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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, Fargo.

The overall winter average temperature was 4.3 degrees cooler than average, and it was the 52nd coolest on record and the coolest winter since 2014. Precipitation-wise, the statewide accumulation was 0.67 inch wetter, and it was the 15th wettest winter on record since 1895 in North Dakota. Overall, 58 high and 115 low daily temperature records were broken or tied. In addition, a staggering 179 daily precipitation records were broken or tied. A total of 352 records, including temperature- and precipitation-related occurrences across the state, were tied or broken.

The 2017-2018 drought ended toward the end of the season. While the meteorological season ended, the snow season still continues. Concern for major flooding along the Red River Valley is raised as many communities are preparing for a major flood. In this issue, you will find those concerns highlighted in eastern and western 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

Red River Valley on April 11, 2011. (Vern Whitten Photography)

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 winter season (Dec. 1, 2018, through Feb. 28, 2019) was 2.09 inches, which was 1.72 inches less than the last season (autumn 2018) but 1.11 inches more than last winter (winter 2017-18) and 0.67 inch more than the 1981-2010 average winter precipitation (Table 1). This would rank winter 2018-19 as the 15th wettest winter since such records began in 1895. 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. Based on historical records, the state average winter precipitation showed a slight negative long-term trend of 0.01 inch per century during this period of record since 1895. The highest and lowest seasonal winter average precipitation for the state ranged from 2.99 inches in 1968-69 to 0.59 inch in 1989-90. The "Historical Winter Precipitation for North Dakota" time series (Figure 2) shows a graphical depiction of these statistics.

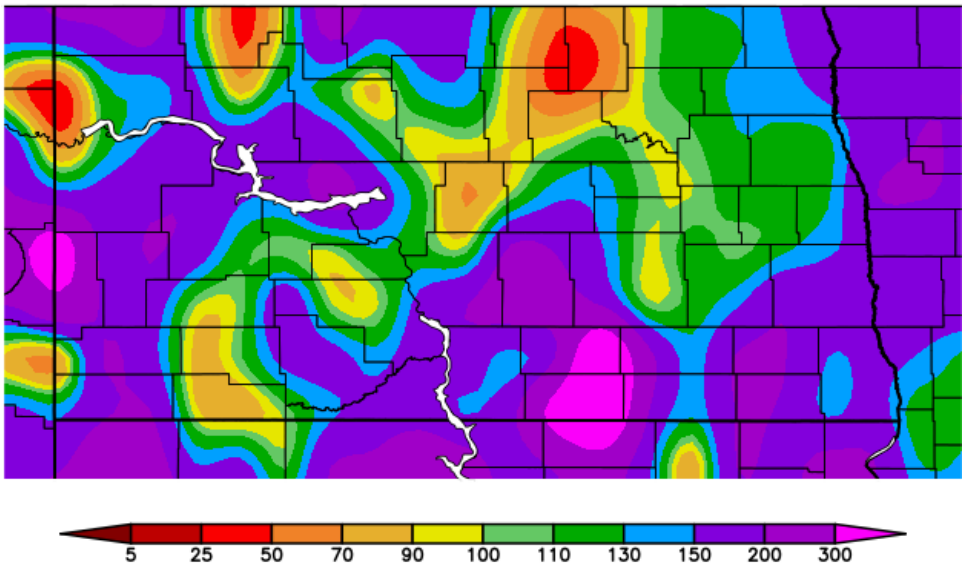
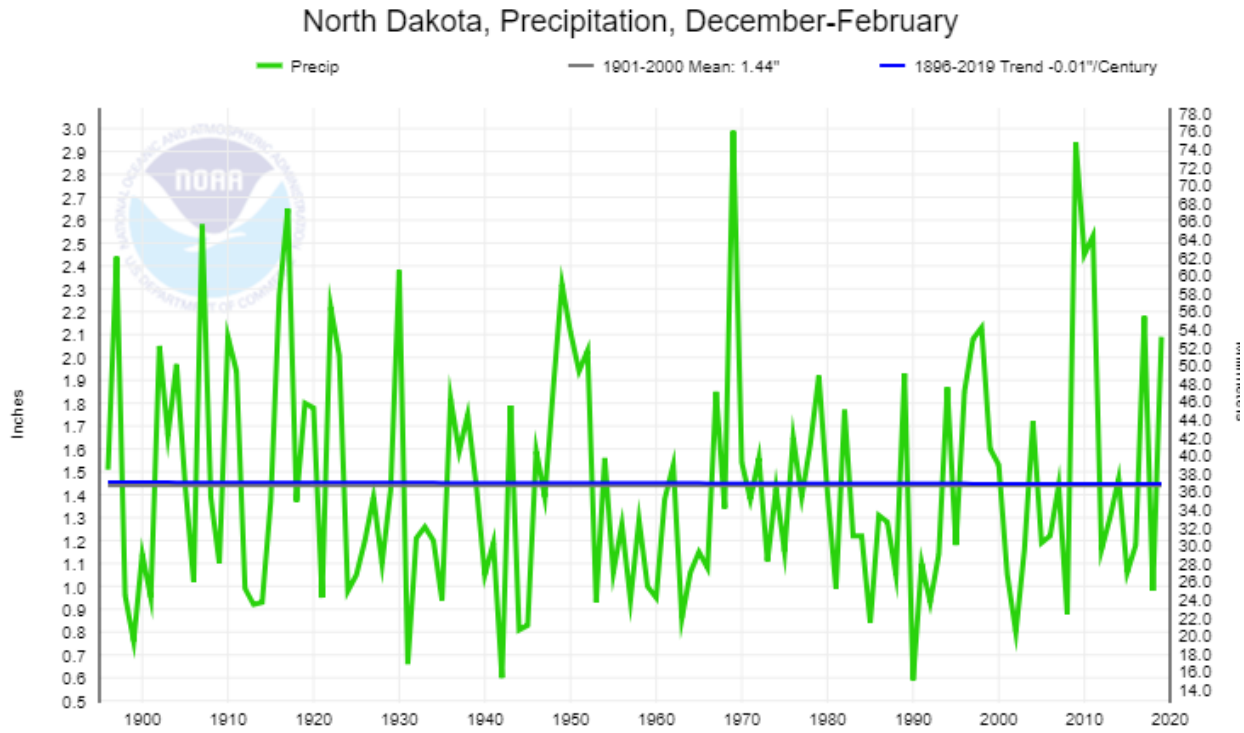


