NORTH DAKOTA STATE CLIMATE OFFICE ndsco

North Dakota Climate Bulletin

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In This Issue

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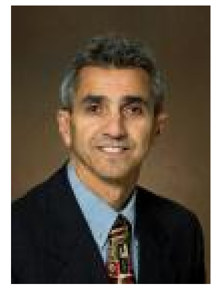
From the State Climatologist



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, Fargo.

Even though the overall winter temperature was 2.6 degrees cooler than average, this winter was the 55th warmest because of the nature of the distribution of temperatures, and it was the 25th driest on record since 1895 in North Dakota. Overall, 60 highest and 73 lowest daily temperature records were broken or tied. In addition, 60 highest daily precipitation records, including 32 daily snowfall records, were broken or tied. A total of 193 records, including temperature- and precipitation-related occurrences across the state, were tied or broken. Drought conditions improved, compared with the previous season. However, by the end of the season, the western half of the state still was experiencing the drought hangover. The drier-than-average winter in the area, combined with dry soil leftover from the previous season, is a precursor for a continuation of the 2017 drought into 2018. However, the evaporation rate in spring is approximately half as much as it is in the summer; therefore, less precipitation in early spring is necessary, compared with summer, to halt the drought progress.

Detailed monthly climate summaries for December, January and February, along with several other local resources for climate and weather information, can be accessed individually via www.ndsu.edu/ndsco/.

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

Observing snow with CoCoRaHS Network. (Adnan Akyüz. NDSU)

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, 2017, through Feb. 28, 2018) was 1.01 inches, which was 2.02 inches less than the last season (fall 2017), 1.18 inches less than the last winter (winter 2016-17) and 0.41 inch less than the 1981-2010 average winter precipitation. It also was the driest winter since 2007-08. This would rank winter 2017-18 as the 25th driest winter since such records began in 1895. Figure 1 shows the percent of normal precipitation distribution geographically. Based on historical records, the state average winter precipitation showed no long-term trend during this period of record since 1895. The highest and lowest seasonal winter average precipitation for the state ranged from the highest amount of 2.99 inches in 1968-69 to the lowest amount of 0.59 inch in 1989-90. The “Historical Winter Precipitation for North Dakota” time series on Page 5 shows a graphical depiction of these statistics.

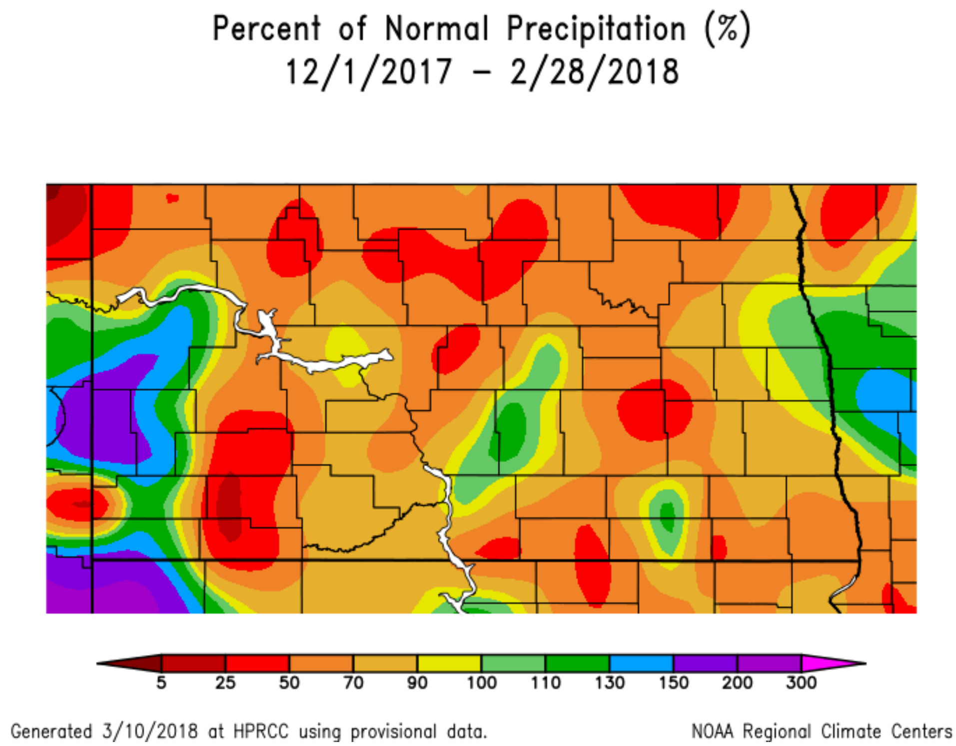


Figure 1. Precipitation percent of normal in winter 2017-18 for North Dakota. (HPRCC)

Temperature

The average North Dakota temperature for the season (Dec. 1, 2017, through Feb. 28, 2018) was 10.9 F, which was 32.4 F cooler than the last season (fall 2017), 3.1 F colder than the last winter in 2016-17 and 2.6 F colder than the 1981-2010 average winter temperature. It also was the coldest winter since 2013-14. However, because winter temperature values are not normally distributed, the current value was closer to the warmer half of the distribution. Therefore, this would rank winter 2017-18 as the 55th warmest winter since such records began in 1895. Figure 2 shows the departure from normal temperature distribution geographically. Based on historical records, the average winter temperature showed a positive trend of 0.46 F per decade since 1895. It ties with Alaska for the steepest winter trend record in the U.S. However, it still is the steepest 1890-to-2018 winter trend in the U.S. (State averages prior to 1925 are not available for Alaska.) The highest and lowest seasonal winter average temperatures for North Dakota ranged from the highest amount of 22.2 F in 1986-89 to the lowest amount of minus 3 F in 1935-36. The "Historical Winter Temperature for North Dakota" time series on Page 6 shows a graphical depiction of these statistics.

