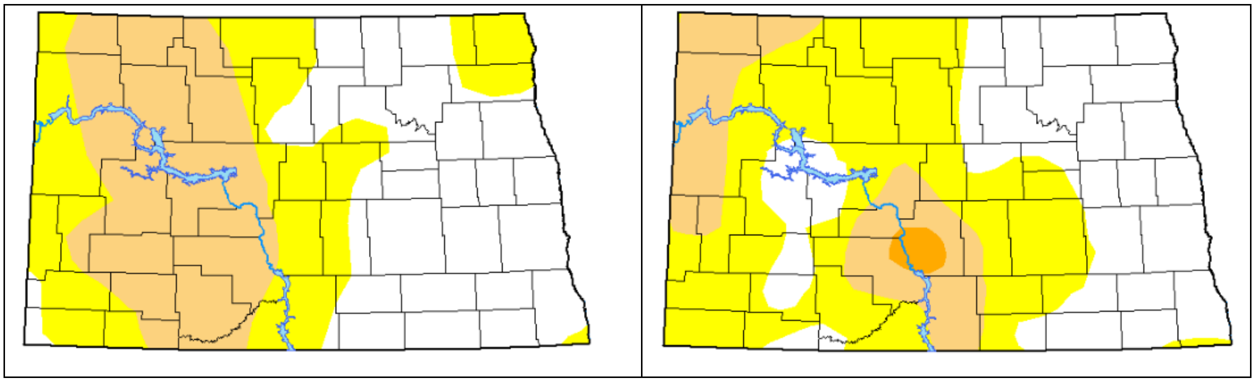


Figure 5. Drought Monitor map comparison for North Dakota in the beginning (on the left, 5a) and at the end (on the right, 5b) of summer 2020. (U.S. Drought Monitor)