Figure 1. Precipitation percent of normal in winter 2018-19 for North Dakota. (High Plains Regional Climate Center, NDSU)



Winter Precipitation Statistics
Record high value: 2.99 inches in 1968-69
Record low value: 0.59 inch in 1989-90
Trend: minus 0.01 inch per century

Winter 2018-19 value: 2.09 inches
1981-2010 average: 1.42 inch
Monthly ranking: 15th wettest
Record length: 125 years

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

Table 1. North Dakota Winter Precipitation Ranking Table.

Period	Value	Normal	Anomaly	Rank	Wettest/Driest Since	Record Year
Winter 2018-19	2.09”	1.42”	0.67	110th driest 15th wettest	Driest since 2018 Wettest since 2017	1990 1969

Temperature

The average North Dakota temperature for the season (Dec. 1, 2018, through Feb. 28, 2019) was 9.2 F, which was 29.7 F cooler than the last season (autumn 2018), 1.7 F cooler than last winter (2017-18) and 4.3 F cooler than the 1981-2010 average winter temperature. This would rank winter 2018-19 as the 52th coolest winter 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. Based on historical records, the average winter temperature showed a positive trend of 0.45 F per decade since 1895. The highest and lowest seasonal winter average temperatures for North Dakota ranged from 22.2 F in 1986-87 to minus 3 F in 1935-36. The "Historical Winter Temperature for North Dakota" time series (Figure 4) shows a graphical depiction of these statistics.

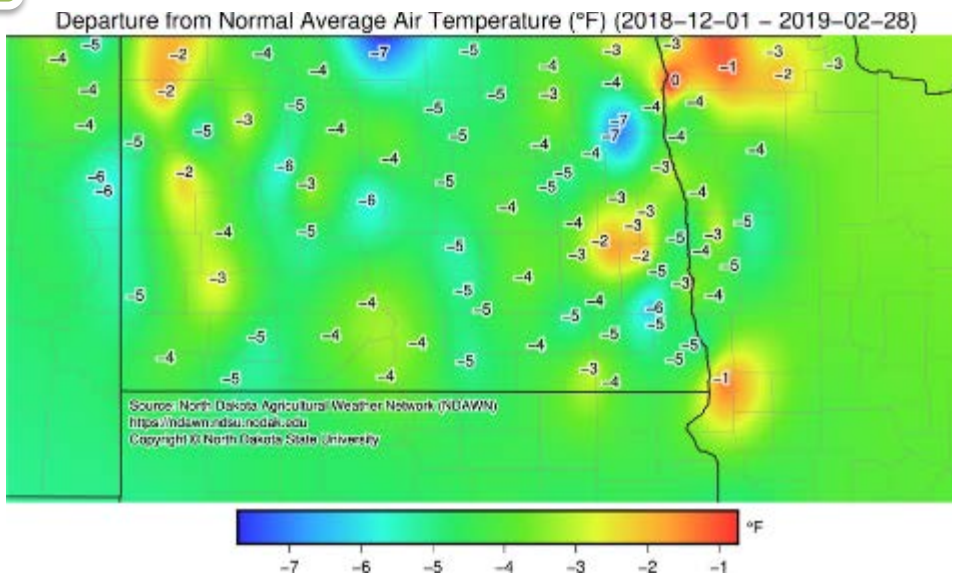
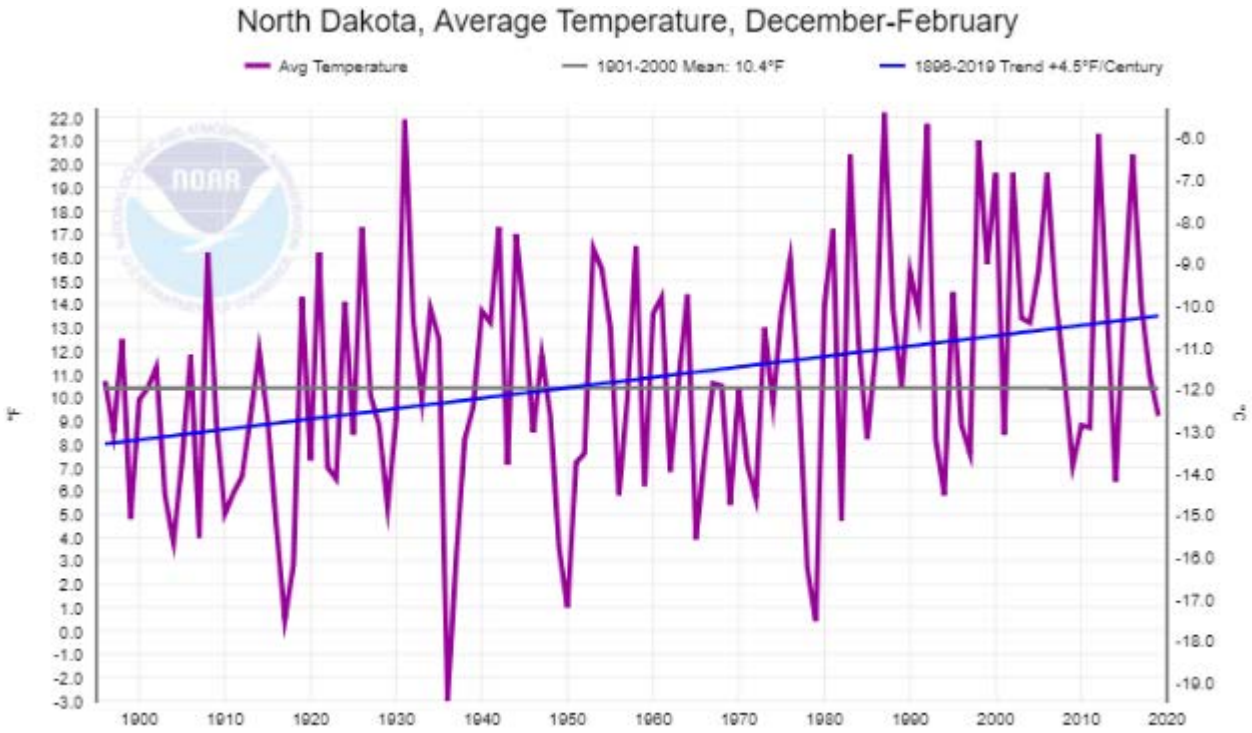


