North Dakota Climate Bulletin

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In This Issue

Produced by
Adnan Akyüz, Ph.D.
State Climatologist

Graphics
NCEI, NDSCO, NDAWN, NOAA, CPC, USDM

Contributing Writers
R. Kupec
A. Schlag
G. Gust

North Dakota State Climate Office
www.ndsu.edu/ndsco

North Dakota State University

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 only 0.3 degree cooler than average, which would make it the 56th coolest summer on record and the coolest summer since 2014. Precipitation-wise, the statewide accumulation was 1.03 inches wetter, and it was the 30th wettest summer on record since 1895. Overall, 34 high and 35 low daily temperature records were broken or tied. In addition, 51 daily precipitation records were broken or tied. A total of 120 records, including temperature- and precipitation-related occurrences across the state, were tied or broken.

Drought conditions intensified in north-central North Dakota along the Canadian border. Hay fields in these areas never recovered from the 2017-2018 drought. Even in the short term, dryness early in the summer exacerbated the impact. The Hydro-Talk section in this issue summarizes the evolution of the drought conditions in North Dakota.

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

Stratus Nebulosus Undulatus clouds over a Standing Rock prairie in North Dakota. Photo: F.A. Akyüz, NDSU

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, 2019) was 9.33 inches, which was 5.36 inches more than the last season (spring 2019), 0.41 inch more than last summer (summer 2018) and 1.03 inches more than the 1981-2010 average summer precipitation (Table 1). This would rank the summer of 2019 as the 30th wettest summer since such records began in 1895.

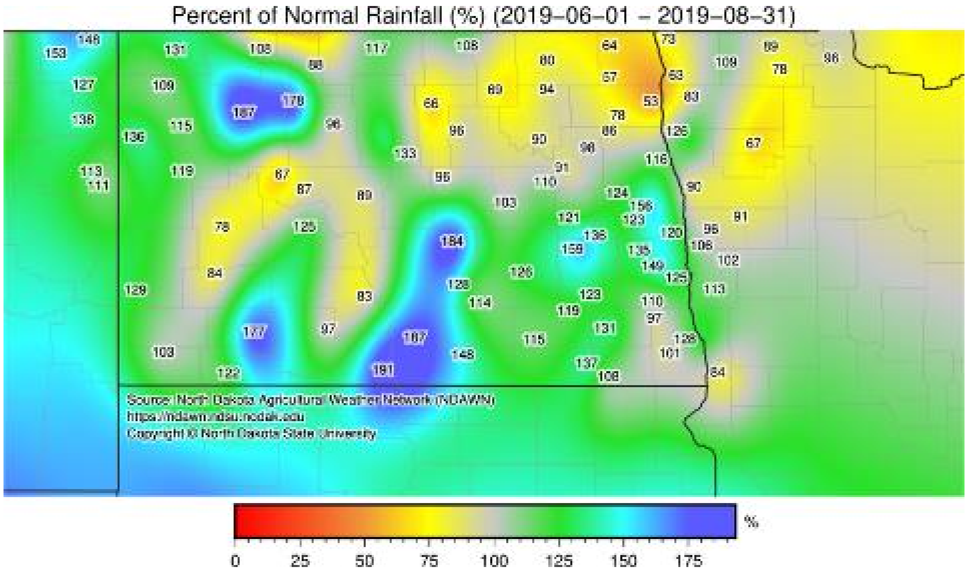
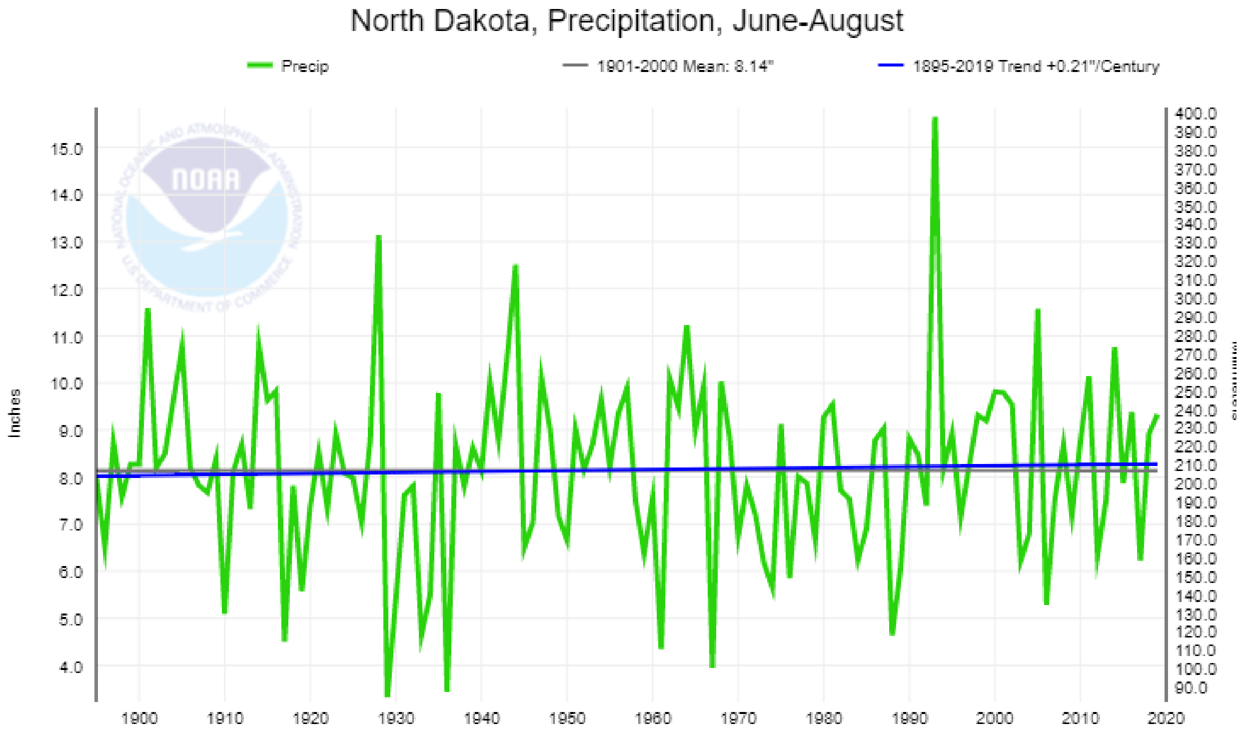