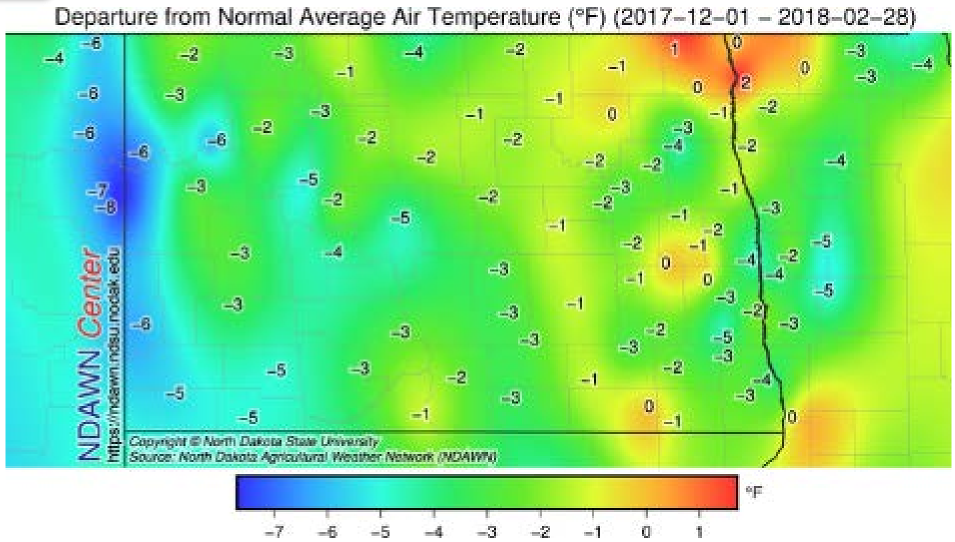


Figure 2. Temperature departure from normal in winter 2017-18 for North Dakota. (NDAWN)

Drought: Following the 14th driest growing season in 2017, the end of the winter yielded the seventh driest 12 months in a row from March through February. In earlier parts of the winter, a majority of the locations experienced snow drought. As a result, frost was observed deeper into the soil than usual. However, back-to-back snowstorms in the east and north of the Missouri River helped reduce the snowfall deficits to less concerning levels for drought but were not enough to raise concerns for flooding. Figure 3 below shows the drought conditions in the beginning and the end of the winter (USDM).

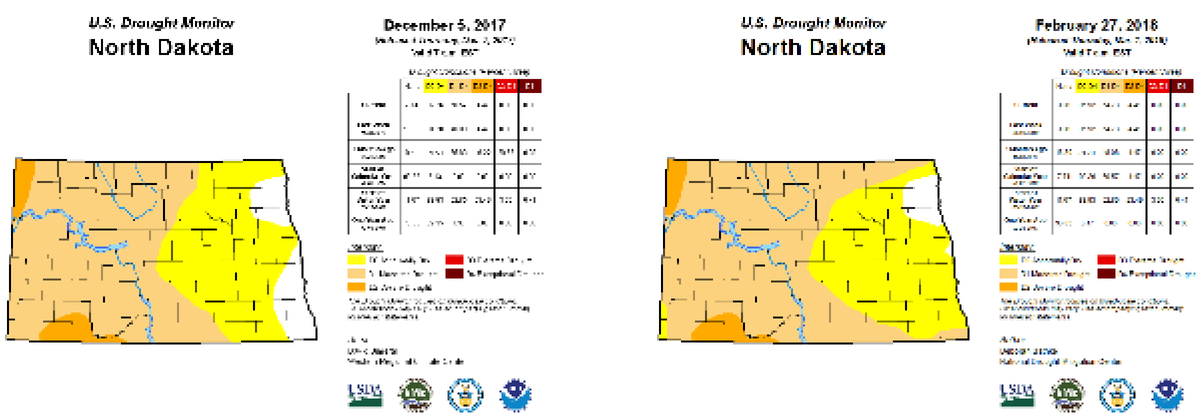


Figure 3. Drought Monitor map comparison for North Dakota in the beginning (on the left) and at the end (on the right) of winter 2017-18 (USDM).

Figure 4 below shows the statewide drought coverage in percentage and intensity (DO, D1, etc) in time scale representing the state from the beginning to the end of the month, with one-week resolution.