Figure 3. Temperature departure from normal in winter 2018-19 for North Dakota. (NDAWN)



Winter Temperature Statistics
Record high value: 22.2 F in 1986-87
Record low value: minus 3 F in 1935-36
Trend: 0.45 F per decade

Winter 2018-19 value: 9.2 F
1981-2010 average: 13.5 F
Monthly ranking: 52nd coldest
Record length: 125 years

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

Table 2. North Dakota February Temperature Ranking Table.

Period	Value	Normal	Anomaly	Rank	Warmest/Coolest Since	Record Year
Winter 2018-19	9.2	13.5	-4.3	52nd coolest 73rd warmest	Coolest since 2014 Warmest since 2018	1936 1987

Drought: Overall drought conditions improved throughout the season (Figure 6). By the end of the season, no parts of the state was experiencing drought (nearly a 17 percent reduction in coverage, compared with the beginning of the season). Figure 5 below shows the drought conditions in the beginning and the end of the winter.

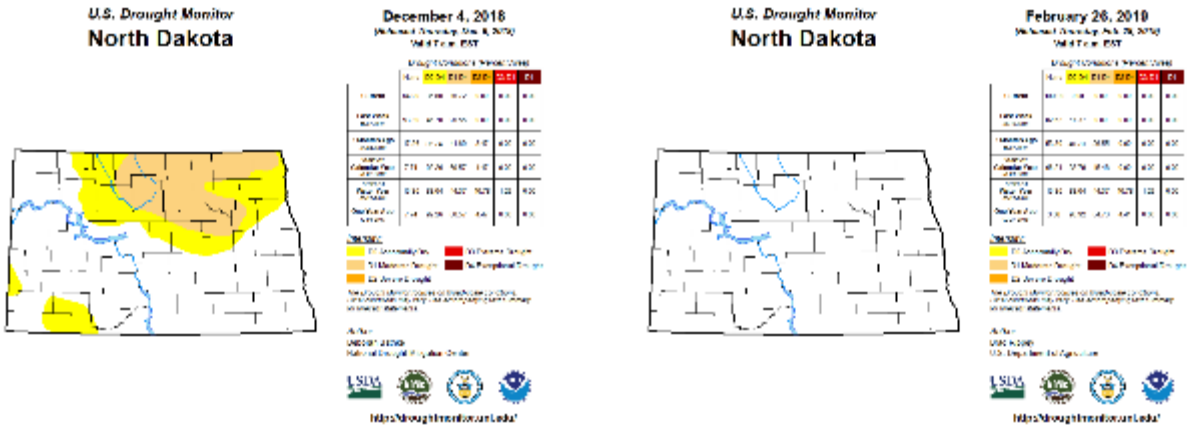


Figure 5. Drought Monitor map comparison for North Dakota in the beginning (on the left) and at the end (on the right) of winter 2018-19. (U.S. Drought Monitor)

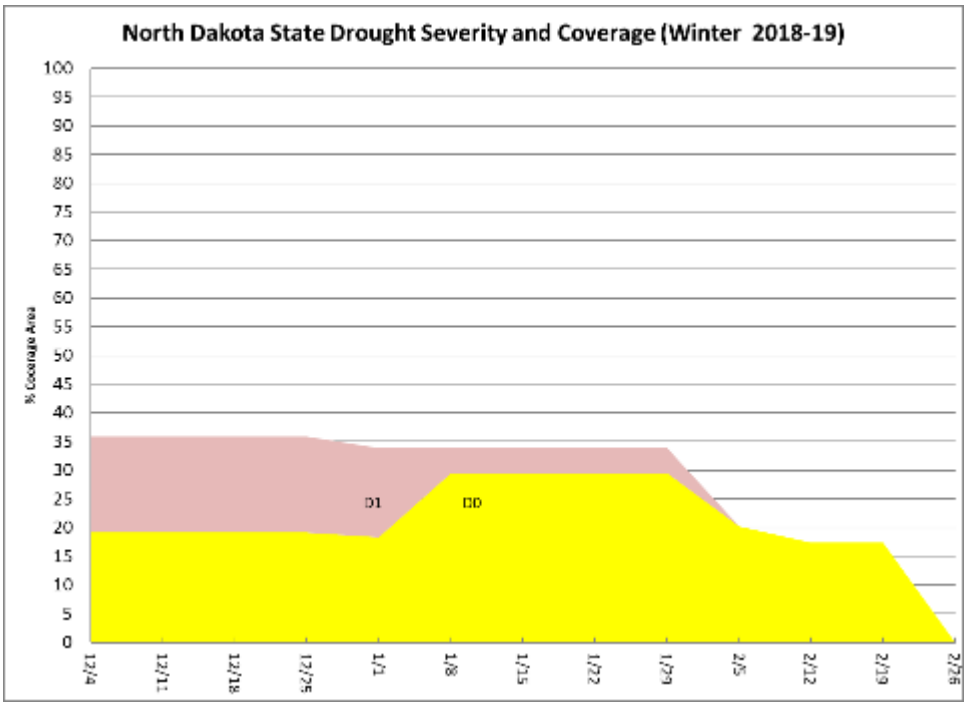


Figure 6. Statewide drought coverage in percentage and intensity (DO, D1, etc.) in a time scale representing the state from the beginning to the end of the season, with a one-week resolution.