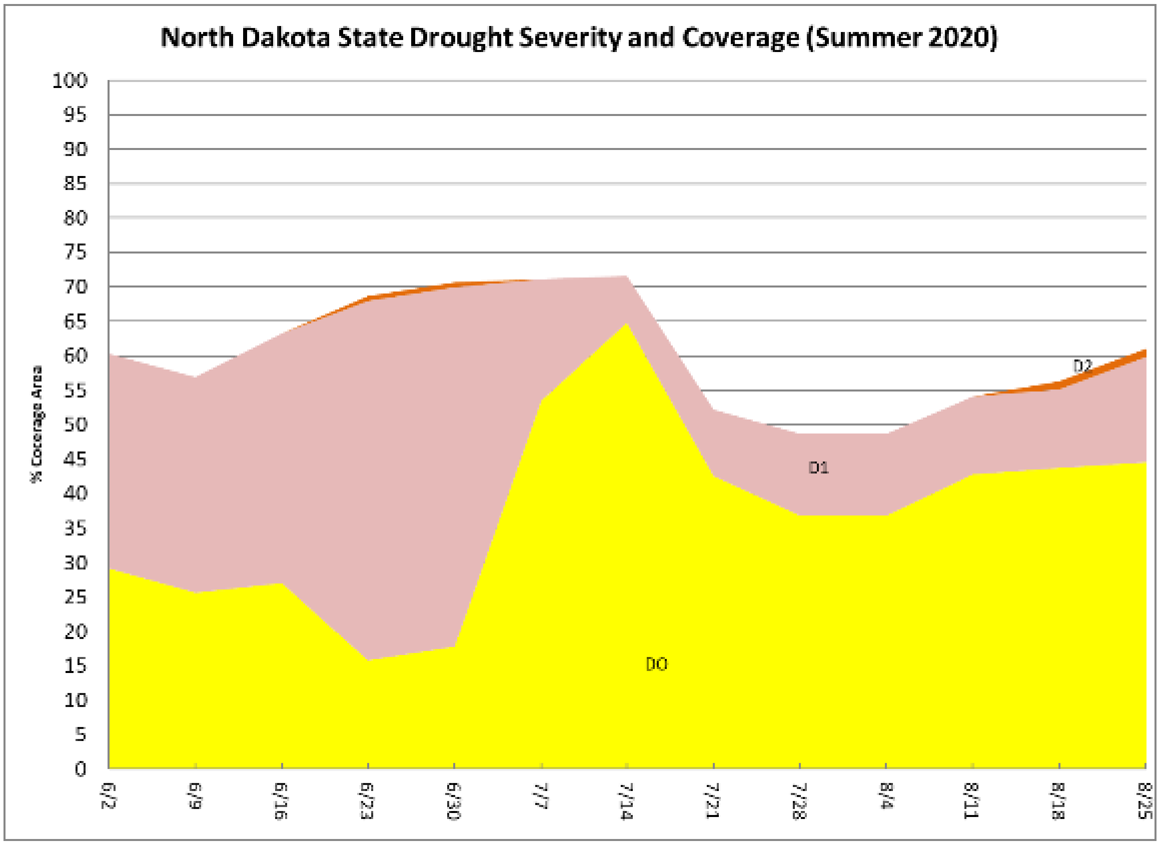


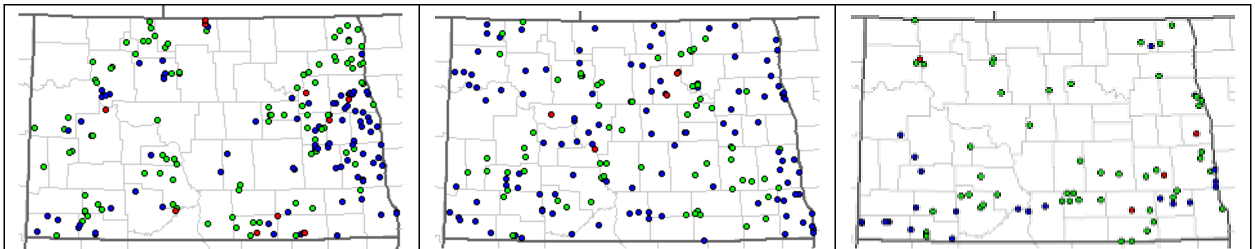
Figure 6. Statewide drought coverage in percentage and intensity (DO, D1, etc.) in a time scale representing the state from the beginning to the end of the season, with a one-week resolution in summer 2020.

Storms and Record Events

State Tornado, Hail and Wind Events for Summer 2020

Table 3. The numbers in the table below represent the number of tornados and hail and wind events accumulated monthly and seasonally.

	June	July	August	Seasonal Total
Tornado	12	5	4	**21**
Hail	106	66	49	**221**
Wind	93	132	26	**251**
Total	**211**	**203**	**79**	**493**



June	July	August
North Dakota Storm Events	North Dakota Storm Events	North Dakota Storm Events

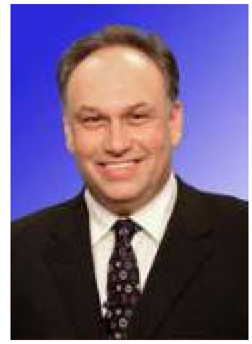
Figure 7. Geographical distribution of the storm events in the table above in each month. The dots are color-coded for each event (red: tornado; blue: wind; green: hail).

State Record Events for Summer 2020

Table 4. The numbers in the table below represent the number of select state record events (records broken or tied) accumulated monthly and seasonally.

Category	June	July	August	Seasonal Total
Highest daily max. temp.	19	1	13	**33**
Highest daily min. temp.	21	11	7	**39**
Lowest daily max. temp.	0	2	5	**7**
Lowest daily min. temp.	4	0	5	**9**
Highest daily precipitation	10	34	11	**55**
Highest daily snowfall	0	0	0	**0**
Total	**54**	**48**	**41**	**143**

Seasonal Outlook



Fall 2020 Outlook — By R. Kupec[3]

Summer 2020 brought warmer than average temperatures to nearly all of North Dakota. Precipitation was markedly different from east to west. Most of the Red River Valley had above-average rainfall, while generally, areas west of the valley tended to be dry. The summer climate outlook called for average to slightly below average precipitation and temperatures near seasonal averages. The temperature forecast proved correct for about the western two-thirds of the state, while nearly no location was “slightly below average” in precipitation. This is further proof that summer is, in many ways, the most difficult season to forecast.