Figure 1. Precipitation percent of normal in summer of 2019 for North Dakota. (North Dakota Agricultural Weather Network, NDAWN)

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 that are 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 was 14.65 inches, recorded in Mayville, Traill County. The greatest seasonal snowfall accumulation was a trace, recorded in multiple locations: Litchville, Bismarck, Underwood, Grassy Butte and Taylor. 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 highest and lowest seasonal summer average precipitation for the state ranged from 15.54 inches in 1993 to 3.32 inches in 1929. The “Historical Summer Precipitation for North Dakota” time series (Figure 2) shows a graphical depiction of these statistics.



Summer Precipitation Statistics
Record high value: 15.54 inches in 1993
Record low value: 3.32 inches in 1929
Trend: 0.21 inch per century

Summer 2019 value: 9.33 inches
1981-2010 average: 8.3 inches
Monthly ranking: 30th wettest
Record length: 125 years

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

Table 1. North Dakota Summer Precipitation Ranking Table.

Period	Value	Normal	Anomaly	Rank	Wettest/Driest Since	Record Year
Summer 2019	**9.33”**	**8.3”**	1.03	**96th driest** **30th wettest**	**Driest since 2018** **Wettest since 2016**	**1929** **1993**

Temperature

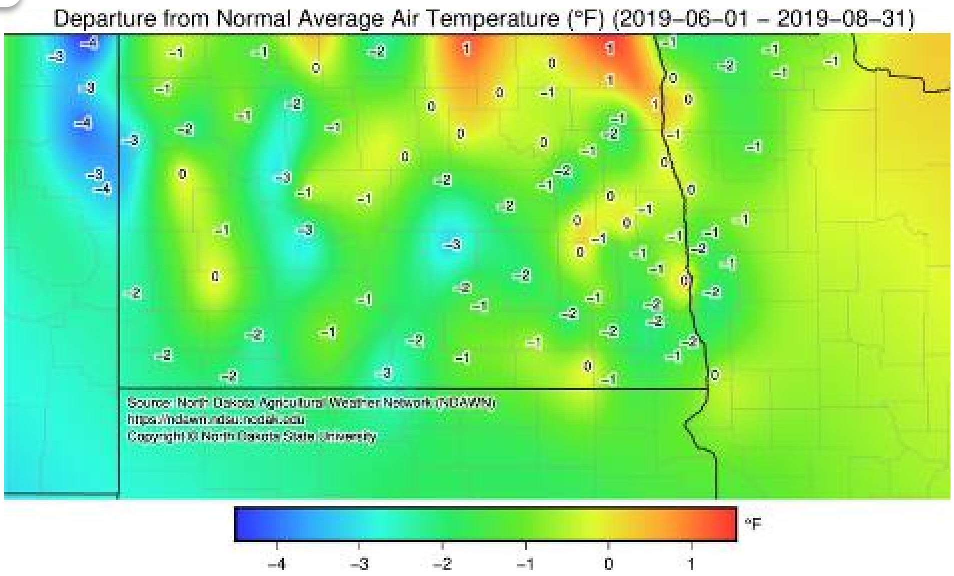
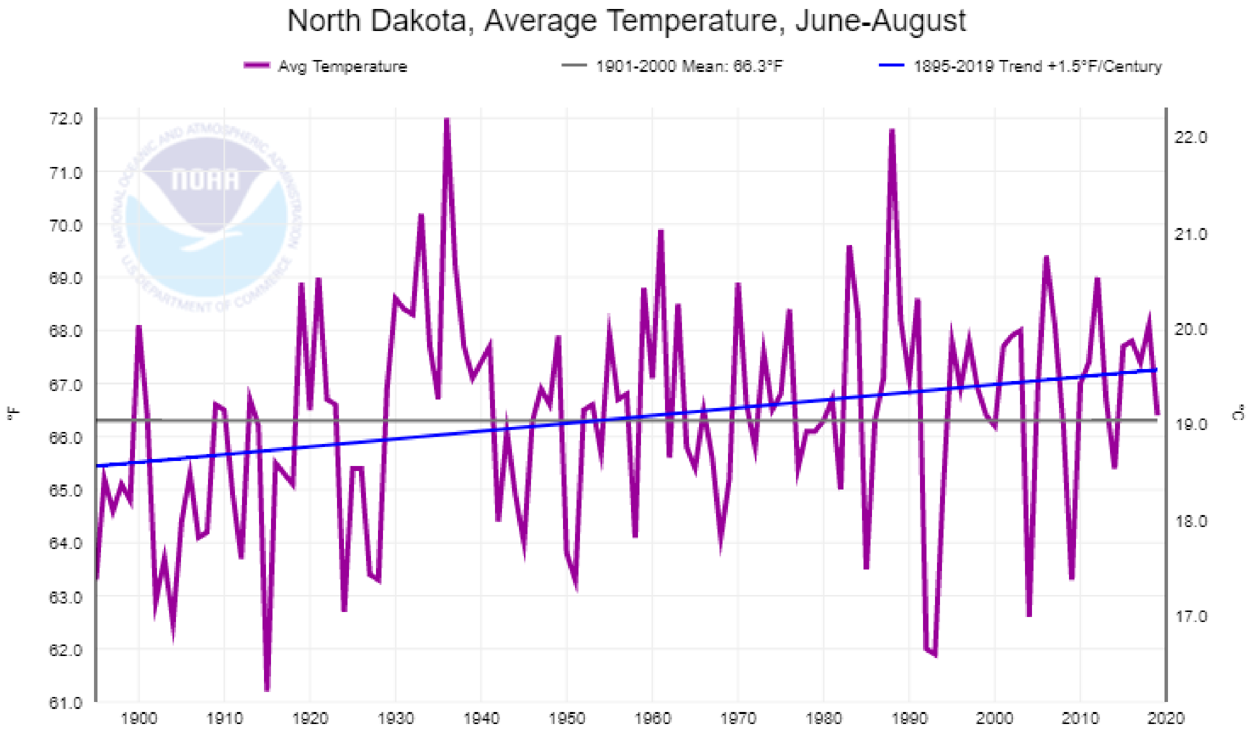