Storms and Record Events

State Tornado, Hail and Wind Events for Winter 2018-19

Table 3. Numbers in the table below represent the number of tornado, hail and wind events accumulated monthly and seasonally.

Month	Tornado	Hail	Wind	Total
December total	0	0	0	**0**
January total	0	0	0	**0**
February total	0	0	0	**0**
Seasonal total	**0**	**0**	**0**	**0**

December 2018 North Dakota Storm Events | January 2019 North Dakota Storm Events | February 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 Winter 2018-19

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

Category	December	January	February	Seasonal Total
Highest daily max. temp.	10	6	0	**16**
Highest daily min. temp.	24	18	0	**42**
Lowest daily max. temp.	1	16	42	**59**
Lowest daily min. temp.	0	26	30	**56**
Highest daily precipitation	18	15	41	**74**
Highest daily snowfall	16	10	79	**105**
Total	**69**	**91**	**192**	**352**

Seasonal Outlook

Spring 2019 Outlook

By R. Kupec[1]

The winter season began as expected, with temperatures above average and precipitation near normal. Around the middle of January, an abrupt change occurred to a cold and wet pattern that erased all of the mild temperatures from the first half of the winter. The winter outlook had called for a warmer than average winter and near to slightly below average precipitation. A slight downturn in temperature was expected in February. That downturn came early and was certainly more than slight. February was so cold that many locations ended the season with one of the top 20 coldest winters on record. Monthly snowfall records were set in Grand Forks and Fargo. Parts of the southwestern corner of the state did record slightly below-average precipitation for the winter, but that was the exception, not the rule.

The main factor for the forecast for a mild winter was the developing El Niño weather pattern in the South Pacific. That did not occur, and for most of the winter, a neutral pattern was seen. Finally, now as we head into spring, weak El Niño conditions exist. El Niño springs usually start out with slightly below-average temperatures and then begin to warm later in the season. May is usually slightly warmer than average statewide in these conditions. Spring precipitation tends to run slightly below average in March and April. Slightly wetter conditions are more prevalent in May. I would expect these patterns to exist this year.

The current Climate Prediction Center (CPC) Winter Outlook gives all of North Dakota an equal chance of above- or below-average temperatures for the season (Figure 8a). The CPC also predicts an equal chance of above- or below-average precipitation (Figure 8b). The next 90-day outlook from the CPC should be available after March 21 at www.cpc.ncep.noaa.gov/products/predictions/90day.

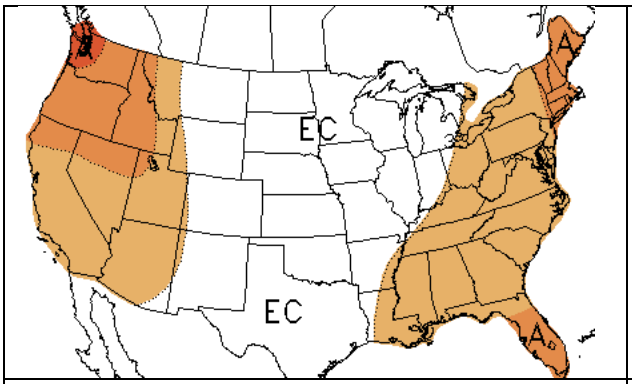


Figure 8a. December through February temperature outlook. (Climate Prediction Center, NOAA)

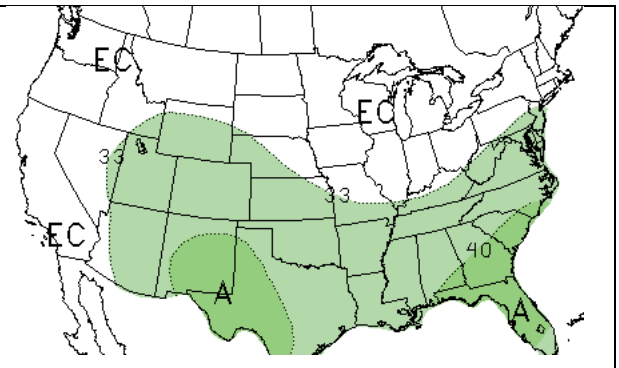


Figure 8b. December through February precipitation outlook. (Climate Prediction Center, NOAA)

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

Hydro-Talk

Hydro Expectations for Spring 2019 — By A. Schlag[2]

Well, I think we can now officially say that El Niño has been pretty much a nonplayer in the net effect of this winter on my earlier expectations for few spring flood problems, which have long since gone the way of the dodo bird. All the way back in early January, things were looking great. All the snow we received in December melted off and things were looking kind of brown across much of North Dakota. In fact, at the beginning of the year, when people asked what I thought about the potential for spring flooding, I would simply turn the question around and ask what they thought of the potential with the lack of an appreciable snowpack. Eventually, we would get to the point where I'd just say that things would have to get pretty miserable to change things this late in the season. Fast-forward a mere seven or eight weeks from those conversations and, well, umm, it's been pretty darn miserable! So let's take a refreshed look at the potential for spring flooding across North Dakota as of today, March 14, 2019. Estimated snow-water equivalent (SWE) values, as shown in Figure 9, after this latest storm are substantial in the river basins east of the Missouri River.