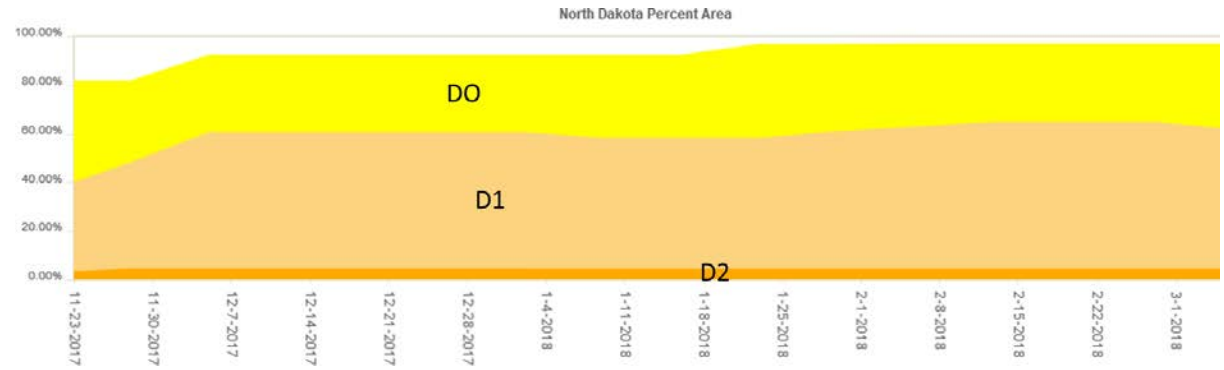


Figure 4. Statewide drought coverage (%) and intensity (Dx) in winter 2017-18 (USDM).

The index that takes into account intensity (D-level) and coverage (%), called the Drought Intensity and Coverage Index (DSCI), was 163 by the end of the season. That is a 6-point increase, compared with the beginning of the season (Figure 5). However, the index reached its maximum value of 295 in the first week of August; that is the second highest value on record since 2000.

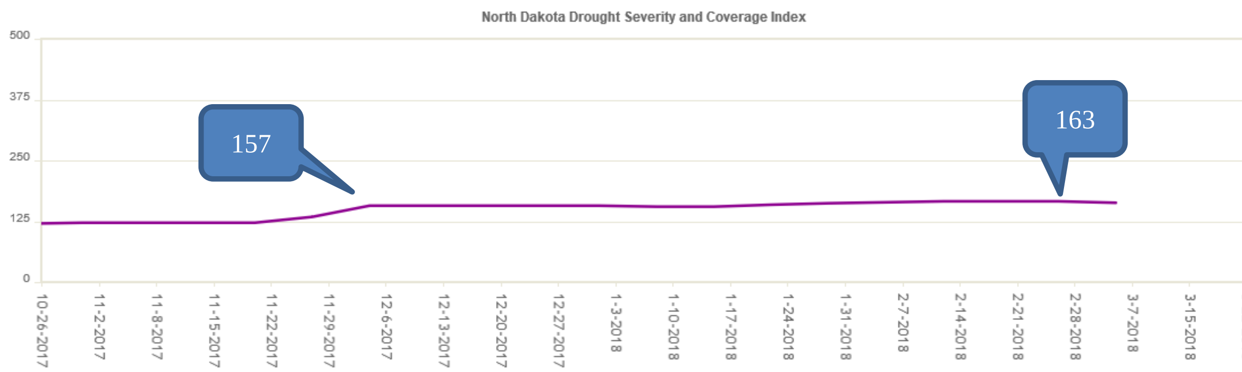
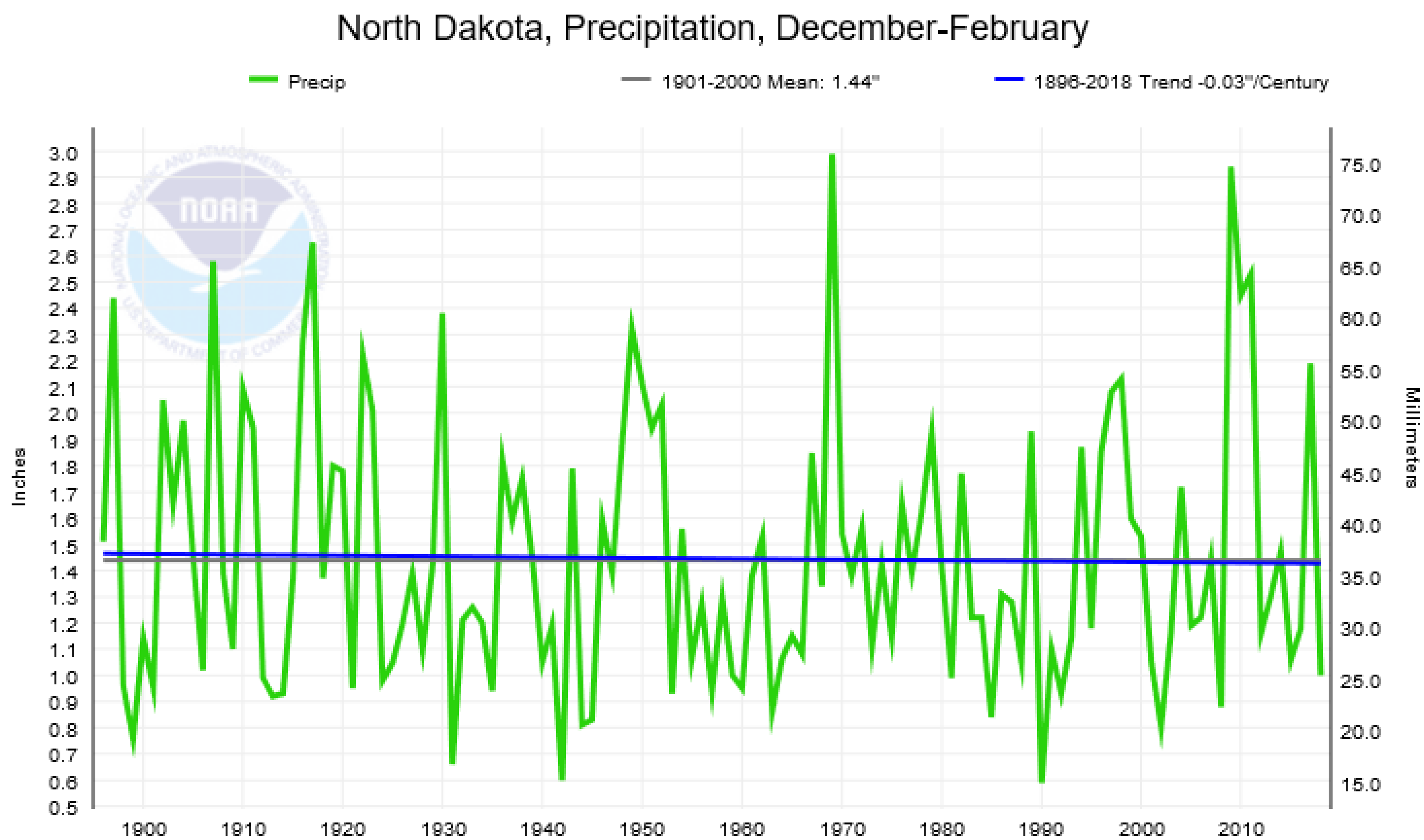


