NORTH DAKOTA STATE CLIMATE OFFICE ndsco

# North Dakota Climate Bulletin

Winter 2019-20 Volume: 14 No: 1

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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 winter average temperature was 2.1 degrees warmer than average, which would make it the 21st warmest winter on record. Precipitation-wise, the statewide accumulation was only 0.09 inch drier than average, which would make it the 61st driest winter on record. However, keep in mind that North Dakota had its wettest year on record in 2019. The drier-than-average season was well-received, especially along the Red River Valley of the North, where the risk of major flooding is heightened. Overall, a total of 188 records, including temperature- and precipitation-related occurrences across the state, were tied or broken.

Extreme wet conditions last fall following a short growing season put stress on agricultural products such as corn, sunflower seeds and sugarbeets. The Science Bits section addresses problems related to unharvested fields, snowpack, sun angle, albedo and flood risk.

Detailed monthly climate summaries for December, January and February, 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


*Unharvested cornfield*
*(National Weather Service, Grand Forks, 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 winter season (Dec. 1, 2019, through Feb. 29, 2020) was 1.33 inches, which was 7.44 inches less than the last season (fall 2019), 0.75 inch less than last winter (winter 2018-19) and 0.09 inch less than the 1981-2010 average winter precipitation (Table 1). This would rank the winter of 2019-20 as the 65th driest (61st wettest) winter since such records began in 1895.

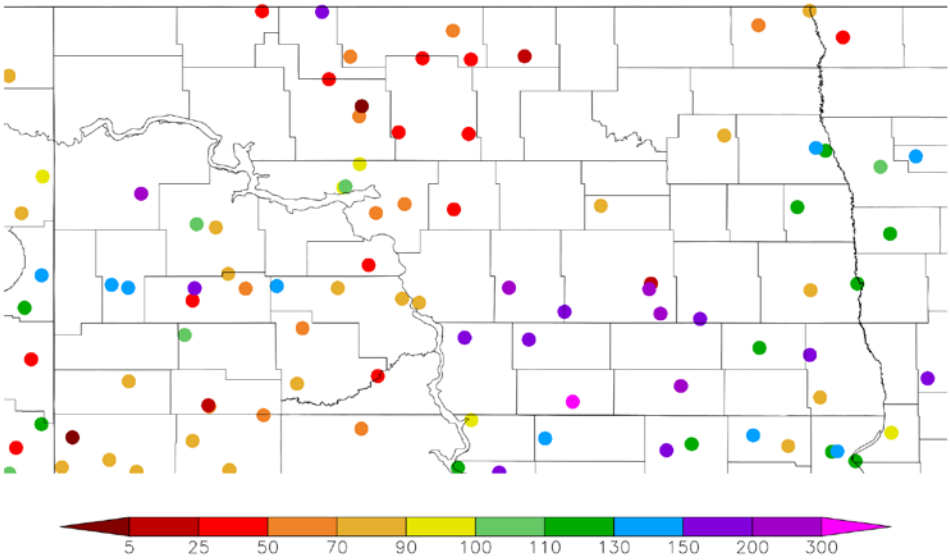



Figure 1. Precipitation percent of normal in winter of 2019-20 for North Dakota. (High Plains Regional Climate Center, HPRCC)

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 of the season was 5.19 inches, recorded in Grand Forks, Grand Forks County. The greatest seasonal snowfall accumulation was 51 inches, recorded in Streeter, Stusman County. 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 0.59 inch in the 1989-90 season to 2.99 inches in the 1968-69 season. The “Historical Winter Precipitation for North Dakota” time series (Figure 2) shows a graphical depiction of these statistics.