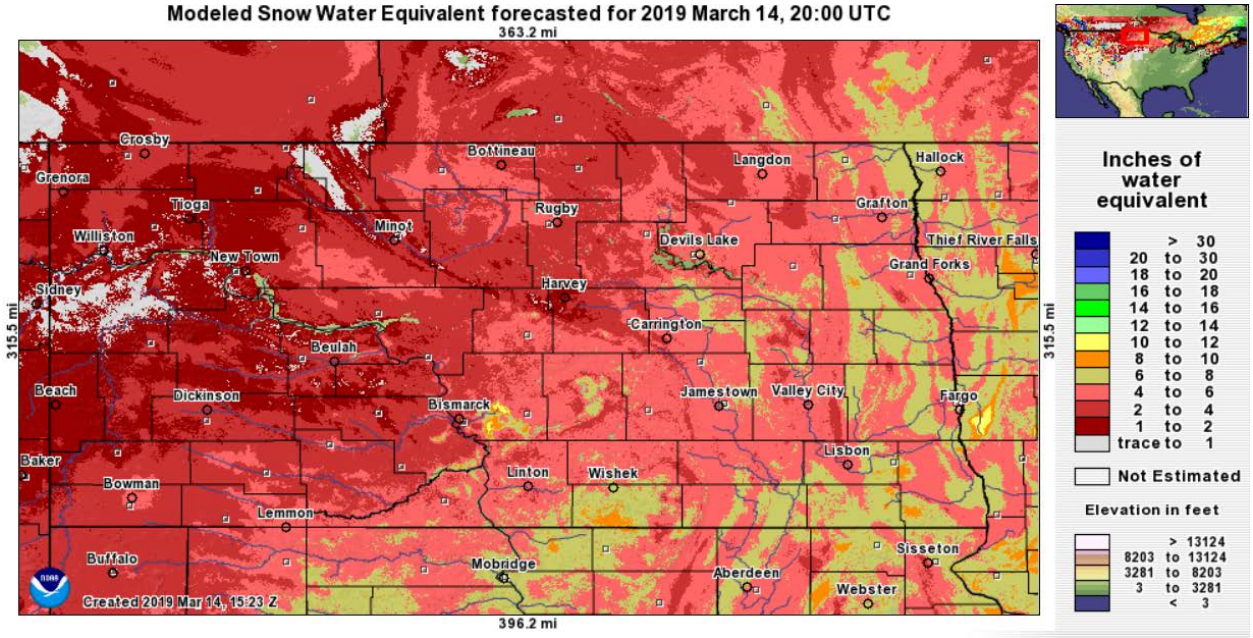


Figure 9. Estimated snow-water equivalent values across North Dakota.

In looking at the SWE distribution, it's relatively easy to break the state up into sectors with similar risks of flooding going into the latter half of March and early April. Beginning in the northwest corner of the state, the upper Missouri and Yellowstone basins are roughly slightly

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below normal and slightly above normal, respectively. In this sense, the uncontrolled Yellowstone is fairly likely to create strong enough flow to cause minor flooding in North Dakota at the Missouri River near the Williston forecast point. Other small streams in the area, such as the Little Muddy, have roughly a near-normal flood risk. The Souris River Basin in north-central North Dakota is below normal risk of flooding upstream of Minot, with an increase to near normal in the Logan, Sawyer and Velva areas. Significantly increased risk in the Souris Basin can be found from Towner up through the Westhope stretch of the Souris and its tributaries of Deep River and Willow Creek.

In the southwestern quarter of the state, all streams such as the Knife, Heart, Cannonball and Cedar Creek are going to make an honest attempt at reaching minor flood stage. The real key here is the duration of the melt. Anything other than a very rapid melt is going to see much of them fail to reach flood stage as they simply run out of water.

To the east of the Missouri, streams including Painted Woods, Burnt Creek, Apple Creek and Beaver Creek near Linton are all primed to make a good push at reaching flood stage. In particular, Beaver Creek received a heaping helping of SWE out of the two most recent storms and now possesses sufficient SWE to reach flood stage under anything other than the most gentle of melt seasons.

Farther east, the James River Basin below Jamestown now has the highest SWE and likelihood of reaching flood stage outside of the Red River Valley. Overland flooding and high water along all of the small streams south of Jamestown are expected and may even translate into flood concerns along the James River itself near the community of LaMoure. The biggest question here is runoff above the Jamestown and Pipestem dams above Jamestown. All indicators suggest that the dams will be able to exert a considerable amount of control over the James during the spring melt. This should help the southern extent of the region get its snowmelt season in the rearview mirror ahead of seeing any water originating from above Jamestown.

Much of the above is based on current conditions and the very favorable forecast for weather conditions during the third full week of March. Lack of precipitation during the 16th-23rd, along with generally mild temperatures in the upper 30s and lower 40s, will encourage runoff to commence first in the Badlands and spread north and east late in the third week. The last week of March will see the western streams of North Dakota rise as pathways from the countryside to the rivers open. With a little luck, we'll get some of this water moving and out of the area before spring rains find their way into North Dakota, and that will help focus the flood-fighting efforts on the more eastern part of the state.

Another Wild Red River Basin Flood Season

By G. Gust [3]

It was an early winter. It's been a cold and snowy winter. And at this mid-March writing, it's now a prolonged winter, with a late spring thaw barely beginning to emerge.

Yet here we are as a state, already facing the ominous task of preparing for another round of moderate to major-scale flooding, in and around eastern North Dakota and the greater Red River and Devils Lake Basin (Figure 10).