Figure 5. Statewide Drought Coverage and Intensity Index (DSCI) in winter 2017-18 (USDM).

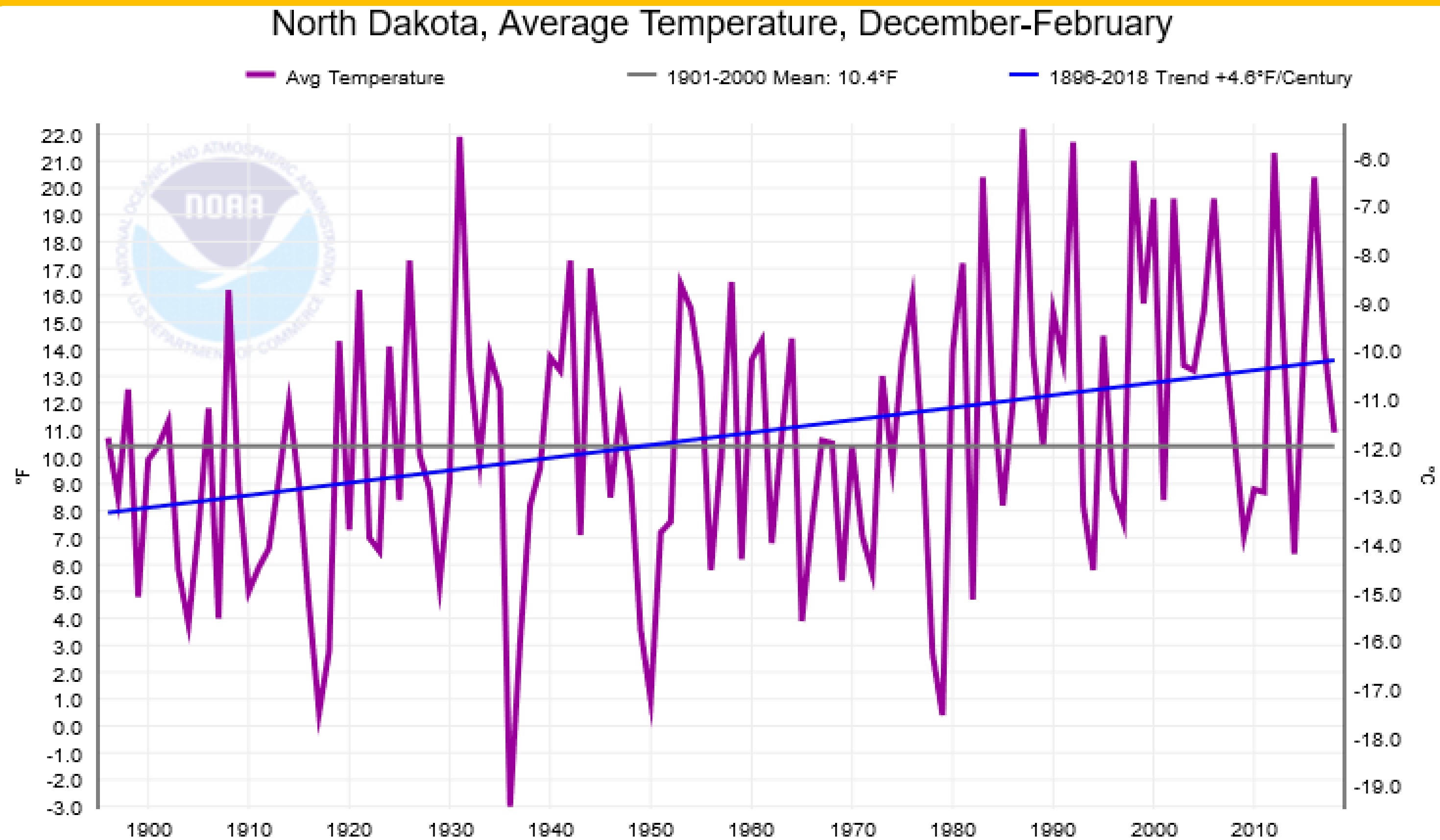
HISTORICAL WINTER PRECIPITATION FOR NORTH DAKOTA