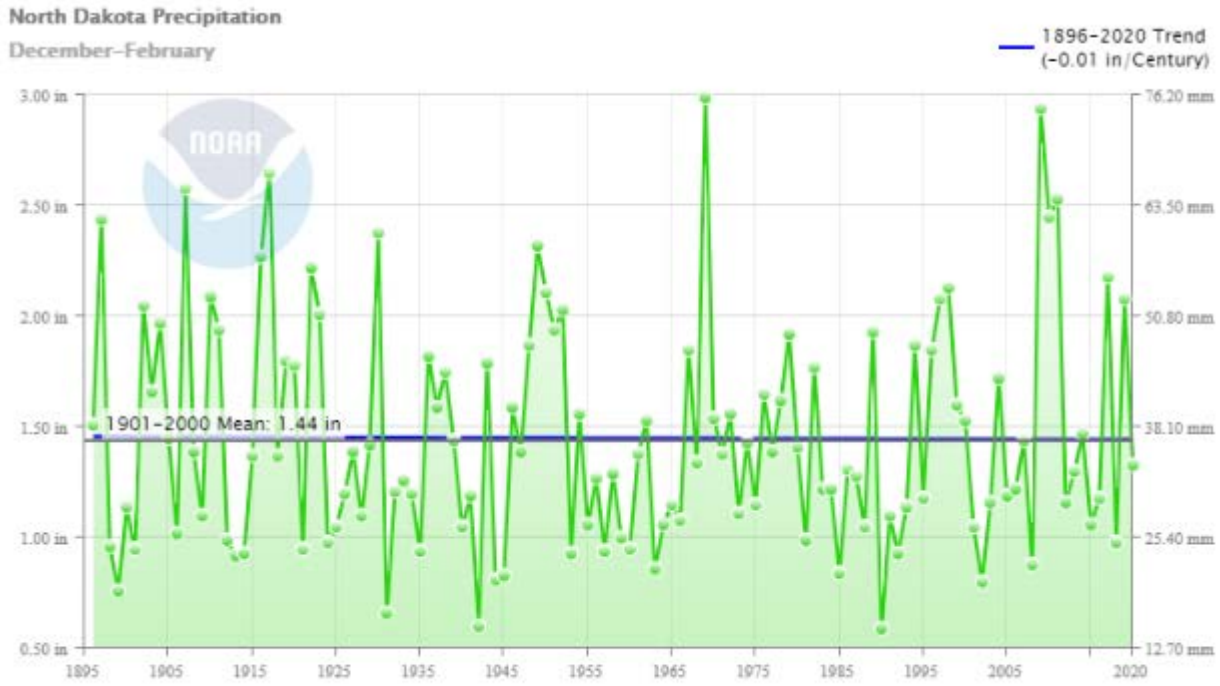



**Figure 2. Historical winter precipitation time series for North Dakota.**

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

| Period | Value | Normal | Anomaly | Rank | Wettest/Driest Since | Record Year |
|---|---|---|---|---|---|---|
| **Winter 2019-*20*** | **1.33”** | **1.42”** | - 0.09” | **61st driest**<br>**65th wettest** | **Driest since 2018**<br>**Wettest since 2019** | **0.59” (1989-90)**<br>**2.99” (1968-69)** |

[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

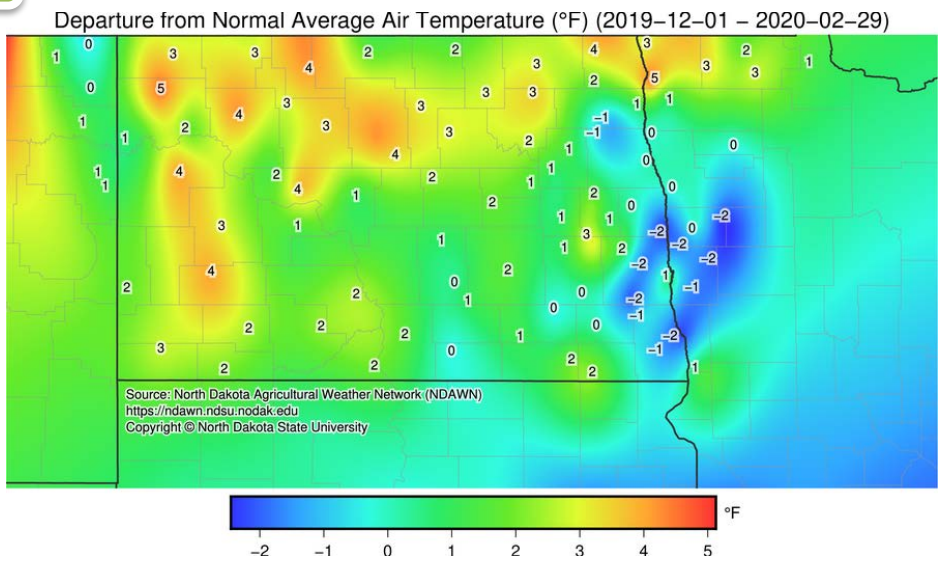



Figure 3. Temperature departure from normal in winter 2019 for North Dakota. (North Dakota Agricultural Weather Network)

The average North Dakota temperature for the season (Dec 1, 2019, through Feb 29, 2020) was 15.6 F, which was 25.1 degrees cooler than the last season (fall 2019), but 6.3 degrees warmer than last winter (2018-19 season). It was 2.1 degrees warmer than the 1981-2010 average winter temperature, which would rank winter 2019 as the 21st warmest 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. In contrast, numbers that are 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 winter temperature showed a positive trend of 4.5 degrees per decade since 1895 (the highest long-term temperature trend in the U.S.) The highest and lowest seasonal winter average temperatures for North Dakota ranged from minus 3 F in the 1935-36 season to 22.2 F in the 1986-87 season. The “Historical Winter Temperature for North Dakota” time series (Figure 4) shows a graphical depiction of these statistics.