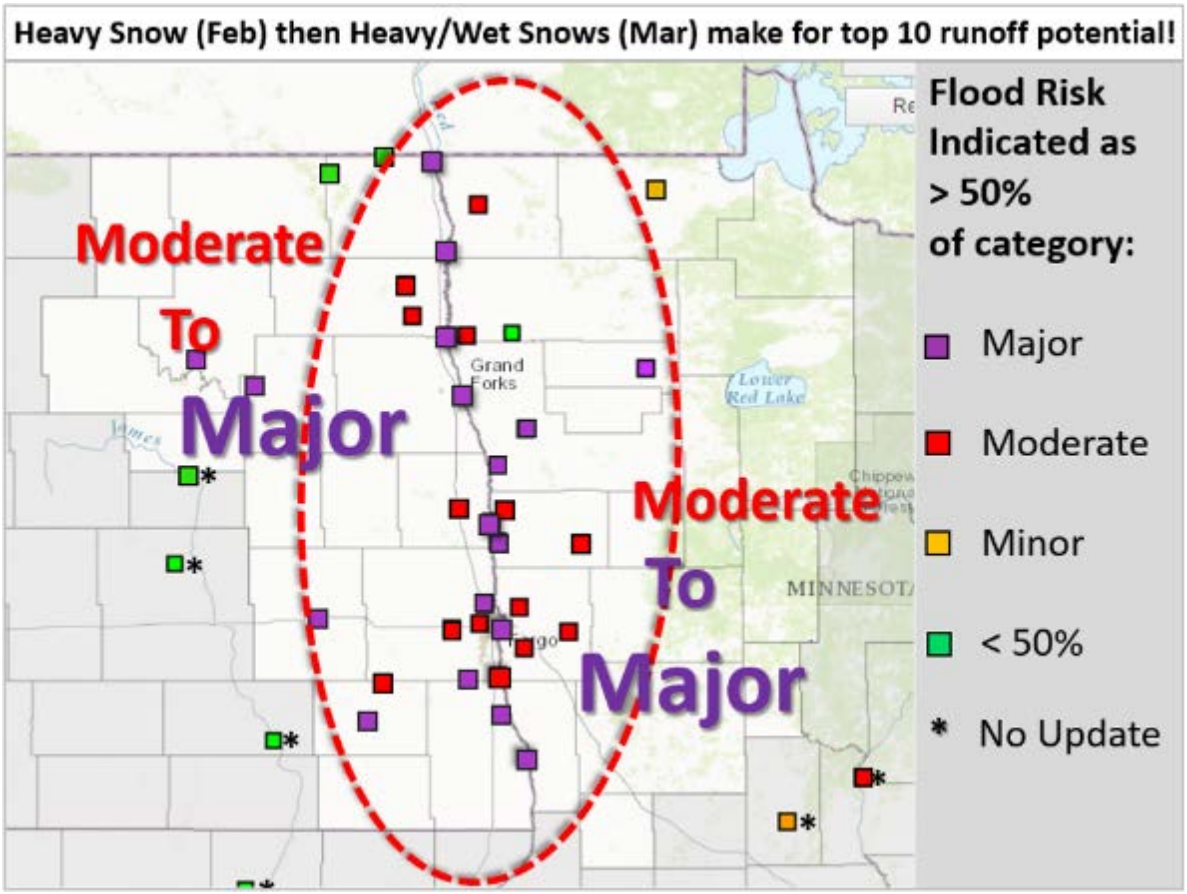

Figure 10. Flood risk map of the Red River Valley.

Antecedent Conditions: The prospects for an especially harsh winter and significant spring flooding did not seem at all likely as we moved from summer into the 2018 autumn season. The dry trend of recent years, 2017-2018, had been steadily tapering off across much of the state, with only the far northeast and north-central parts of the state still holding onto abnormally dry to moderate drought conditions.

In fact, September and October saw above-normal precipitation across most of eastern North Dakota, to the point that soils were well wetted going into freeze-up and fall harvest conditions were difficult. In addition, an early winter storm dumped some 6 to 16 inches of wet snow across much of the east, on Oct. 10 through 11 (see web article at: www.weather.gov/fgf/2018_10_10_HeavySnow), which should have been telling. Most all of this early

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

snow did melt before the end of October, but a wet topsoil surface was established, which may yet come into play for the upcoming spring flood.

Recall that it had previously been quite dry. Fall rains and melted snow were thus able to easily soak into the ground, leaving little to no residual standing water at freeze-up. Area rivers and streams saw little actual runoff from those autumnal rain, and ended the water year very near normal late-season levels.

It was not only a wet fall, but a cold one as well. For the last four months of 2018, eastern North Dakota averaged 2-3 degrees cooler than long-term normal. And although early season snow fell (and melted) in October, the ground remained largely bare of a deep insulating snow layer through much of November. So looking at the spring flood "ingredients" listed in Figure 11 below, the first three antecedent conditions were established.