Record High Value: 2.99 inches in 1968-69
Record Low Value: 0.59 inch in 1989-90
Seasonal Trend: 0.00 inches per decade (no trend)

Winter 2017-18 Value: 1.01 inches
1981-2010 Average: 1.42 inches
Seasonal Ranking: 24th Driest Winter
Record Length: 124 years

HISTORICAL WINTER TEMPERATURE FOR NORTH DAKOTA



Record High Value: 22.2 F in 1986-87
Record Low Value: minus 3 F in 1935-36
Seasonal Trend: 0.46 F per decade

Winter 2017-18 Value: 10.9 F
1981-2010 Average: 13.5 F
Seasonal Ranking: 55th Warmest (69th Coldest)Winter
Record Length: 124 years

Storms and Record Events

State Tornado, Hail and Wind Events for Winter 2017-18

Table 1. Numbers in the table below represent the number of tornado, hail and wind events accumulated monthly and seasonally.

Month	**Tornado**	**Hail**	**Wind**	**Total**
September Total	0	0	0	**0**
October Total	0	0	0	**0**
November Total	0	0	0	**0**
Seasonal Total	**0**	**0**	**0**	**0**

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).

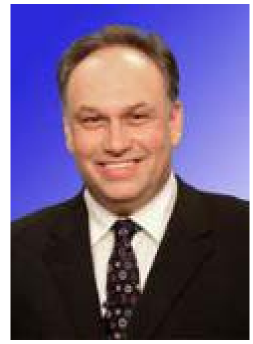
None Reported	None Reported	None Reported
December 2017 North Dakota Storm Events	January 2018 North Dakota Storm Events	February 2018 North Dakota Storm Events

State Record Events for Winter 2017-18

Table 2. 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	7	2	**19**
Highest Daily Min. Temp.	25	16	0	**41**
Lowest Daily Max. Temp.	25	9	0	**34**
Lowest Daily Min. Temp.	16	17	6	**39**
Highest Daily Precipitation	12	11	5	**28**
Highest Daily Snowfall	4	11	17	**32**
Total	**92**	**71**	**30**	**193**

Seasonal Outlook



Spring 2018 Outlook — By R. Kupec[1]

The 2017-18 winter outlook called for precipitation to be greater than in winter 2016-17 and to be closer to average across the state except in northeastern North Dakota, where slightly above-average precipitation was expected. This forecast was an accurate prediction for this past winter. Much of the state experienced slightly below-average precipitation, with the northeast a little above.

The temperature forecast called for the season to end several degrees below average. This, too, was correct, with most areas running nearly 2 to 4 degrees cooler. Much of the winter chill can be attributed to an especially cold February that saw temperatures 7 to 14 degrees below the 30-year average. The La Niña weather pattern in the Pacific Ocean and the ridge of high pressure in the Atlantic, which pushed Arctic air toward North America, were largely responsible for this winter's numbers.

As March begins, patterns are beginning to change. The La Niña in the Pacific is beginning to weaken, and indications are that by the end of spring, it will enter a neutral phase. High pressure in the Atlantic has gone away and a strong jet stream across the southern U.S. is developing. This should diminish the amount of cold air being pushed down from the Arctic.

La Niña patterns in the spring tend to favor slightly cooler and wetter conditions across North Dakota. The cool temperatures are most pronounced in April. While a breakdown of the high pressure in the Atlantic minimizes the intrusion of Arctic air, the strong southern jet stream inhibits the northward migration of substantially warmer air. This further aids the cool conditions that would be expected with a La Niña. With these factors, expect a slightly cooler and wetter spring statewide.

The current Climate Prediction Center (CPC) spring outlook is predicting below-average temperatures in western North Dakota and an equal chance of above- or below-average temperatures in the eastern half of the state (see Figure 6a). For precipitation, the CPC forecast calls for above-average precipitation for all of North Dakota (see Figure 6b).

The next 90-day outlook from the CPC should be available after March 15 and another will be available on April 19 (www.cpc.ncep.noaa.gov/products/predictions/90day).

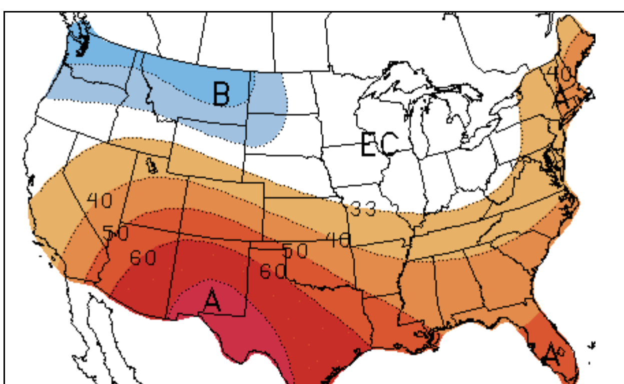


Figure 6a. March through May temperature outlook

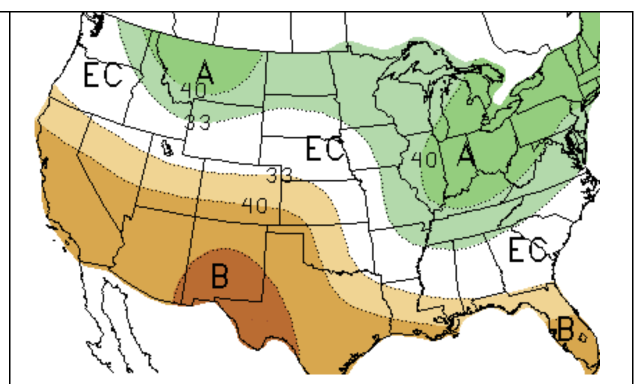


Figure 6b. March through May precipitation outlook

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

(Climate Prediction Center, NOAA.)	(Climate Prediction Center, NOAA.)