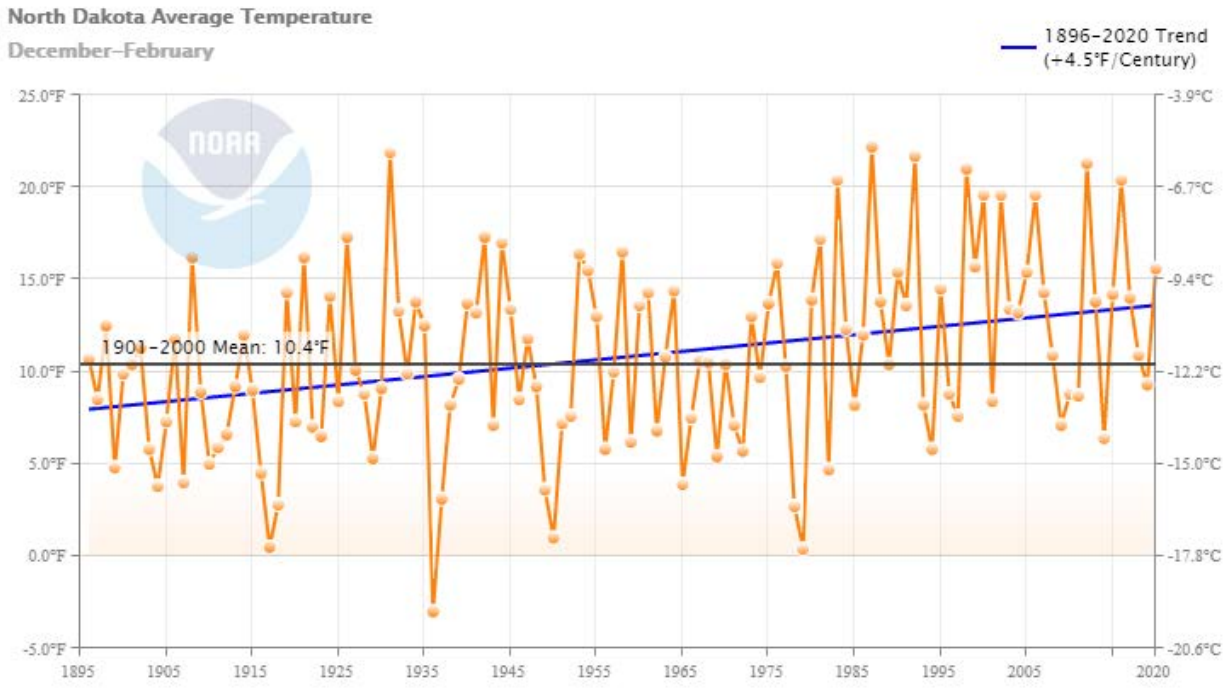



**Figure 4. Historical winter temperature time series for North Dakota.**

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

| Period | Value | Normal | Anomaly | Rank | Warmest/Coolest Since | Record Year |
|---|---|---|---|---|---|---|
| Winter 2019 | 15.6 F | 13.5 F | 2.1 F | 105th coolest<br>21st warmest | Coolest since 2019<br>Warmest since 2016 | -3 F (1935-36)<br>22.2 F (1986-87) |

[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:** Even though the state did not contain any dryness anywhere in the state, this page is kept as a placeholder for future drought conditions. Figure 5 below shows the drought conditions in the beginning and the end of winter. Figure 6 shows the drought intensity and coverage in a time scale. Both of the figures show no drought conditions spatialy and temporally.

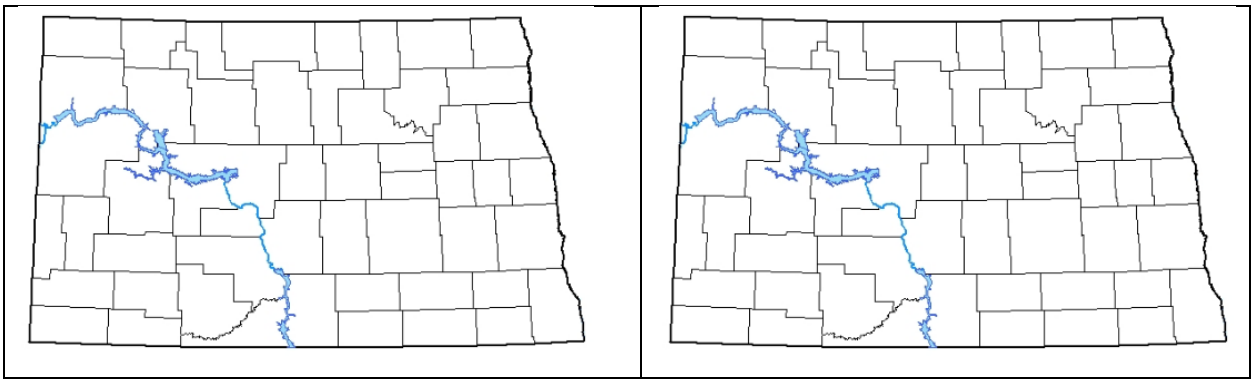


Figure 5. Drought Monitor map comparison for North Dakota in the beginning (on the left) and at the end (on the right) of winter 2019-2020. (U.S. Drought Monitor)