Figure 3. Temperature departure from normal in summer of 2019 for North Dakota. (NDAWN)

The average North Dakota temperature for the season (June 1 through June 31, 2019) was 66.4 F, which was 29.1 F warmer than the last season (spring 2019), 1.7 F cooler than last summer (2018) and 0.3 F cooler than the 1981-2010 average summer temperature. This would rank summer 2019 as the 56th coolest summer or 70th 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 that are greater than zero in the same figure are shaded in orange and red to depict the region with above-average temperatures. Based on historical records, the average summer temperature showed a positive trend of 0.15 F per decade since 1895. The highest and lowest seasonal summer average temperatures for North Dakota ranged from 72 F in 1936 to 61.2 F in 1915. The “Historical Summer Temperature for North Dakota” time series (Figure 4) shows a graphical depiction of these statistics.



Summer Temperature Statistics
Record high value: 72 F in 1936
Record low value: 61.2 F in 1915
Trend: 0.15 F per decade

Summer 2019 value: 66.4 F
1981-2010 average: 66.7 F
Monthly ranking: 56th coldest
Record length: 125 years

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

Table 2. North Dakota Summer Temperature Ranking Table.

Period	Value	Normal	Anomaly	Rank	Warmest/Coolest Since	Record Year
Summer 2019	66.4	66.7	**-0.3**	**56th coolest** **70th warmest**	**Coolest since 2014** **Warmest since 2018**	**1915** **1936**

Drought: After the end of the drought of 2017-18, abnormally dry conditions appeared in the north-central parts of the state. By the end of the season, only less than 7% of the state was under at least moderate drought conditions based on the official Drought Monitor scale. Figure 5 below shows the drought conditions in the beginning and the end of the summer. Figure 6 shows the drought intensity and coverage in time scale.

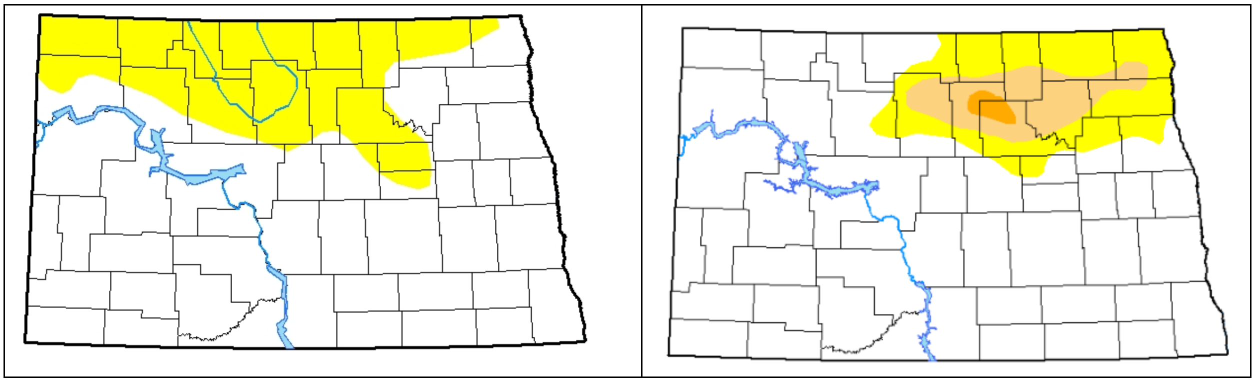


Figure 5. Drought Monitor map comparison for North Dakota in the beginning (on the left) and at the end (on the right) of summer 2019. (U.S. Drought Monitor)