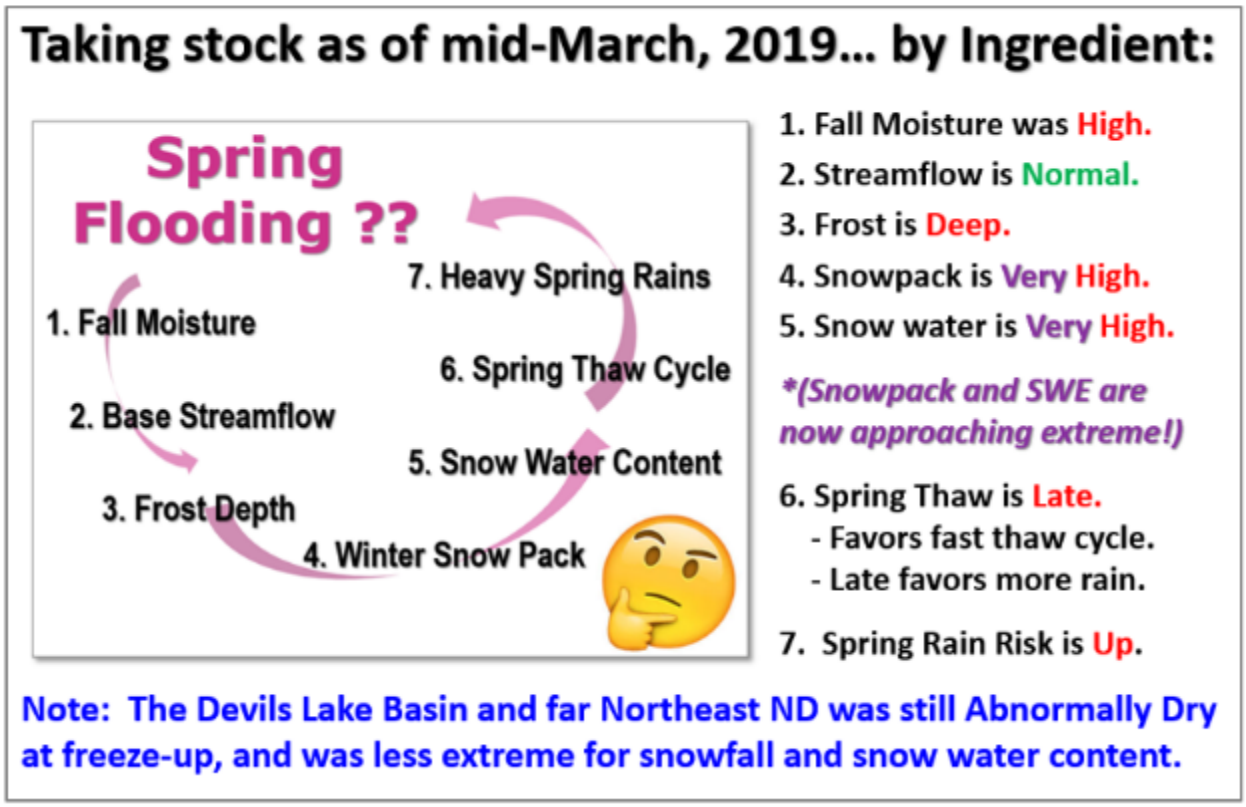

Figure 11. Spring flood ingridients.

At the Mid-winter Mark: Frost depths plunged to 2 feet or more through early December, and by mid-January were pushing depths of 3 feet or more across much of the Red River Basin. Yet when the first spring flood outlook was issued on Jan. 24, the typical midwinter mark, snowpack was not that worrisome and only minor to moderate, or near-normal, levels of flooding were anticipated.

Things turned much colder and snowier from late January into February, with February snowfall breaking records across the eastern third of North Dakota and most of all of Minnesota, while temperatures averaged some 12-14 degrees below normal. Due to the exceptionally cold air in which it formed, the record snowfall contained a relatively low per-unit water content. Yet its huge overall volume ended up providing double the typical February water supply.

The updated spring flood outlook, issued on Feb. 21, bumped the flood prospects up well into the moderate category, with even a few main-stem Red River locations expected to touch near the major flood level.

Then came March: As Figure 11 shows, something clearly dramatic was occurring with our overall winter snowpack and snow-water content. February had seen record snowfall and a doubling of our typical February

precipitation amount. But winter months are also our driest overall months, so doubling February moisture is only an extra 0.75 to 0.85 inch of water in the mix.

Two classic Colorado lows rammed into the state on the 9th and 14th of March. These storms typically form off the southern or central Rockies, and as they push toward our northern Plains region, are able to draw a much moister southern Plains air mass into the vicinity, and thus produce a much broader scale storm with a very wet, heavy snow.

A Historic "Bomb" Cyclone: The second of the two storms was especially intense, with a record-setting low central pressure over Kansas, which produced exceptionally strong to severe blizzard conditions into much of central and eastern North Dakota from March 13 into the 14th.

As Figure 12 illustrates, the southeastern half of North Dakota gained at least an inch of moisture in those two storms, with far southeastern North Dakota gaining up to 2 inches of moisture - in a combination of rain, sleet and snow. Further to the south, eastern South Dakota and northeastern Nebraska saw upward of 3 inches of rain onto their much warmer and nearly melted snowpack, creating record flooding throughout that area.

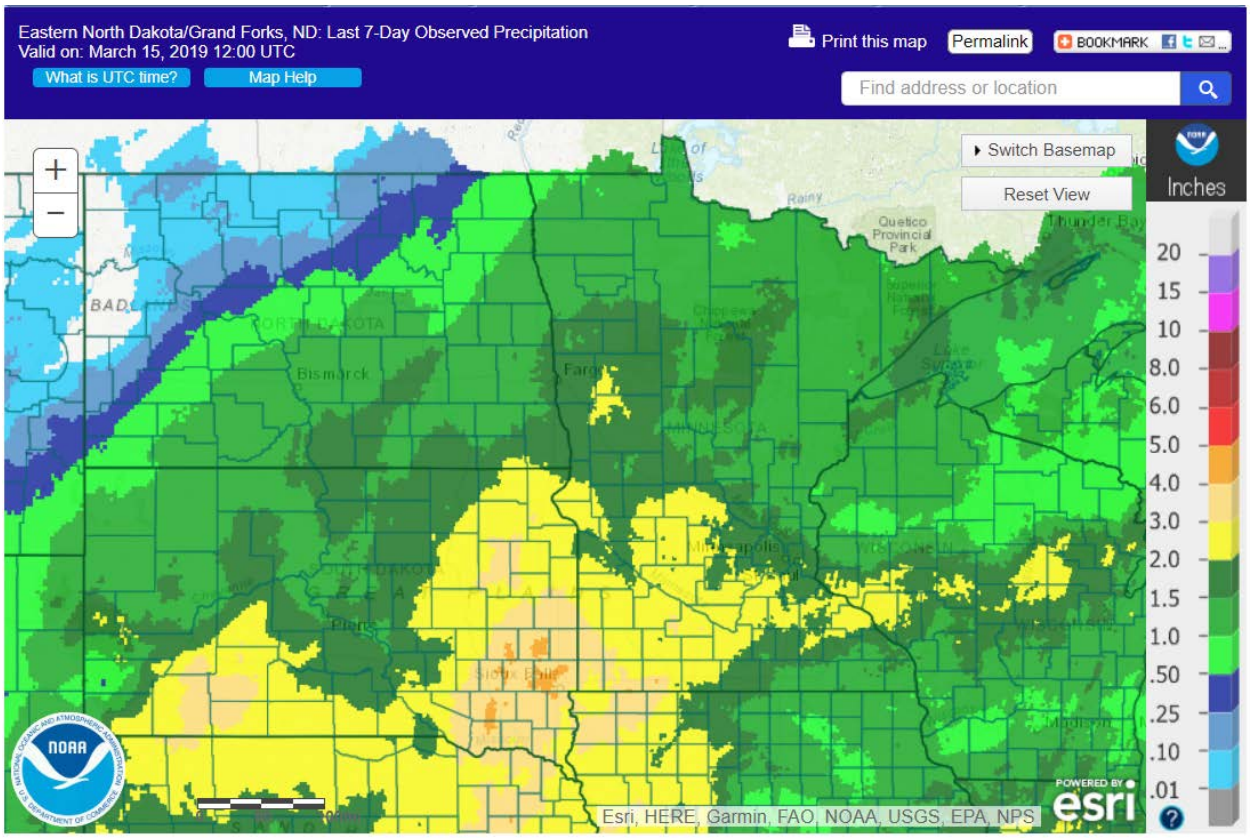

Figure 12. Eastern North Dakota, seven-day (valid on March 15) observed precipitation accumulation.