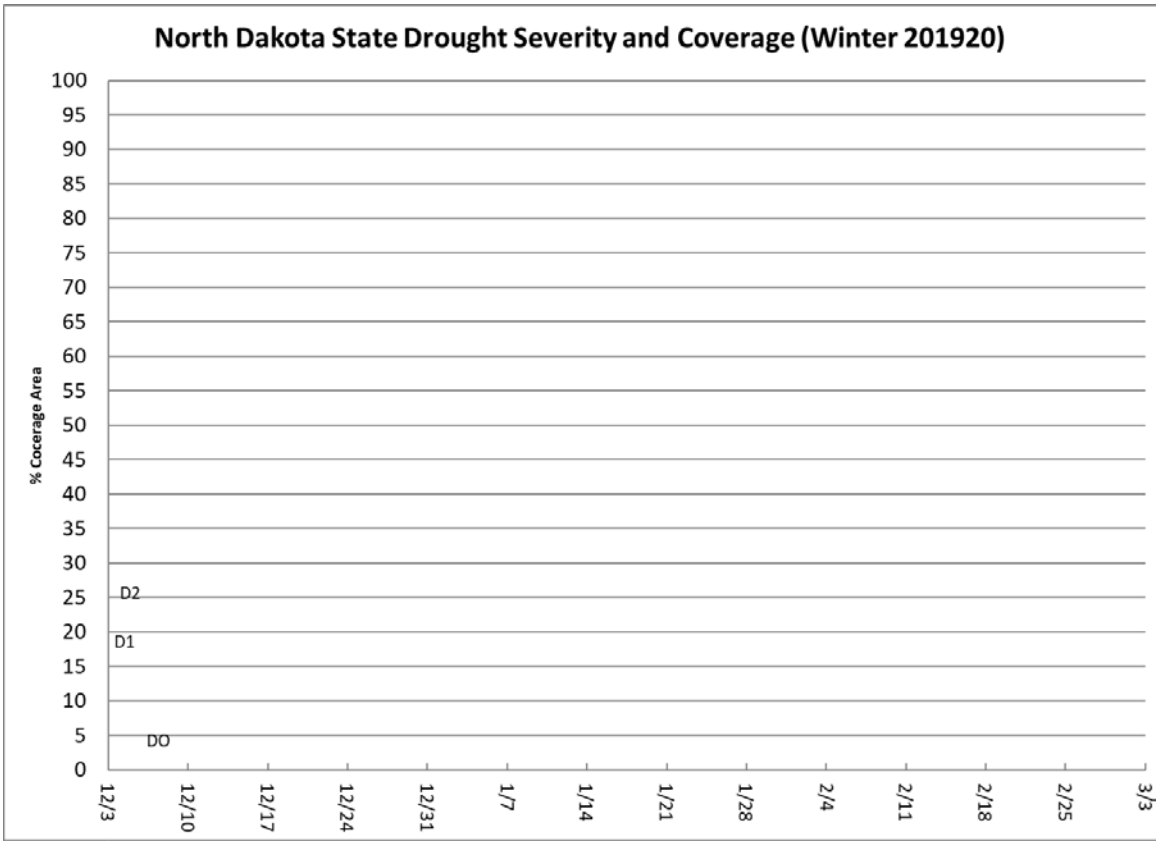


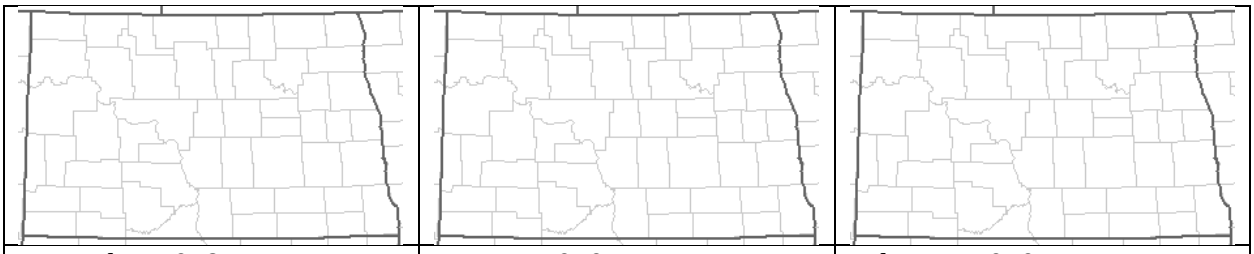

Figure 6. Statewide drought coverage in percentage and intensity (D.O., D1, etc.) in a time scale representing the state from the beginning to the end of the season, with a one-week resolution.

# Storms and Record Events

## State Tornado, Hail and Wind Events for Winter 2019-20

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

| | December 2019 | January 2020 | February 2020 | Seasonal Total |
|---|---|---|---|---|
| Tornado | 0 | 0 | 0 | **0** |
| Hail | 0 | 0 | 0 | **0** |
| Wind | 0 | 0 | 0 | **0** |
| **Total** | **0** | **0** | **0** | **0** |



December 2019 North Dakota Storm Events | January 2020 North Dakota Storm Events | February 2020 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 2019-2020

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 | December | January | February | Seasonal Total |
|---|---|---|---|---|
| Highest daily max. temp. | 5 | 0 | 1 | **6** |
| Highest daily min. temp. | 8 | 4 | 6 | **18** |
| Lowest daily max. temp. | 2 | 3 | 7 | **12** |
| Lowest daily min. temp. | 5 | 0 | 6 | **11** |
| Highest daily precipitation | 52 | 13 | 6 | **71** |
| Highest daily snowfall | 53 | 13 | 4 | **70** |
| **Total** | 125 | **33** | **30** | **188** |

# Seasonal Outlook

## Winter 2019-20 Outlook

By R. Kupec[3]

Winter 2019/20 in North Dakota started with above-average precipitation across much of the state. As January began, it were as if someone threw a magical switch and the weather became dry statewide. For most of the winter, a strong jet stream across the deep south of the U.S. has dominated the weather. In December, that jet stream occasionally swung north and brought several substantial snowfalls to the eastern portion of the state. Areas north and west of Bismarck missed more of these storms and started the season with near- to below-average precipitation. Since the start of January, that southern jet stream has stayed very stable across the southern U.S. and has not shifted north into the Central Plains. This has resulted in below-average precipitation statewide for January and February.

Much of the state also has seen above-average temperatures for the winter. The weaker northern jet stream has been just strong enough to keep much of the arctic air to our north. The one area of the state with slightly below-average temperatures was portions of the Red River Valley. Here a deep snowpack from a late December storm likely helped keep temperatures lower.

The winter outlook had called for similar conditions to those seen last winter, with colder and wetter than average conditions. The El Niño/La Niña pattern in the southern Pacific remained nearly the same as last year, but subtle differences in the northern Pacific and Atlantic Oceans changed the southern jet stream and kept more of the very cold air locked up over Greenland.