As we head into fall 2020, signs are pointing toward a developing La Niña in the South Pacific. (La Niña is cooler than average sea surface temperatures in the South Pacific that can change the flow of the jet stream across North America.) Current conditions are analogous to fall 2016 and also close to fall 2017. Both of those autumns had precipitation that tended to be below average and temperatures that were warmer than average. November of 2016 was one of the warmest Novembers on record for North Dakota. There is a correlation between a developing La Niña and warmer autumns, particularly the months of October and November. Sea surface temperatures in both the Northern Pacific and Atlantic Oceans remain warm and sea ice in the Arctic is on the low side. According to the National Snow and Ice Data Center, “Sea ice extent stood at 5.15 million square kilometers (1.99 million square miles) on August 17, essentially tied with 2007 for the third-lowest extent for the date since the satellite record began in 1979.” This means North America is surrounded by relatively warm water; therefore, most of the U. S. and North Dakota should experience warmer than average temperatures for the fall season.

Precipitation during La Niña conditions in the fall trends toward average across all of North Dakota. A deeper examination does find in years with warm water in the Northern Pacific and a developing La Niña a trend for wet Septembers followed by drier Octobers and closer to average precipitation for November. So far, September has begun on the dry side in much of the state but this comes after some spots saw large amounts of precipitation in August. It is possible that this is a sign of the La Niña fall pattern developing early.

The current Climate Prediction Center (CPC) fall outlook has a similar outlook for temperatures, calling for above-average temperatures for all of North Dakota and, for that matter, all of the continental U.S. (Figure 8a). The CPC precipitation forecast gives an equal chance of above- or below-average precipitation for all but the far northwestern corner of the state (Figure 8b). The next 90-day outlook from the CPC should be available after Sept. 17 at www.cpc.ncep.noaa.gov/products/predictions/90day.

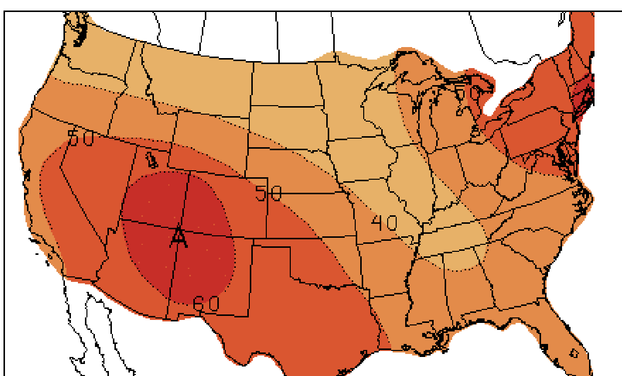


Figure 8a. September through November temperature outlook. (Climate Prediction Center, NOAA)

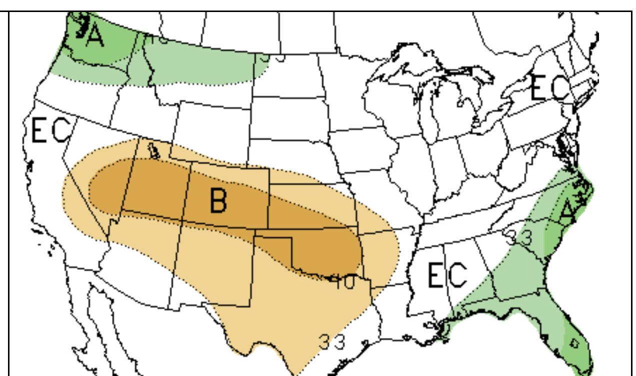


Figure 8b. September through November precipitation outlook. (Climate Prediction Center, NOAA)