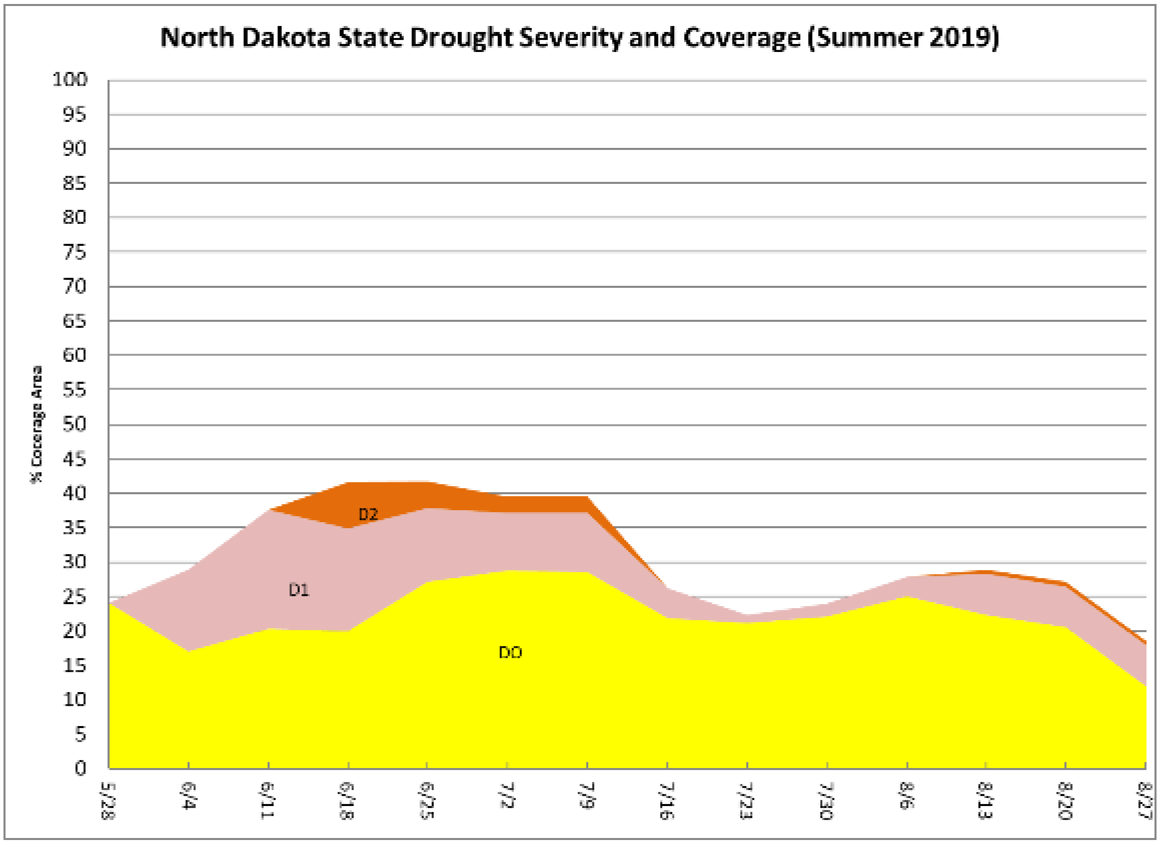


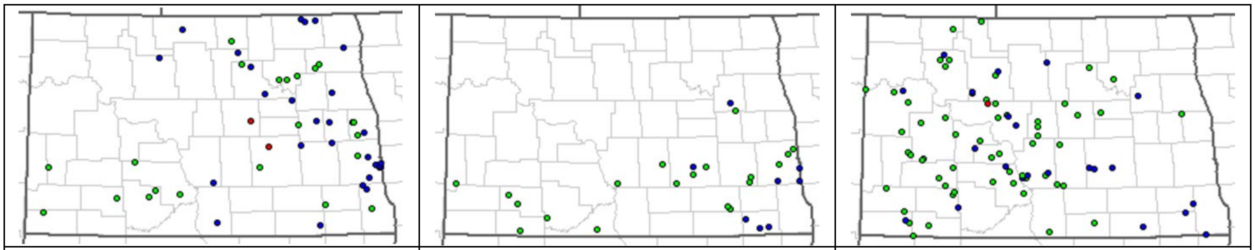
Figure 6. Statewide drought coverage in percentage and intensity (DO, D1, etc.) in a time scale representing the state from the beginning to the end of the season, with a one-week resolution.