Conditions in both the Pacific and Atlantic Oceans are not expected to change much through the spring. Historically, this combination means near-average precipitation for the season statewide and temperatures near to slightly above average. The current Climate Prediction Center (CPC) spring outlook has a slightly different forecast for temperature and precipitation. It gives below-average temperatures expected in about the western half of North Dakota (Figure 8a). It also gives the far western part of North Dakota above-average precipitation, with an equal chance of above or below precipitation for the rest of the state (Figure 8b). The next 90-day outlook from the CPC should be available after March 19 at www.cpc.ncep.noaa.gov/products/predictions/90day.

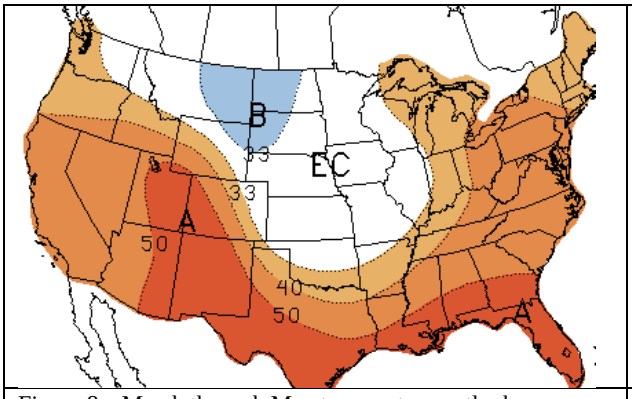



Figure 8a. March through May temperature outlook. (Climate Prediction Center, NOAA)

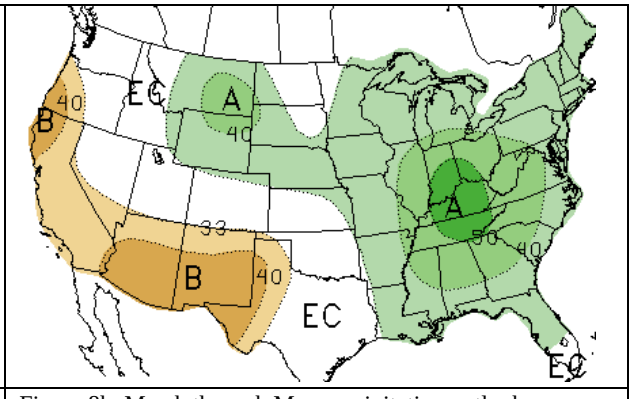



Figure 8b. March through May precipitation outlook. (Climate Prediction Center, NOAA)

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

# Hydro-Talk

## Another Tale of Halves

By A. Schlag[4]

I am not even sure how to describe last winter at this point: Was it short or long, warm or cold, wet or dry? Talk about needing to put a little perspective on things! However, it should be of little surprise that North Dakota squeaked out its wettest year on record in 2019 (Figure 9).

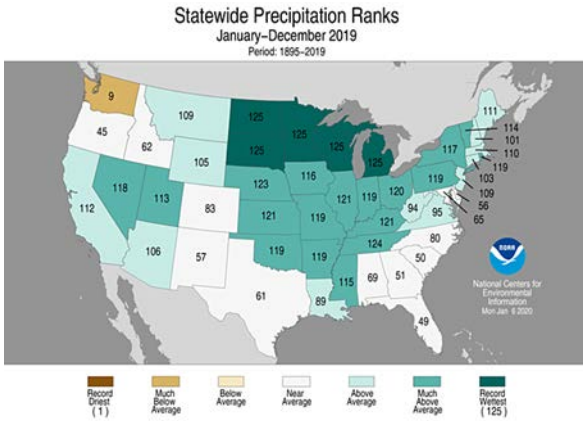



Figure 9. Statewide Precipitation Ranking, 2019

As shown in Figure 10, only the southeastern one-third of the state continued with the wetter-than-average signature into the first half of winter. This doesn't necessarily mean that that western one-third of North Dakota was unusually dry; it simply managed to find ways to lose much of the moisture received. The same cannot be said for the southeastern part of the state, including the James, Sheyenne and Red River basins. In fact, even as the region went through January, February and early March, a robust snowpack remained centered over much of the same three basins. See Figure 11.

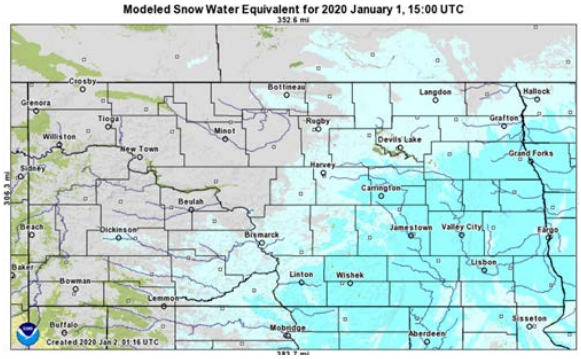



Figure 10. Water equivalent as of Jan. 1, 2020.