[3] The corresponding author, Rob Kupec, is chief meteorologist at KVRR-TV in Fargo, N.D. Email: rkupec@kvrr.com

Hydro-Talk

Too much water during a drought? By A. Schlag[4]

During the past several years, drought has been a general topic for us across North Dakota. Again, when looking at the U.S. Drought Monitor map of North Dakota, we see vast swaths of the state under some degree of unusually dry conditions (Figure 5b). However, across much of the state, surface waters have been rising for years. We have all heard about the problems caused by the rise in Devils Lake, but what is just as important to many residents is the rise that they have observed in their own little corner of the world. From Rice Lake in Ward County to Twin Lakes in LaMoure county, and all the way back over to yet another Rice Lake in Emmons county, rising water across the state has been a problem for several years. Indeed, homes have been destroyed, major roadways such as I-94, Highway 83 and numerous state and county roads have been closed or raised in recent years. Similarly, productive agricultural land has been swallowed by the rising water and rendered unusable for perhaps a generation.

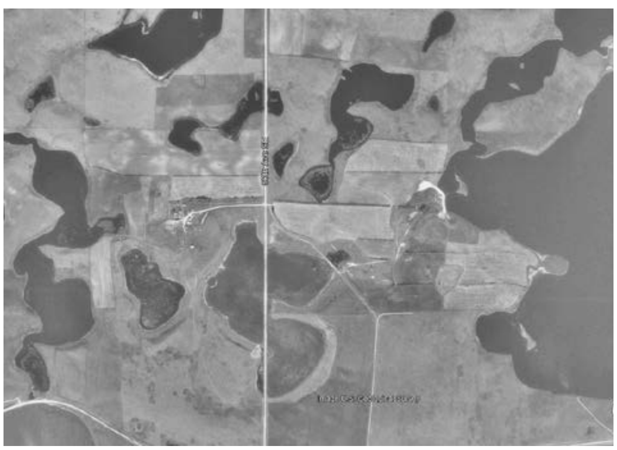


Figure 9a. Google Earth image dated 9/24/1997.

Figure 9b. Google Earth image dated 6/3/2017.

In Figures 9a and 9b, I somewhat randomly picked an area near Medina to look at with Google Earth Pro. The trick to understanding how this rise is possible during a period marked by notable droughts is in understanding the importance of timing for the precipitation. While all precipitation is created equally, its effect on the countryside is often very different. Winter rains and snow tend to be conserved for the spring melt and runoff season, while summer rains see the lion’s share of moisture undergo evapotranspiration within a few days and end up back in the atmosphere. Then as autumn approaches, by mid-September, the evapotranspiration becomes minor as temperatures fall and vegetation rapidly goes dormant in anticipation of winter. Based on this generic description of the seasonality of water availability for replenishing ground and surface waters, the two seasons where significant water is usually available for causing an increased recharge are spring and fall. So, while we have had our fair share of droughts, they are often centered around the growing season where impacts on agriculture are very important to the region. Conversely, large rain and snow events have created unusually generous recharge to ground and surface waters during the spring melt seasons, and though less frequent, fall also has been a season of multiple large rain and snow events during the past several years.

[4] The corresponding author, Allen Schlag, is the service hydrologist at the NOAA’s National Weather Service in Bismarck, N.D. Email: Allen.Schlag@noaa.gov

With all that being said, what's the prognosis for a continuation of this above historically normal runoff even in the midst of frequent droughts? Well, I don't have a crystal ball that allows me to look multiple years down the road, but I do have the Climate Prediction Center (CPC) to help me with the upcoming winter. A La Niña advisory issued by the CPC is already in place and is expected to last through the 2020-2021 winter season. Figures 10a and 10b are a bit of an early look at the upcoming winter season.