Hydro-Talk

Spring 2018 Flood Outlook for Western and Central N.D.

By A. Schlag[2]

I've found myself writing a lot this past year on drought, how we got to dry from years of wet, the status of drought and the potential for drought to continue its presence in North Dakota. Because it is March, I am going to talk a little about the flood potential for North Dakota as we head into spring. So let's cover what we know and expect out of the upcoming spring snowmelt and runoff season.

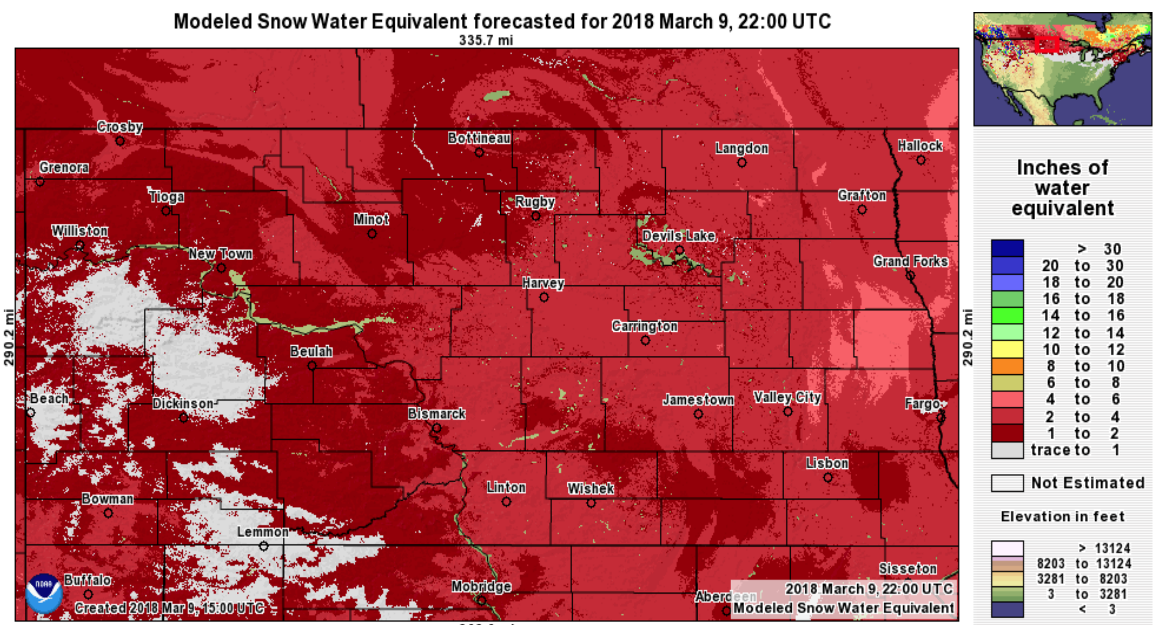


Figure 7. Modeled snow-water equivalent for March 9, 2018. (NOHRSC)

First and foremost, thanks to a large rain and snow storm March 4-6, there is finally an appreciable amount of snow-water equivalent (SWE) across western and central North Dakota.

While Figure 7 above of modeled SWE from the National Observational Hydrologic Remote Sensing Center (NOHRSC) tends to be higher than field measurements, the relative depiction of the snowpack is excellent and suggests there is at least enough water in the snowpack now to lessen the hangover of a dry 2017. This was not necessarily the case at the beginning of March.

However, the general dryness of the soils is shown to the right, and these soil moisture maps available from the Climate Prediction Center (CPC) suggest there is ample room in the root zone for much of the water currently frozen on top of the ground. The 20- and 40-plus millimeters of

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missing water in the ground is a huge switch from last spring, when the region was well above normal for soil moisture (Figure 8). Given anything other than a very fast melt with additional heavy rainfall, the soils should take advantage of this meltwater as it's generated, despite soil temps that remain below freezing. All it will take is the warming of the upper 2 to 4 inches of soil to dampen runoff significantly, and that's relatively easy to do with the strength of the sun this time of year.

When looking forward to the spring melt season, we are already in the historically normal time of the year for seeing the loss of at least some snow. Average daytime highs in the Bismarck area for March 9 are 37 F, and while expectations are we will remain below normal in the near term, even below-normal temperatures during the second half of March melt snow. This suggests the area is in for a protracted and gentle melt season where much of the SWE ends up in the ground.

That being said, we disregard the fickleness of Mother Nature at our peril; she has been known to throw a mean curve to us in the northern Great Plains from time to time.