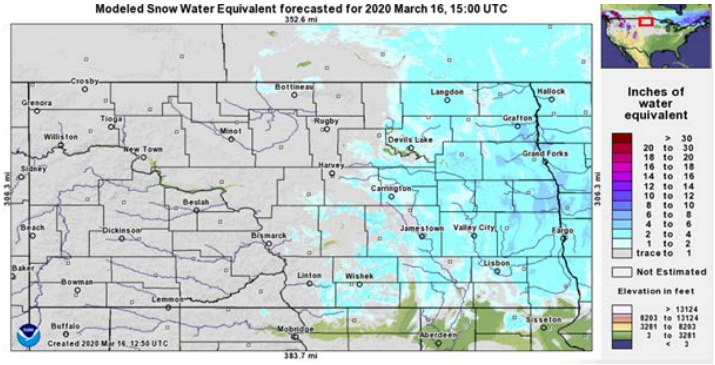



Figure 11. Water equivalent as of March 16, 2020.

The difference between the western and eastern parts of the state was the strength of the warm spell that affected the state during late February and early March. For example, during February, the Bismarck area had five days with daytime highs of 40 degrees and above, with another nine days of above 40 degrees in March, including a 59 degree-day on March 7. Jamestown, though, only had three days above 40 degrees (two of which were Feb. 1-2) and only four days in March. Farther east, Fargo similarly only had two days of 40-degree temperatures in February (again, Feb. 1-2) and another two days in March. Climate data for these sites can be found at Bismarck_Climate (https://w2.weather.gov/climate/index.php?wfo=bis) and Fargo_Climate (https://w2.weather.gov/climate/index.php?wfo=fgf), respectively. That is the reason for what has set the stage for the current flood risks going forward into our "normal" spring snowmelt season.

[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

So let's dig down a little bit more and see where the different geographic areas of the state currently sit concerning flood risk going forward. In the western tributaries to the Missouri River, most of the smaller watersheds now have run out of widespread snow-water equivalent (SWE). Only the Cannonball River reached flood stage, and if it had not had its ice cover, it most likely would have remained below flood stage. Similarly, other streams such as Apple Creek made a run up to near flood stage and then ran out of water. The Yellowstone and Missouri rivers west of Williston are running high for this time of year, with a little bit of minor flooding along the Missouri. Still, once they lose their ice cover in the coming days, it is tough to imagine their water levels remaining high. The Knife, Heart and many other tributaries were all well within their banks. Flood risk now is centered on still frozen ground and the potential for heavy spring rains.

In the Souris River Basin, only the area from Towner up through Westhope appears to have much potential for even minor flooding. Most of that expected runoff will be coming from the SWE out of McHenry, Bottineau and Rolette counties. The overall risk of damaging floods appears to be well below historically normal levels.

In the James River Basin, unusually wet ground and water frozen in place remain from last October. This is going to provide a run at flooding along the Pipestem Creek and James River north of Jamestown. The Jamestown and Pipestem dams are once again fully prepared to intervene in any flooding to help minimize downstream high water. That being said, the James River at LaMoure and all points further south are at still well above average levels of flood risk going into the second half of March and early April.

In the Prairie Pothole Region, many small to medium-sized bodies of water are entering spring already near their usual high water mark. Runoff from melting snow and the eventual spring rains should be expected to push some of these waterbodies to lay claim to previously dry acres of land, and any nearby low-lying roads. Road closures as a result of rising water in these potholes could last many weeks or even the entire summer.

Farther east and in the Sheyenne and Red River basins, plenty of SWE remains on the wet and frozen ground to create a well above-normal risk of damaging high water. This region thankfully has been spared from collecting much more SWE in February and March, but flood risks will remain high going through spring. Depending on the exact location, NWS models continue to highlight the potential for Top 10, or maybe even a Top 5 event. As we are now rapidly approaching the season where 1- to 2-inch rain events are not uncommon, any rain on snowmelt is going to be on everyone's radar.

Overall, given how brutal the entry into winter was this past year, it would appear that Mother Nature has been begrudgingly benevolent with the past five to seven weeks of weather. It has, at its best, removed much of the flood risk from western North Dakota and, at its worst, at least not added to what can already result in severe flood problems in the eastern part of the state.

# Science Bits

## Sun Angle, Albedo and Standing Crop Impact on Spring Snowmelt

**By G. Gust[5]**

One of the oddest visual features of this recent winter (December, January, February) period was the prevalence of standing crops in otherwise snowcovered fields. This was largely a consequence of the record wet fall (SON) season and reflective of the difficulties seen statewide in the harvest of later-season row crops.

**How much standing-crop was left out there?**

By early November, unharvested root crops such as potatoes and sugarbeets would have frozen their stalks and leaves and mostly died down to the soil surface, leaving little residual material to affect snowcover.

But row crops such as soybeans, corn and sunflowers ripened in place and were left standing above the excessively wet, then snowcovered and at least partially frozen soil. News and crop reports from the late fall and winter period show that many farmers harvested their soybeans first, as plants were closer to the ground and more likely to get covered over by early season snow.

Across the state, corn has been the most noticeable of the yet-to-be harvested 2019 crops. The North Dakota Crop Progress and Condition report, released Nov. 25 2019, indicated that the soybean harvest was at 89% (five-year average of 99%) while the corn harvest was only at 30% (five-year average of 95%) and the sunflower harvest was at 41% (five-year average of 90%).