Storms and Record Events

State Tornado, Hail and Wind Events for Summer 2019

Table 3. 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	2	0	1	**3**
Hail	22	20	62	**104**
Wind	32	8	22	**62**
Total	**56**	**28**	**85**	**169**



June 2019
North Dakota Storm Events

July 2019
North Dakota Storm Events

August 2019
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 2019

Table 4. 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.	9	0	0	**9**
Highest daily min. temp.	8	15	2	**25**
Lowest daily max. temp.	6	0	26	**32**
Lowest daily min. temp.	2	1	0	**3**
Highest daily precipitation	3	28	18	**49**
Highest daily snowfall	0	0	2	**2**
Total	**28**	**44**	**48**	**120**

Seasonal Outlook

Autumn 2019 Outlook

By R. Kupec[1]

Summer 2019 was a fickle season. What started as warm in June faded to cool in August. Overall, most of North Dakota had slightly below-average temperatures for the season (see Figure 3). The one exception was the far northern Red River Valley, where dry conditions allowed temperatures to run slightly above average. While that one part of the state was easy to categorize as dry, the picture across the rest of North Dakota was much more complicated (see Figure 1). Heavy downpours from thunderstorms created an interesting mosaic of areas with excessive rain and ones lacking in moisture.

The summer outlook called for slightly warmer-than-average temperatures and near-average rainfall except across the north, where drier conditions were forecast. The cool August temperatures skewed the overall summer temperatures below average. It's hard to say whether the summer forecast was correct or incorrect for rainfall, given the varied degree of summer rain across the state. The exception is again in northeastern North Dakota, where the dry forecast rang true.

As we enter the autumn season, the tepid El Niño weather pattern in the South Pacific has faded into a neutral state. That is forecast to last through the winter season. Sea surface temperatures in the northern Pacific are running warmer than average. Precipitation and temperatures during neutral El Niño/La Niña conditions trend toward average across all of North Dakota. A deeper examination finds that in years with warm water in the northern Pacific, the trend is for wet Septembers, followed by drier Octobers and closer to average precipitation for November. Overall, I would expect the fall to end with temperatures near normal and slightly above-average precipitation.

The current Climate Prediction Center (CPC) fall outlook agrees with the above-average precipitation forecast (see Figure 8b) but has a slightly different forecast for temperatures (see Figure 8a). It is not only calling for above-average temperatures in North Dakota, but for all of the U.S. The next 90-day outlook from the CPC should be available after Sept. 19 at www.cpc.ncep.noaa.gov/products/predictions/90day.

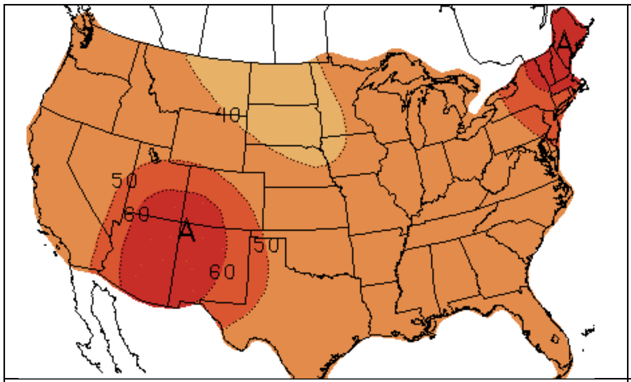


Figure 8a. September through November temperature outlook. (Climate Prediction Center, NOAA)

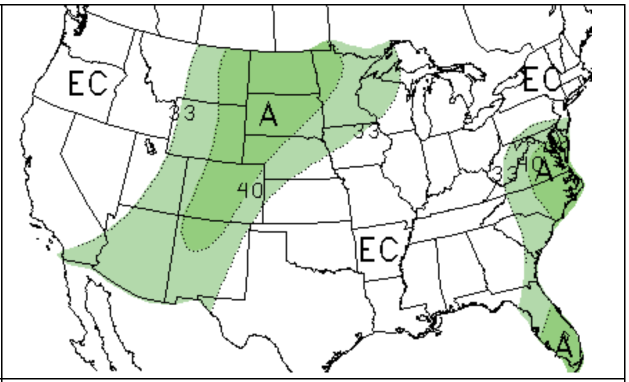


Figure 8b. September through November precipitation outlook. (Climate Prediction Center, NOAA)

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

Hydro-Talk

Summary of the Growing Season, 2019

By A. Schlag[2]

I've often noted that here in North Dakota, the difference between the haves and have-nots is a very fine line. This spring's rainfall is an amazing example of just how tight that boundary can be. The May pattern for rainfall, as shown in Figure 9, helps explain why we've had a persistent drought designation up along our border with Canada.

Often, though, we tend to ignore a lack of rainfall in May as our farmers use this dry spell to make the most of their time. Not surprisingly, the U.S. Drought Monitor (USDM) in Figure 10 reflected this dryness with widespread D0-D1 designations by balancing impacts and the overall moisture deficits.

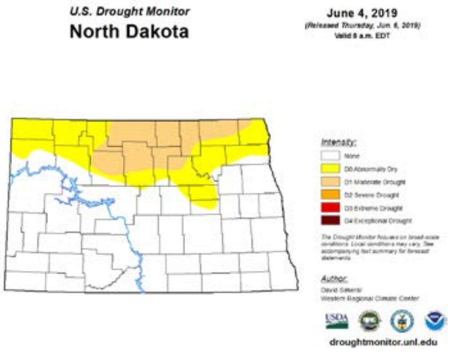

Figure 10. USDM in early June.