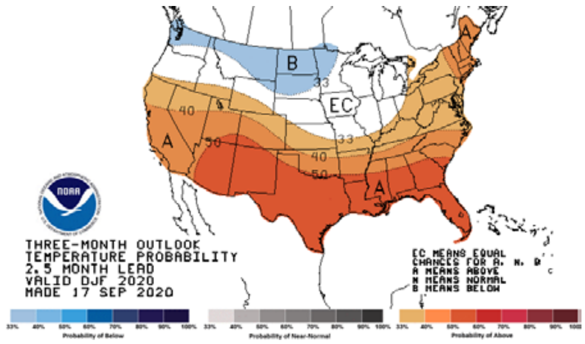


Figure 10a. CPC temperature outlook for DJF.

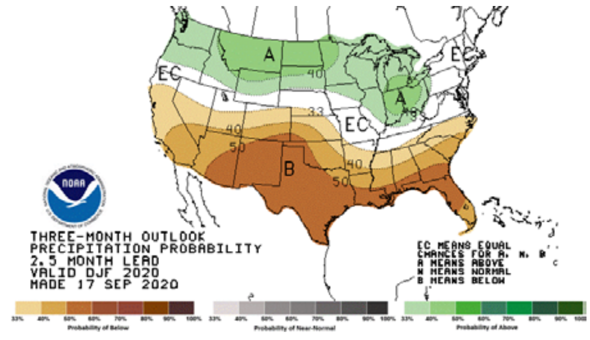
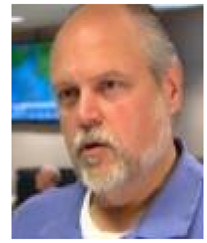


Figure 10b. CPC precipitation outlook for DJF.

Even though December-February (DJF) is considered meteorological winter, March's importance cannot be overstated when it comes to the spring flood season. Regrettably, the JFM and FMA counterparts to the above images suggest a greater than normal risk of being cooler than normal with above-normal precipitation. If such a future were to come to fruition, there is a real risk of going into the spring melt with an above normal snowpack. Winter seasons, as that favored for this year, are exactly what have contributed so greatly to all the rising water in North Dakota during the past 20+ years.

ndsco Science Bits



The Derecho - Summer's most extreme downburst winds

By G. Gust[5]

The highly publicized, extremely damaging and conspicuously named **Midwest Derecho of 10 August 2020** may end up qualifying as one of the U.S.'s Top 10 natural disasters of this seemingly disaster-prone year. Check out the YouTube presentation on this storm, hosted by the Midwest Climate Center[6]. Referred to by many as an "Inland Hurricane"[7], this storm was neither so rare nor so categorized.

The storm type is properly called an *MCS*. Unlike its tropical cousin, this extra-tropical storm is more correctly categorized as a Meso-scale Convective System, or MCS, and most commonly called a *squall line* – a type of organized line of thunderstorms, often producing strong thunderstorm outflow and "straight-line" wind damage, versus the circular wind damages common to a tornado (Fujita 1981)[8].

The radar signature (Figure 11) most often seen with these storms is referred to as a *bow echo*, based on the bowing shape of the leading edge of the storm once it starts to produce downburst winds. Preliminary wind or wind damage reports are indicated by the blue "w" symbol on the map.