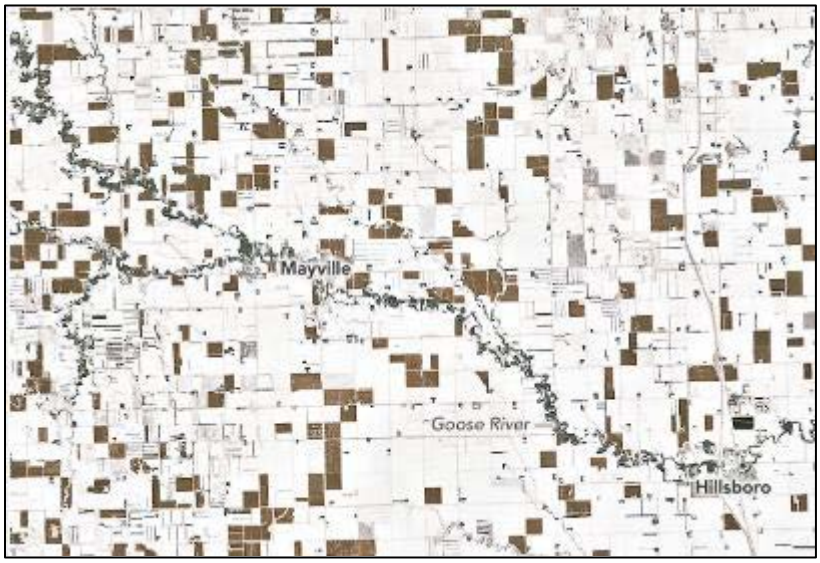



Figure 12. Landsat 7 satellite image on Dec. 9, 2019.

The crop report released on Dec 9, the same day as the Landsat 7 satellite image shown in Figure 12, reported that only 43% of the state's roughly 4 million corn acres had been harvested, with 57% of the crop (nearly 2.3 million acres) still standing in the fields. Through late January, the corn harvest was at 49% and the sunflower harvest was at 67%. By late February, the corn harvest stood at 61% and the sunflower harvest was at 79%.

North Dakota's weekly *Crop Progress and Conditions Reports* are available online at www.nass.usda.gov/Statistics_by_State/North_Dakota/index.php.

**How would a standing corn field affect snowmelt?**

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

That is a question us meteorologists and hydrologists have been scratching our respective heads over. The reasoning goes as follows: Because the corn stalks are darker than the snow, the area of corn should absorb more energy from the sunshine and warm up a bit more each sunny day than the surrounding snowscape.

As the image in Figure 13 (from UCAR[6]) shows, forested areas tend to warm a bit more on a sunny day than the surrounding snow-covered prairie. Much of this is due to the darker color of the trees, which absorb more energy from the sun and re-radiate heat to the surrounding air. Otherwise, a bright snow-covered landscape will reflect most of the sunlight and convert only a small fraction of the energy into heat. This is similar to how dark-colored clothing will help keep you warmer on a sunny day than light-colored clothing of the same materials.

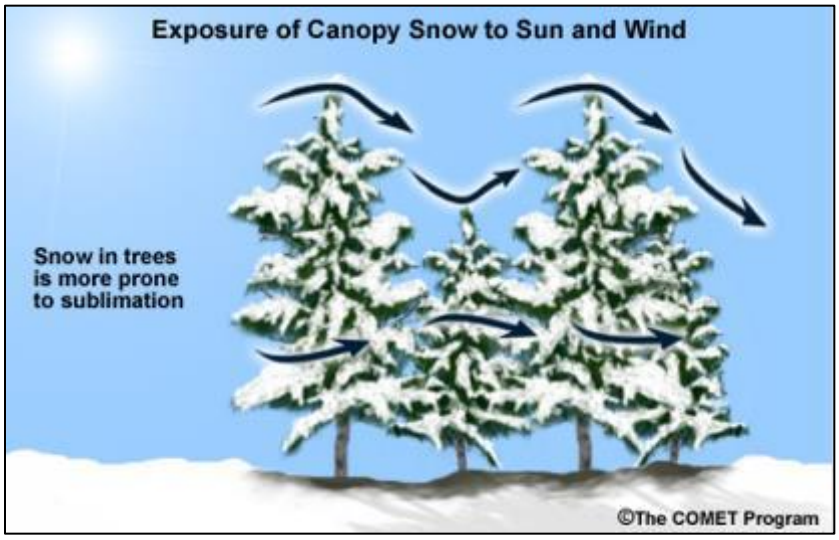



Figure 13. Exposure of canopy snow to sun and wind. (UCAR)

Most of us are very familiar with this **albedo effect** as it affects our urban, suburban or rural areas. Dark surfaces, such as a street, a driveway or a trampled feedlot, will absorb more solar energy and warm more quickly than the nearby snow-covered lawn or field. On a larger scale, a sparse snowcover across one part of the state can cause that region to have temperatures rise 10 to 20 degrees warmer than an adjacent snowbound area.

**Yet sun angle is king**

In our yards, we have noticed how small areas of exposed dark soil will start to expand, and in the absence of fresh snow, a few sunny days can start to open larger and larger patches of bare ground.