In keeping with the extended dryness along the border with Canada, D2 was introduced and D1 was extended a little to the south and west.

By the end of July, the expansion of the above-normal rainfall areas helped ease the overall moisture deficits across most everywhere west and south of Ward County (Figure 12).

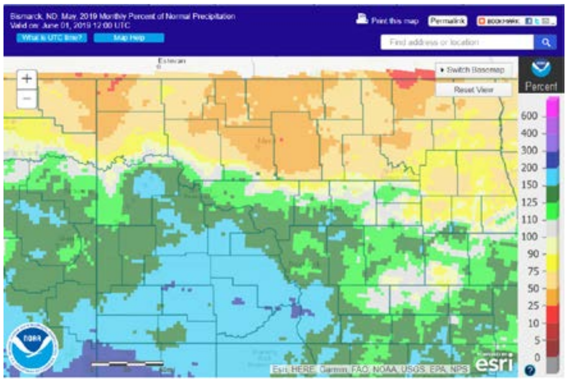

Figure 9. Percent of normal rainfall for May.

As June rolled around, the moisture across the state was, for the lack of a better term, very North Dakota-like. This is the time of year where we need the moisture the most in support of the native grasses, planted forage and small-grain crops. Counties with a lack of moisture in Figure 11 tend to be quick in reporting impacts to agriculture.

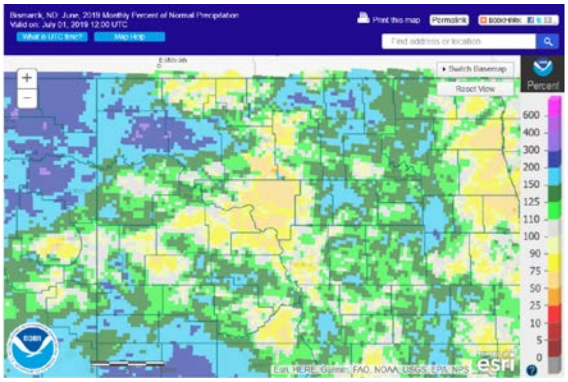

Figure 11. Percent of normal rainfall for June.

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[2] 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

This improvement in meteorologic drought from Divide over into Bottineau County came with a rapid improvement in the drought designation (Figure 13). The same cannot be said, though, for much of McHenry, Pierce and Benson counties. Regrettably, research from NDSU has shown that the majority of native vegetative growth used for forage has taken place by early July. While the places that received above-normal moisture helped fill the heads of small grains and improved the outlook for row crops, it came too late to help ranchers and their livestock.

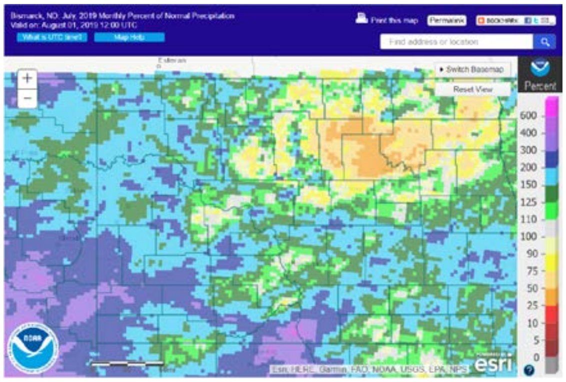


Figure 12. Percent of normal rainfall for July.

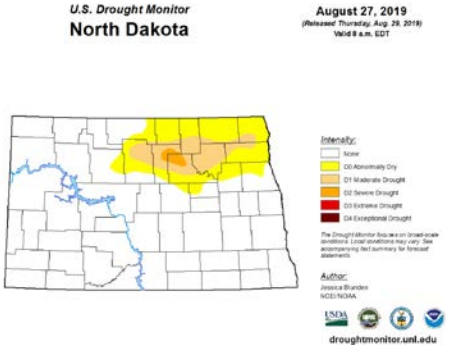


Figure 13. USDM in late July.

Oddly enough, while the contributors to the USDM tend to look at a variety of different time frames (seven-, 14-, 30-, 60- and 90-day), the latest USDM map looks pretty similar to the year-to-date precipitation map in Figure 17.

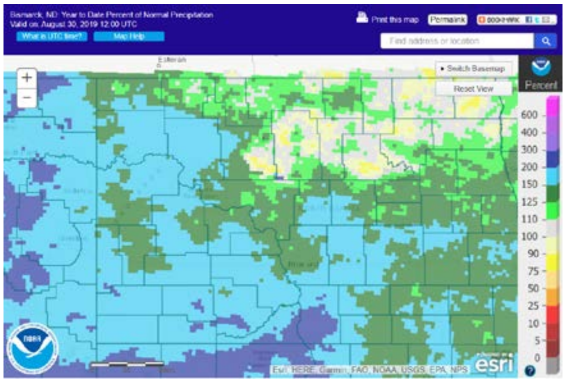
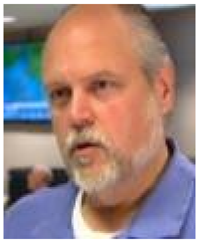


Figure 17. Year-to-date percent of normal precipitation map.