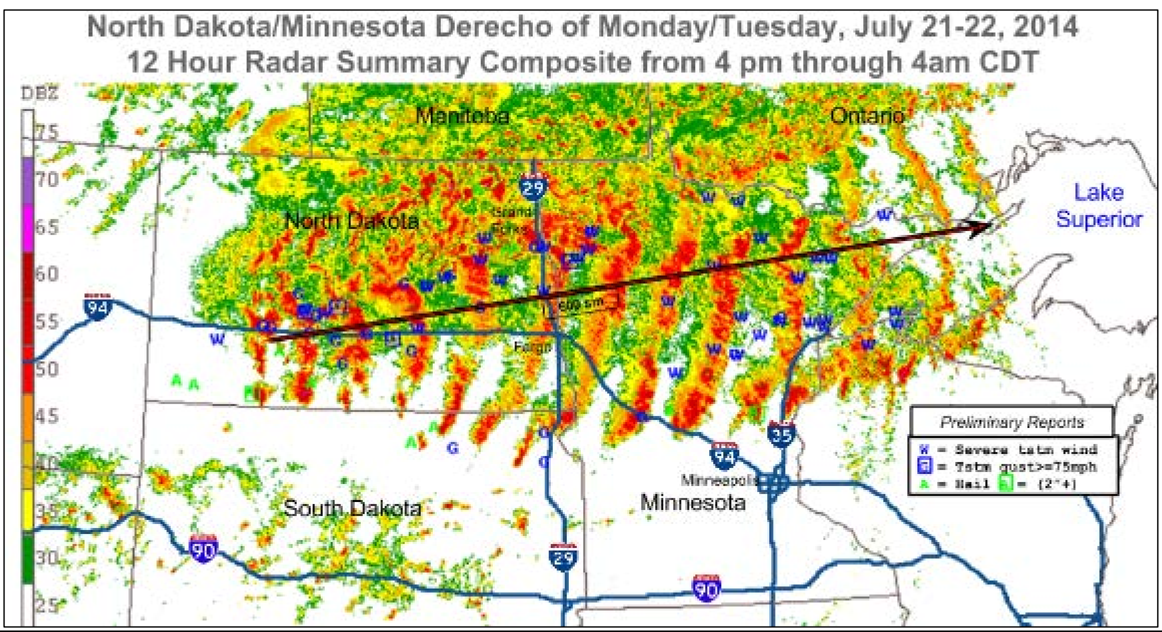


Figure 11. **The North Dakota/Minnesota Derecho of July 21, 2014**. The hourly radar composite shows the progression of an MCS, which crossed most of North Dakota and all of northern Minnesota in less than 12 hours. Image courtesy of the Greg Carbin and NWS/ Storm Prediction Center.

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[5] Greg Gust is the warning coordination meteorologist at the National Weather Service, Grand Forks, N.D. Email: gregory.gust@noaa.gov

[6] https://mrcc.illinois.edu/multimedia/news.jsp

[7] Doyle Rice, Deadly derecho leaves path of destruction across the Midwest, 800,000 without power, USA Today, Aug. 11, 2020. www.usatoday.com/story/news/nation/2020/08/11/derecho-inland-hurricane-destruction-midwest-iowa-illinois-indiana/3343472001/

[8] Fujita, T.T., 1981: Tornadoes and downbursts in the context of generalized planetary scales. *J. Atmos. Sci.*, **38**, 1511–1534.

A later investigation identified many more wind and hail reports and six distinct tornadoes embedded within the overall downburst wind patterns, as shown in this updated Storm Prediction Center (SPC) map (Figure 12). Most all of these extreme wind gusts were produced by thunderstorm downbursts of one type or the other. And many of these were recorded during one of the frequent derecho-scale storms that cross our state.