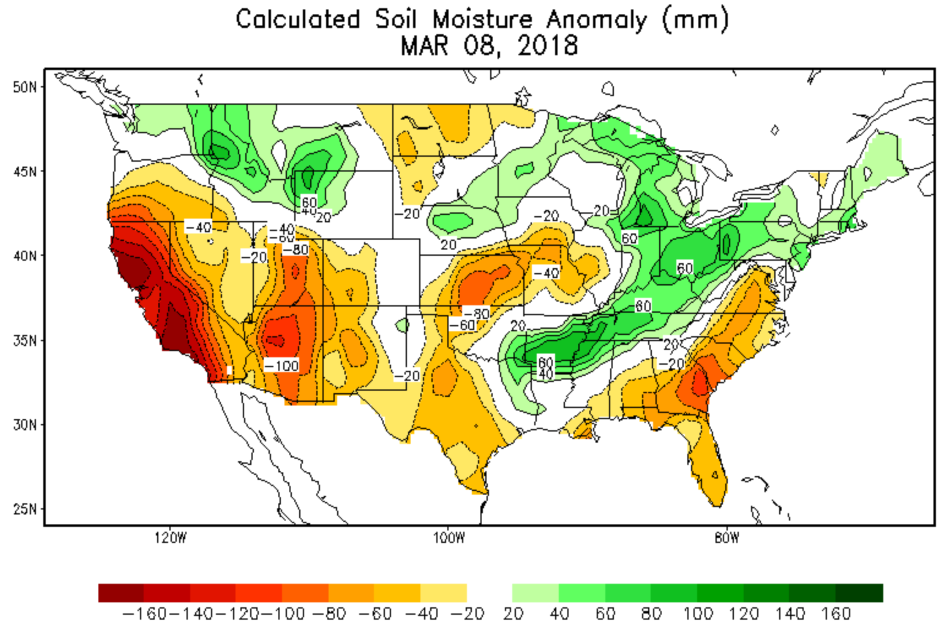
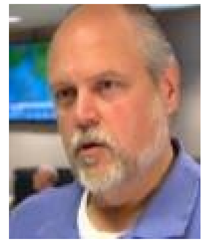


Figure 8. Calculated soil moisture anomalies in millimeters. (CPC)

Science Bits



What might spring bring: Drought or flood?

By G. Gust[3]

Once again, as spring unfolds across these northern Plains, it's possible that parts of North Dakota may move rather abruptly from winter snow to spring runoff flooding to episodic wildfires, and even to areas of drought.

Drought Carryover? - After an abnormally dry year in 2017, with periods of D1 drought stretching across eastern North Dakota, most of the eastern area's soils and streamflows went into freeze-up within the middle to low ranges for their respective periods of record. The soil moisture rankings for southeastern North Dakota were closer to normal at the year's end, largely due to late-season rainfall, while the northeast saw conditions go from quite wet last spring to quite dry by late autumn (Figure 8).

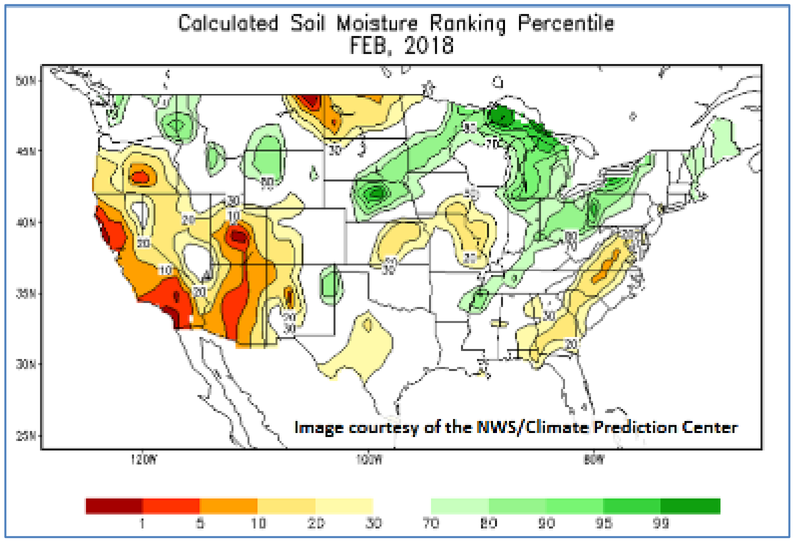


Figure 8. Calculated soil moisture ranking percentiles for February 2018. (CPC)

Winter Moisture Sketchy - Although winter cold was widespread across the state, winter snow cover and snow water content were less extensive. Central portions of the Red River Valley proper were snowiest, with the stretch between Grand Forks and Traill counties edging slightly above normal for winter season precipitation. But the Devils Lake and Upper Sheyenne River Basins received just a little more than half of their normal winter precipitation (Figure 9). Note that those same areas faced soil moisture deficits going into winter freeze-up.

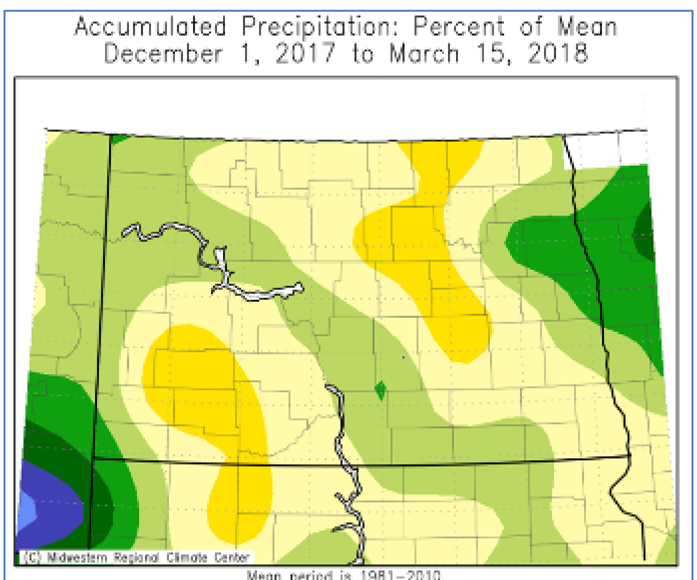


Figure 9. Dec. 1 through March 15 accumulated percent of normal precipitation. (HPRCC)

Wickedly Deep Frost - Of course, soils were deeply frozen this winter, including more than 40 inches deep across all of the eastern third of the state. So that raises at least two questions: whether there will be enough snow to produce runoff across the landscape, and whether the dry soils will overcome the frost and manage to soak up the melt.