Apparent drought conditions across the state can vary wildly when doing a tour of North Dakota even though actual deficits tend to be less than a couple of inches of rain.

What can be inferred from this is that the amounts of rain may be even less important than timing. We are in a state with a water-limited ecosystem and agriculture, but local perception of drought tends to be the amount of rain received from late May through the middle of July as it unduly affects hay and pasture production for the entire year. Yeah, row crops need moisture up through August, but lacking moisture during the early season really dampens the overall perceptions across North Dakota of how well we are doing with respect to drought.

Science Bits



Putting More Science Into NWS Services **By G. Gust[3]**

Using an Integrated Warning Team Approach

Long gone are the days, *if they ever existed*, when the weather/water/climate scientists (meteorologists, hydrologists or climatologists) sat enclosed in their laboratory, made their measurements, turned their related weather cranks, pushed out their weather forecast or warning, and walked out the door.

There's no one left "behind the curtain." In fact, it's much more likely that weather, water and climate people of old relied just as heavily on personal contacts from around their service areas as we do today; that they diligently scoured the wire services and available aircraft, satellite or surfaced-based observations as they tightly coordinated their own weather-related reports; and then they spent significant amounts of time directly briefing their reports to local agency officials, the public (directly via weather radio broadcasts), their local broadcasters and their broadcast meteorologist counterparts. Times have changed and technology certainly has exploded, but the need for effective two-way crisis communications always has been an integral part of the National Weather Service (NWS) forecast and warning process.

Most sciences are quite inter-related. In recent years, our "hard" sciences of meteorology and hydrology have grown by leaps and bounds, as has our technology - with such topics often highlighted in this section of the *Bulletin*. In addition, we quite often highlight other fields in the physical and biological sciences as they relate to our primary weather, water or climate services. Past articles have alluded to the role of crops and evapotranspiration in summer storm potential and development. Soil conditions and soil moisture tracking frequently are discussed in conjunction with articles on flooding and drought. And at least one past article has mentioned the role of social sciences and "crowd sourced" information in improving our awareness of area weather and water conditions.

In warning situations, good social science can be the key! In such situations, "effective communication" is often crucial. Effective two-way communication requires that a message be received, understood, usable (more than a handshake, if you will), and most certainly along a two-way street.
In electronic communications, information can seem to flow in only one direction or another, but two-way communication in nearly continuous along that electronic process to ensure lines remain open. *Siri* just won't listen to you if you don't have enough *bars* on your device! Stepping outside the technology of a communication process, those continuous handshakes that occur in our internet-connected lives, let's consider what leads to effective, two-way, crisis communication. That's when one entity truly needs a specific type of information and another entity recognizes the need and is able to provide that information in a timely manner and in a fashion that works for the recipient. In a crisis situation, the right information may lead to proper actions - it just may save a life! Within the NWS, warning coordination meteorologists like me tend to keep one toe in the social science pool, and so recognize the need to continuously improve such critical communications. While we are talking about human communicators, aside from their technical communications devices, we really need to better understand other types of people and their various information needs.

So just what is an integrated warning team? In the weather (or water) forecasting and warning world, an integrated warning team (IWT) is a group comprised of all the key entities involved in ensuring that appropriate warning information is made readily available to those who are most likely to be affected by

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

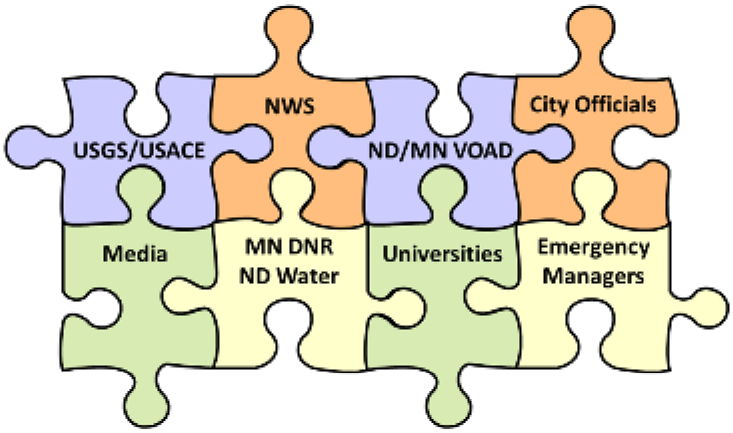
an impending weather/water incident. Our earliest forms of an IWT were informal, maybe a seasonal "refresher" meeting (such as we still hold today!) between the local NWS office and our broadcast meteorology counterparts, sharing knowledge of local weather conditions and working to improve weather messaging to the public at large. As our relationships with local emergency management have grown, we've had more opportunities to improve our understanding of local storm impacts and our ways to communicate such impacts to each other and to the public. Emergency managers in North Dakota and Minnesota hold a variety of regular local, regional or statewide meetings, which often include a sampling of some other partner agencies, such as public safety, public health or transportation. What do you think? If we just stir that interagency pot a bit more briskly, could a more flavorful concept of storm "impacts" develop?