***Hurray for spring thaw!***

And if you're really cold on an otherwise sunny winter day, just stand (out of the wind) near a dark-colored, but sun-facing brick wall or tree and you quite likely will feel some of that absorbed and re-radiated heat energy around you. In winter, that vertical wall receives a much more direct sun angle,

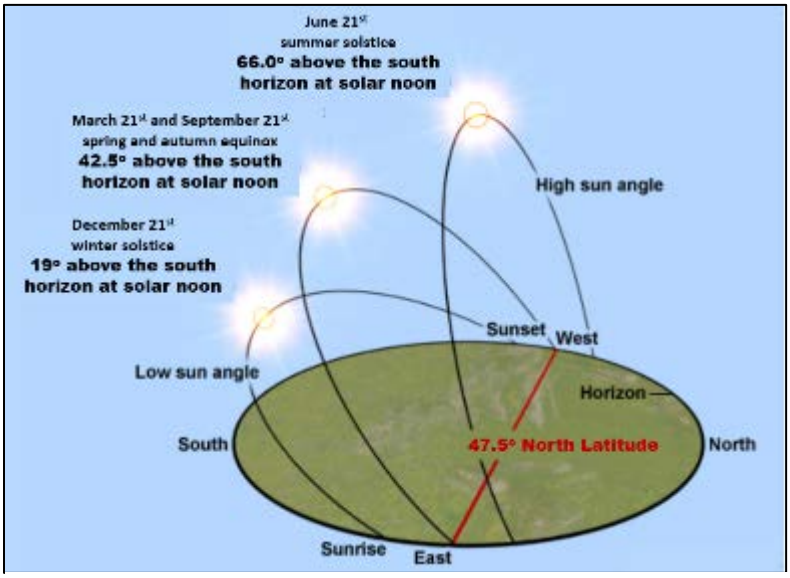



Figure 14. Seasonal sun angles at 47.5 degrees north latitude (approximate location of Carriungton, N.D.). (UCAR).

[6] For COMET/UCAR, the source of this material is the COMET® website at http://meted.ucar.edu of the University Corporation for Atmospheric Research (UCAR), sponsored in part through cooperative agreements with the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce (DOC). ©1997-2017 University Corporation for Atmospheric Research. All rights reserved.

and more solar energy per unit surface area, than a nearby horizontal surface (Figure 14).

For all the variations in bright or dark that we encounter throughout the winter season, color and sun angle certainly can combine to make some areas warmer than others and thus can lead to faster or slower snowmelt from one yard to the next, and from one county to the next. See Figure 15 for seasonal sun elevation angle at Carrington, N.D.

**But what about those corn fields?**[7]
Of the two snow modelling processes used by the NOAA's National Weather Service, neither SNODAS, as used by NOAA's National Operational Hydrologic Remote Sensing Center (NOHRSC), nor SNO17, as used by NOAA's North Central River Forecast Center, is able to model snowmelt at the cornfield scale. Instead they combine the measured or estimated snowcover over several square mile areas and then model the melt process across each of numerous small subbasins within the larger subbasins of our streams and rivers.

**And the verdict is …**
*Not yet scientifically validated!* But anecdotally, it would appear that most corn fields appear also to have collected a bit more snow during our windy, blowing and drifting winter days. In some areas, it even appears that there is less snow in shelter belts and more spread across the corn fields. Because of this, these fields may be holding on to their snow just a day or two longer than an adjacent (harvested) stubble field, and the stubble field maybe a day or so longer than a tilled field. Otherwise, this author has noticed a few locations where snow content was relatively uniform among the adjacent corn field, stubble and tilled acreage, and where the snowmelt rate also appears to be relatively evenly matched - within a day or so.

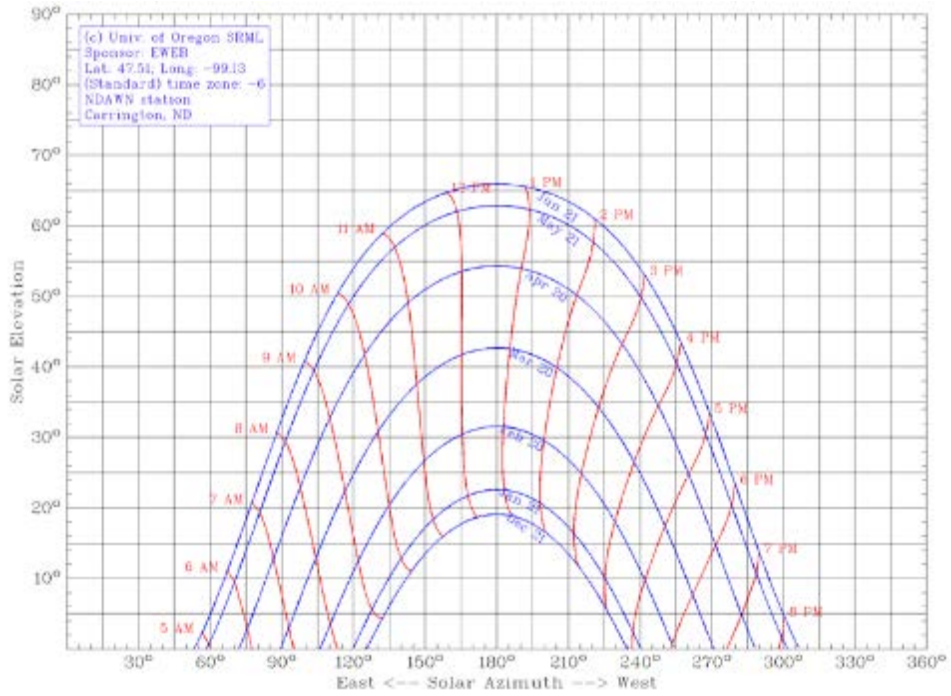



Figure 15. Seasonal sun angle at Carrington. For various other locations: www.ndsu.edu/ndsco/data/energy/sunelevation.

[7] News articles regarding North Dakota corn in the field: https://investigatemidwest.org/2020/01/30/half-of-north-dakotas-corn-is-still-in-the-field-usda-calls-it-on-farm-storage

# 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[8].

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