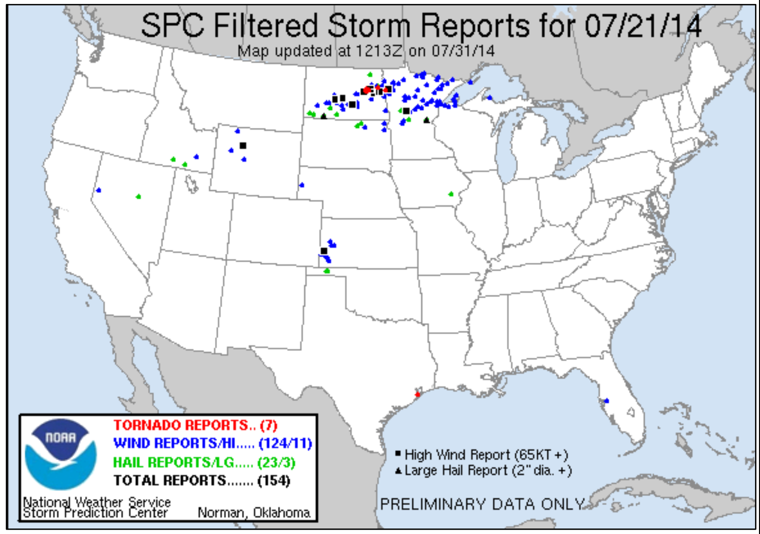

Figure 12. Storm reports on July 21, 2020. (Storm Prediction Center, SPC)

Its damage scale makes it a *derecho*. An MCS can be relatively peaceful and produce widespread rain across a fairly large area. Or it can be quite intense and produce areas of very heavy rain, damaging downburst winds and large wind-driven hail, and contain even a few embedded tornadoes.

In a recent update (Corfidi et al. 2016)[9], the **derecho** is now defined as a family of particularly damaging downburst clusters, either serial or progressive, produced by an MCS and having a sustained bow echo, which produces damage primarily from straight-line winds, and over a swath of at least 400 miles in length. (Previously: >250 miles, Johns and Hirt 1987)[10].

How is such a large wind damage footprint produced?

In SkyWarn Spotter classes, I often teach that "the secret to weather, and especially to severe weather, is to take warm, moist air near the surface, to lift it, to cool and condense it." (Figure 13). "The faster you can lift it, and the deeper the layer of the atmosphere you can lift it through, the bigger the storm, and the more likely you are to have weather of interest to people like me!"

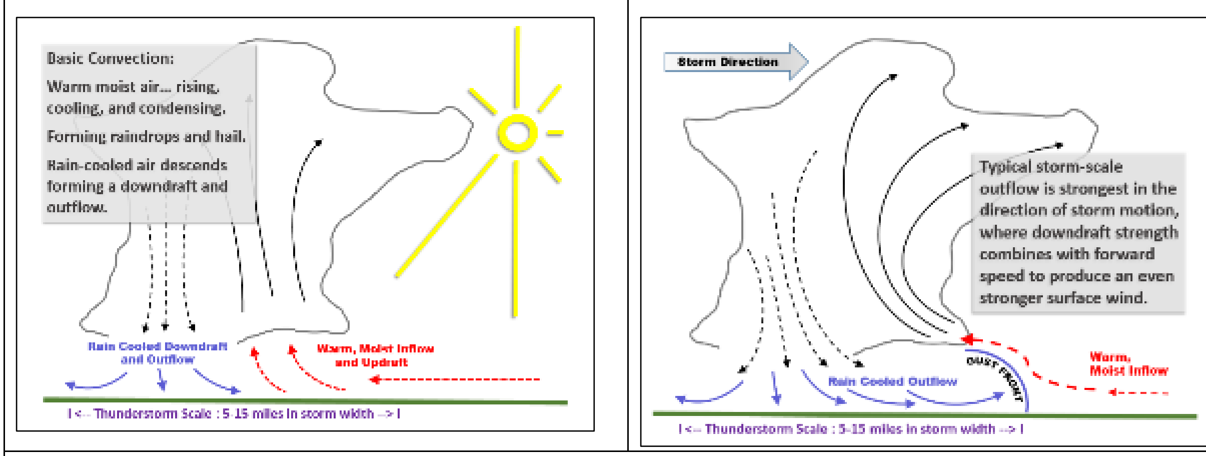

Figure 13. A typical progression of a basic convection and storm development.

[9] Corfidi, S.F., M.C. Coniglio, A.E. Cohen and C.M. Meade, 2016: A proposed revision to the definition of "derecho." *Bull. Amer. Meteror. Soc.*, **97**, 935–949, https://doi:10.1175/BAMS-D-14-00254.1.
[10] Johns, R.H., and W.D. Hirt, 1987: Derechos: Widespread convectively induced windstorms. *Wea. Forecasting*, **2**, 32–49, https://doi:10.1175/1520-0434(1987)002<0032:DWCIW>2.0.CO;2.

