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 in the College of Agriculture, Food Systems, and Natural Resources, North Dakota State University, Fargo, N.D.

The overall winter average temperature was 2.6 degrees cooler than average, which would make it the 69th coldest winter on record. Precipitation-wise, the statewide accumulation was 0.2 inches wetter than average, which would make it the 37th wettest winter on record. Wet conditions in eastern parts of the state not only eliminated the drought but also created major flood potential in much of the Red River Valley. Dry conditions continued in western parts of the state, which maintained severe (D2) and extreme (D3) drought conditions in the western half of the state. This winter was anomalously windy. In fact, it was the windiest winter during the last 33 years. See the discussion in Science Bits about the anomalous winds.

Overall, 260 records, including temperature- and precipitation-related occurrences across the state, were tied or broken.

Detailed monthly climate summaries for December, January and February can be accessed at www.ndsu.edu/ndsco.

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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, 2021 through Feb. 28, 2022) was 1.71 inches, which was 3.25 inches less than the last season (fall 2021), but 1.06 inches more than last winter (winter 2020-21) and 0.2 inches more than the 1991-2020 average winter precipitation (Table 1). This would rank the winter of 2021-22 as the 37th wettest winter since such records began in 1895.

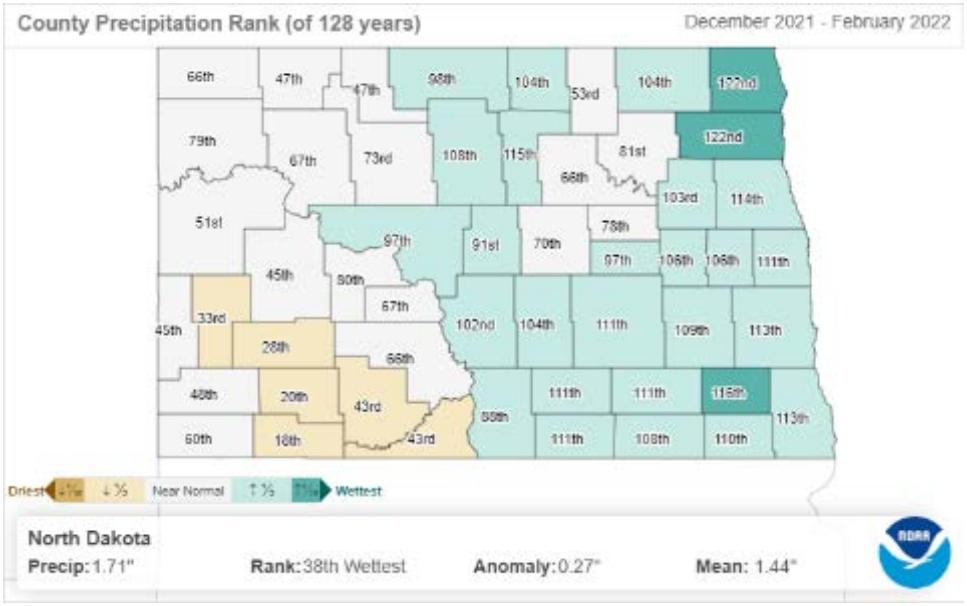


Figure 1. Precipitation rankings in winter of 2021 for North Dakota. (NCEI, National Oceanic and Atmospheric Administration [NOAA])

The counties shaded in brown in Figure 1 indicate drier-than-average conditions in winter 2021. In contrast, the counties shaded in green in the same figure indicate wetter-than-average conditions, and white shadings indicate near-average conditions. The numbers inside the counties are the precipitation rankings, with 1 being the lowest ranking (driest) and 128 being the highest ranking (wettest).

The greatest seasonal precipitation accumulation of the season was 5.15 inches, recorded in Fargo, Cass County. The greatest seasonal snowfall accumulation was 58.4” recorded in Pembina, Pembina County.

Based on historical records, the state average winter precipitation showed a slight negative long-term trend of 0.03 inches per century during this period of record since 1895. The state’s highest and lowest seasonal winter average precipitation ranged from 2.99 inches in 1969 to 0.59 inches in 1990. The “Historical Winter Precipitation for North Dakota” time series (Figure 2) shows a graphical depiction of these statistics.