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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

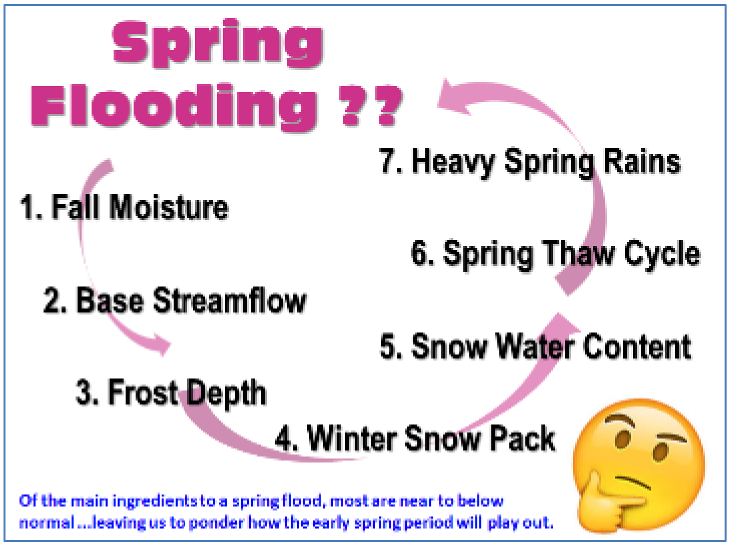

Figure 10. Spring flood components (Gust, 2018)

Spring Flood Components Incomplete! - Although there are various components that go into producing a spring snowmelt flood, any one flood season can see a wide variation in these base ingredients (Figure 10).

Of course, the very worst spring floods will tend to have extremes in most all of these ingredients. But from year to year, the primary predictor of spring snowmelt flooding in neither the antecedent soil moisture nor the winter snowpack; it's the early spring snowmelt cycle.

Thus, a cold and wet spring with an abrupt warmup, coupled with widespread early rains, can be disastrous to a subbasin that receives the heaviest rain and most rapid runoff. That said, early spring rainstorms tend to be spotty, with the heaviest rains only affecting a few counties at a time. Smaller tributaries tend to be more affected this way than the larger main-stem Red River.

Red River and Devils Lake Basin Spring Runoff/Flood Potential Near Normal - With somewhat dry soils, deep frosts, normal to below-normal snowpack and expectations of a somewhat delayed spring thaw, the spring flood risk across the Red River Basin is holding very near normal, while the Devils Lake Basin has a flood risk that is running slightly below normal.

The statewide flood risk map, produced by our NWS/River Forecast Centers, indicates that most eastern North Dakota rivers can expect less than a 50 percent risk on reaching minor flood (Figure 11).

The exceptions would be along the main-stem Red River near Oslo, Minn., and Pembina, N.D., where backwater effects and increased runoff from Minnesota tributaries could produce somewhat higher flows. Also Devils Lake, which is likely to see lower than normal runoff and inflows, still remains at alarmingly high levels as a result of decades of above-normal precipitation.

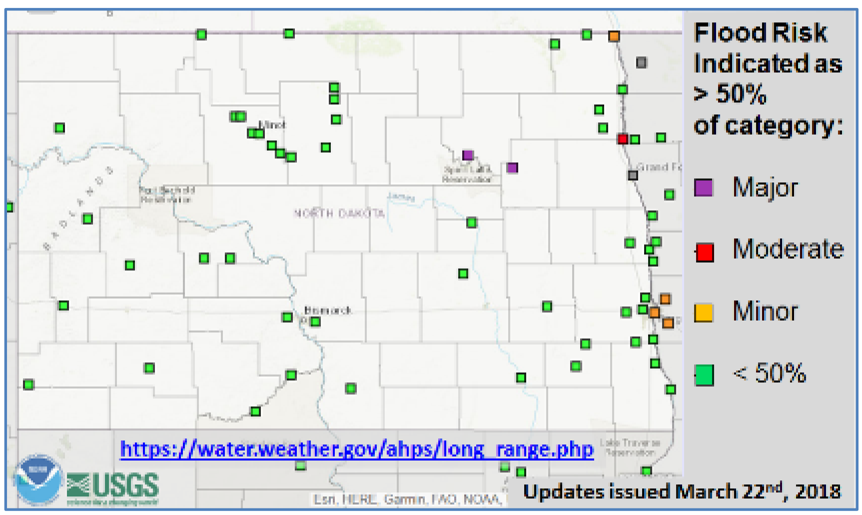

Figure 11. Eastern North Dakota flood risk map. (NWS/NCRFC)

Localized Flash Flooding - And don't forget, any part of the state can experience some localized flash flooding during the spring snowmelt/runoff season if heavy spring rains fall on frozen ground, even while nearby dry grasslands are subject to wildfire and deeper soils are poised for drought.

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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