Whereas all types of wind storms involve large-scale airmass motions and global circulation patterns (not the subject of this article), our summertime winds are much more controlled by regional, local and even storm-scale interactions - think thunderstorm versus blizzard. Thunderstorm motions are much more dramatic in the vertical, both updrafts and downdrafts, than our cool-season storms.

Updrafts. The last issue, we focused on some of the smallest and least damaging of our northern Plains warm-season, storm-scale winds, the dust devil and gustnado. Note that these types of winds form in the *updraft* portion of the storm, much like their much larger cousins, the tornado.

Downdrafts. By far, our largest footprint and thus the most damaging warm-season winds belong to the downdraft or downburst family. Convective storms, which combine downdraft wind with their forward wind speed, can produce more extreme outflow winds.

An MCS is a huge, well-organized thunderstorm cluster. The graphic in Figure 14 depicts the much larger areal extent of a well-developed MCS often extending over several hundred square miles and tracking for hundreds to thousands of miles for a period of several hours to a day or more. These huge storms roll across our region a few times each summer. Fortunately, most MCS episodes do not result in a derecho-scale damage path, yet part of the state is impacted by one such extreme windstorm every year or two. North Dakota specific storm data for each county is tabulated by the National Weather Service office in Bismarck (BIS)[11].

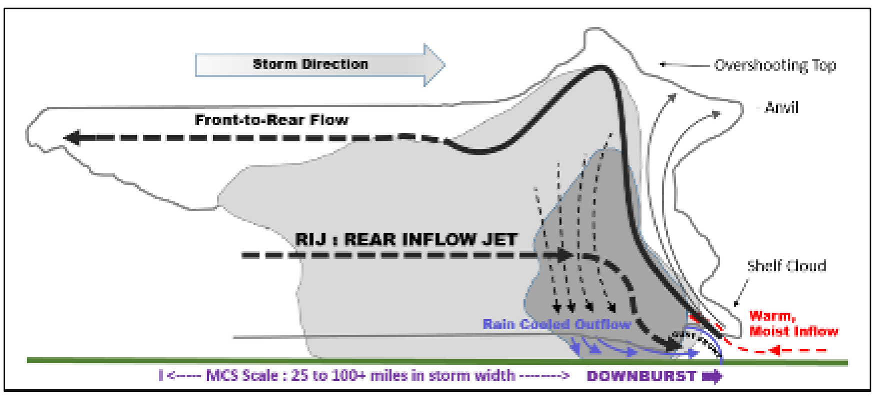

Figure 14. Conceptual model of a squall line (MCS). Figure adopted from Houze et al. (1989)[12].

Definition of the terminologies used based on the American Meteorological Society Glossary of Meteorology[13]:

Main Types of Downbursts:
Microburst – a convective downdraft (downburst) that covers less than 4 kilometers (km) (2.5 miles) in width.
Macroburst – a downburst with a resulting damage path greater than 4 km (2.5 miles) in width. (Can be further subdivided)
Derecho – a particularly damaging downburst with a damage swath of at least about 400 miles in length.

[11] ND Storm Data by Counties: www.weather.gov/media/bis/North_Dakota_County_Statistics.pdf
[12] Houze, R.A., S.A. Rutledge, M.I. Biggerstaff and B.F. Smull, 1989: Interpretation of Doppler weather radar displays of midlatitude mesoscale convective systems. *Bull. Amer. Meteor. Soc.*, **70**, 608–619.
[13] The AMS Glossary of Meteorology: http://glossary.ametsoc.org/

Contacting the North Dakota State Climate Office

Please contact us if you have any inquiries or comments, or would like to know how to contribute to this quarterly bulletin[14].

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[14] *This work is supported by the USDA National Institute of Food and Agriculture, Hatch/Multi State project ND1005365.*