A more formal IWT approach emerges. Around 2009, the NWS office serving the Kansas City, Mo., metro area developed an IWT that not only brought together all three of these core groups (NWS, emergency management and media), but it also included social scientists as a way of better understanding the public's reception, understanding and response to storm warnings - in this case, with a focus on severe thunderstorm and tornado warnings. For these types of **short-fuse warnings** (think short fuse on a stick of dynamite!), such a meeting might examine why people don't automatically head for a storm shelter when they hear the storm sirens screaming. And much to their chagrin, they may have found that most people will seek at least two or three more corroborating sources **before** they make their move to shelter - in those days, it was the radio, local TV, a webpage and a fan favorite, "**call mom!**" This first formal approach served as a blueprint for other NWS offices, and with a little seed money made available through a NOAA program office, longer and better structured approaches followed. Not only were social scientists included in the participant and speaker line-up, but group facilitators often were included to ensure that participants were more fully engaged in the discussions, all voices had a chance, and that ideas and comments were better retained. Little things that may have slid off a regular meeting table were now regularly caught and saved in the record as items to be analyzed and reconsidered later as needed, while the IWT group process moved inexorably toward consensus.

In 2011, a Red River and Devils Lake flood IWT. The NWS Grand Forks office was an early adopter of this idea, and in June of 2011, we hosted a two-day IWT workshop to consider longer-fuse, spring flood-related warning issues. This came in the wake of the devastating Red River flood of 1997, with rampant long-term flooding continuing to plague the Devils Lake Basin, and having just come off a string of three more "devastating" spring snowmelt floods across this northern Plains region (2009, 2010, 2011).

Putting Together the Pieces was held on the campus of North Dakota State University in Fargo and brought together a group of more than 60 individuals representing more than a dozen flood fight entities from the Red River and Devils Lake basins. Local, state and federal agencies were there, along with our voluntary agencies (nonprofits), our broadcast media, academia, social science informers and our session facilitators. Hats off to NDSU's Department of Emergency Management, which recently had branched from the Department of Sociology and Anthropology. It was vital in

A Red River and Devils Lake Basin "Flood" IWT
"Putting Together the Pieces"



This first "Flood IWT" held June 1-2, 2011, found that there are many more involved core-partners during a long duration river or lake flooding episode.

informing and managing that IWT process.

NWS Bismarck hosts an IWT workshop in 2016. Unlike the more specific short-fuse or long-fuse warning issues tackled in previous types of IWTs, this workshop, held on April 12-13, 2016, covered a range of high-impact summer and winter concerns. It included the NWS, along with local media; local, state, tribal and federal agencies; and really anyone involved in weather safety messaging. As would be expected, the key workshop objective was to bring these different groups together in one room to understand more of how they each function, and to move toward establishing a true team approach to the warning process across the state as a whole.

CRED is a flexible web-based app first developed by Andrew Sheppard for the 2013 Red River Flood and updated for use during the Spring 2019 Flood ...thanks to partnerships with the International Water Institute and Houston Engineering.

So, where's this flood IWT stand today? Another formal flood-centric IWT workshop has not been held since the initial 2011 effort. However, the IWT process still continues in a variety of less formal ways. For instance, the **Red River Basin Commission** conducts regular meetings, which include most of the key entities represented in the flood IWT, and regularly provides a forum for discussion of pertinent flood warning issues. At its basinwide annual conference, the RRBC casts a much broader net than the original IWT, reaching hundreds of representatives from numerous additional entities and jurisdictions (including Manitoba, Canada) who also share our flood-related concerns. There also have been several subgroup meetings or teleconferences among our IWT representatives, each designed to tackle one topic or another. The most recent such effort, started during the winter of 2017-18, helped produce a new graphical way of expressing flood risk during the flood outlook period, the **Probabilistic Flood Outlook Summary** (PFOS), which continues to expand in its utility. In advance of the spring flood of 2019, the first basinwide and statewide major flood since 2011, members of that original IWT helped retool the **CRED** mobile flood reporting app (https://cred.wq.io). This app was launched in early 2013 as a direct result of the 2011 IWT workshop.

What's next? Perhaps a winter storm/blizzard-focused IWT workshop? Through 2014 and 2015, the NWS Grand Forks office began gearing up for a winter storm-focused IWT. After attending meetings with a series of partners heavily impacted by winter travel issues, mainly schools, public health and transportation sectors, a small informal meeting of a blizzard IWT was held on Oct. 29, 2015, in Grand Forks. A more formal workshop is being considered for sometime in the next year or two, and to this end, **a one-day winter storm IWT meeting will be held in Fargo on Oct. 1, 2019**.

Like most all-important relationships, there's really no end to an IWT. Formal IWT meeting processes may ebb and flow, and team members may change, but these informal IWT meetings, separate partner group meetings and those episodic or event critical telecons leading up to each big blizzard, big flood or big severe weather outbreak have become a much more informed and informing part of our state's overall preparedness, response and recovery process.

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[4].

North Dakota State Climate Office

College of Agriculture, Food Systems, and Natural Resources
North Dakota State University
304 Morrill Hall, Fargo, ND 58108
Climate Services: 701-231-6577

URL: www.ndsu.edu/ndsco
Email: Adnan.Akyuz@ndsu.edu

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