So Why a Red River Flood: With the combined February and March storms, our middle two ingredients, snowpack and snow-water content, have quickly moved into the Top-10 category for runoff potential[4]. In looking from the beginning of the water year, Oct. 1 through March 15, eastern North Dakota has gained from 6 to 9 inches of moistures, 1 to 4 inches above normal, and much of that is poised for possible runoff later this spring.

[4] By Top-10 category, we mean that total water year-to-date moisture content, from Oct. 1 through March 15, is within the top 10 of a 120- to 130-year record of precipitation measurements at Grand Forks and Fargo, respectively. In addition, it also lies within the 90th percentile of basinwide snow-water-equivalent (SWE) as calculated and tracked by the North Central River Forecast Center during the past 70-plus years or river modelling.

It doesn't have to be a big, big flood, as that still will depend heavily on how the spring temperatures and early rainfall unfold. But the initial ingredients are in place, and a late thaw is a historically risky proposition when it comes to spring flooding.

We still could have a gentle and easy thaw cycle, with little to no additional moisture. The 2013 spring thaw was just such an example, coming in as the latest and gentlest thaw in 130 years of record! But we also could have a catastrophic thaw such as that produced in late March of 2006, when a rapid warm-up and a basinwide 1- to 2-inch rainfall pushed every point along the main-stem Red River into major flood stage within the same 24-hour period – much like what recently has occurred in the Sioux Falls and Omaha areas (Figure 13).

This spring flood season is still just starting to unfold, which much uncertainty in the air, but one thing is for certain across the Red River Basin at least: There will be widespread runoff and widespread flooding of some nature across most all areas.

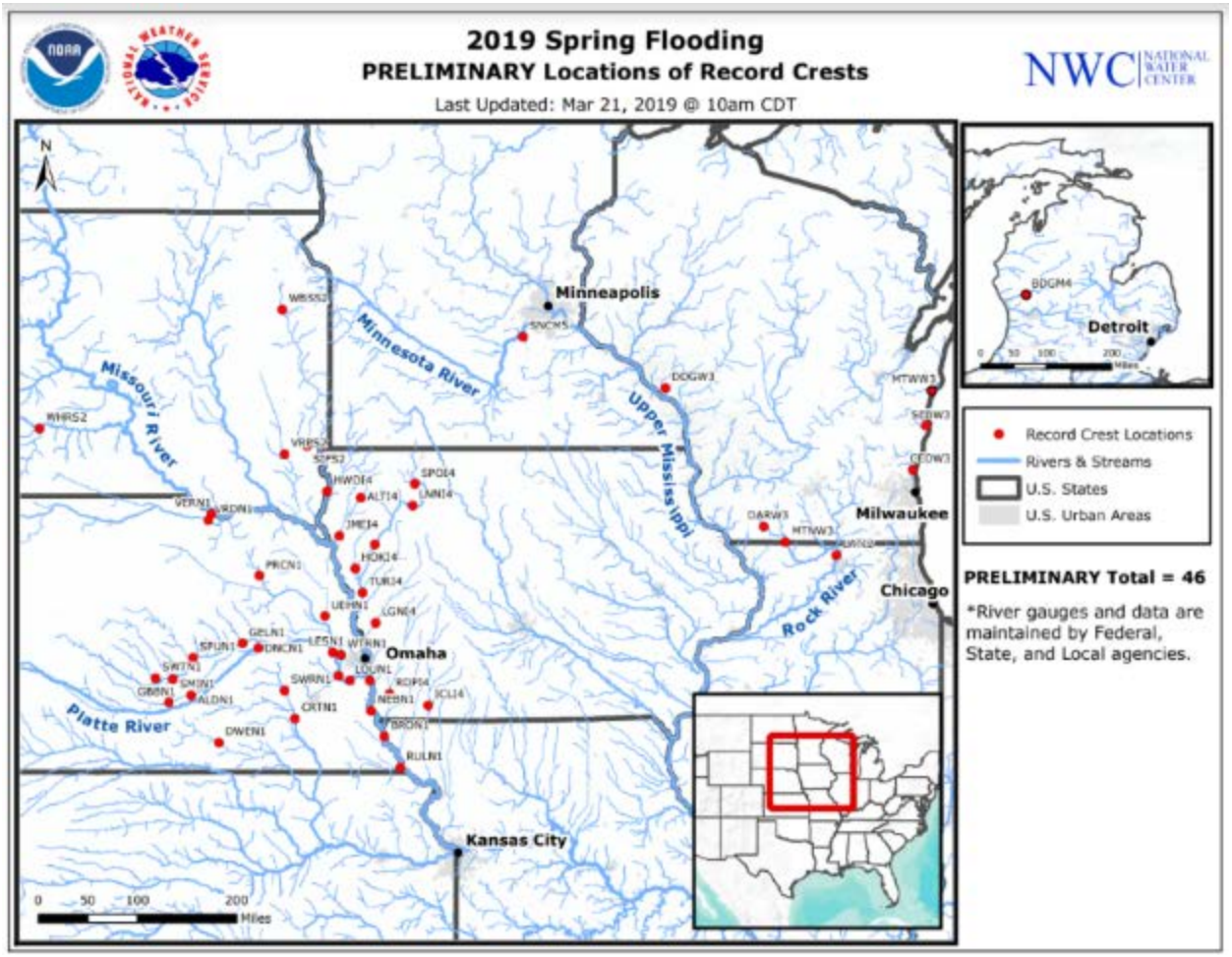

Figure 13. 2019 spring flooding preliminary locations of record crests. (National Water Center)

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.

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