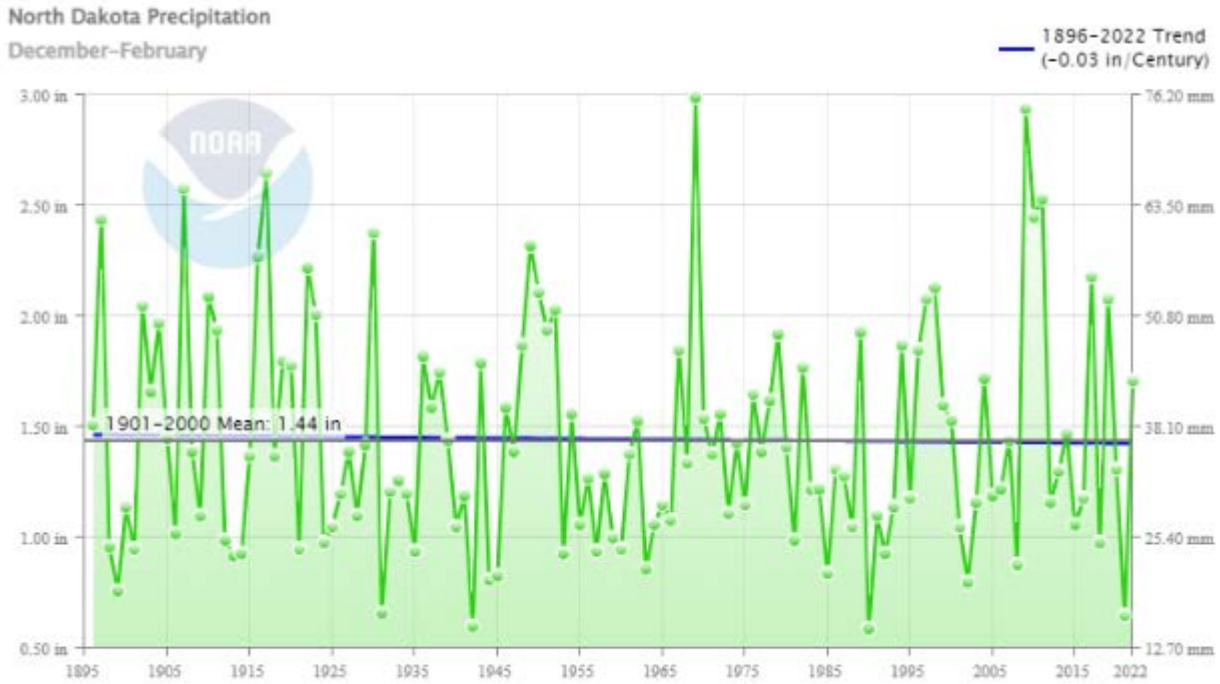


Figure 2. Historical winter precipitation time series for North Dakota.

Table 1. North Dakota W*inter* Precipitation Ranking Table.[1]

Period	Value	Normal	Anomaly	Rank	Wettest/Driest Since	Record Year
Winter 202*1-22*	**1.71”**	**1.51”**	0.2”	**91st driest 37th wettest**	**Driest since 2021 Wettest since 2019**	**0.59” (1990) 2.99” (1969)**

[1] NOAA National Centers for Environmental Information, Climate at a Glance: Statewide Time Series: www.ncdc.noaa.gov/cag.

Temperature

The average North Dakota temperature for the season (Dec. 1, 2021 through Feb. 28, 2022) was 10.8 F, which was 37 degrees cooler than the last season (fall 2021), and 6 degrees cooler than last winter (winter 2020-21). It was 2.6 degrees cooler than the 1991-2020 average winter temperature, which would rank winter 2021-22 as the 69th coldest winter since such records began in 1895 (Table 2).

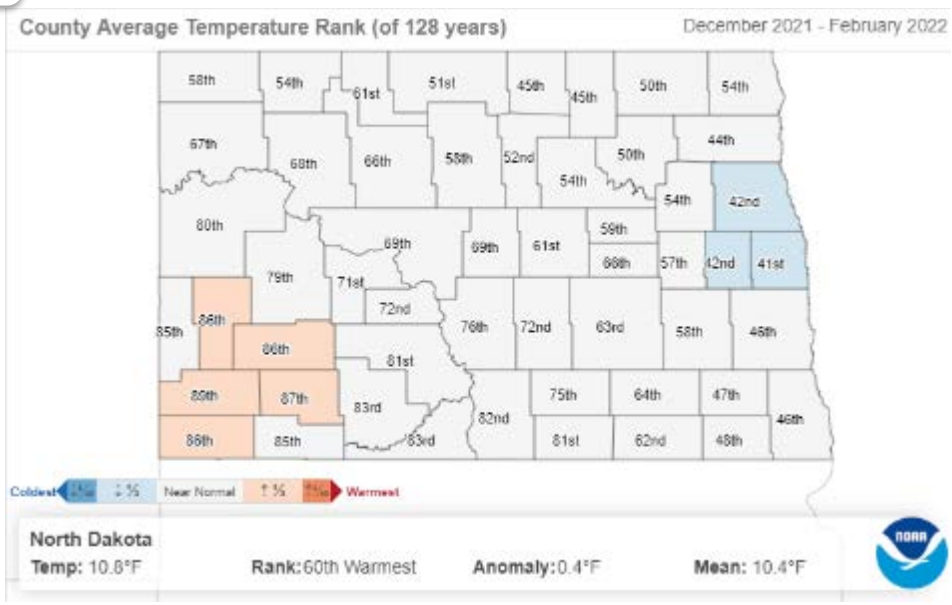


Figure 3. Temperature rankings in the winter of 2021-22 for North Dakota. (NCEI, NOAA).

The counties shaded in peach in Figure 3 indicate warmer-than-average conditions. In contrast, the counties shaded in blue in the same figure indicate cooler-than-average conditions, and the numbers inside the counties are the temperature rankings, with one being the lowest ranking (coldest) and 127 being the highest ranking (warmest).

Based on historical records, the average winter temperature showed a steep positive trend of 4.6 degrees per century since 1895 (the highest long-term temperature trend in the U.S.). The state's highest and lowest seasonal winter average temperatures ranged from 22.2 F in 1987 to -3 F in 1936. The "Historical Winter Temperature for North Dakota" time series (Figure 4) shows a graphical depiction of these statistics.

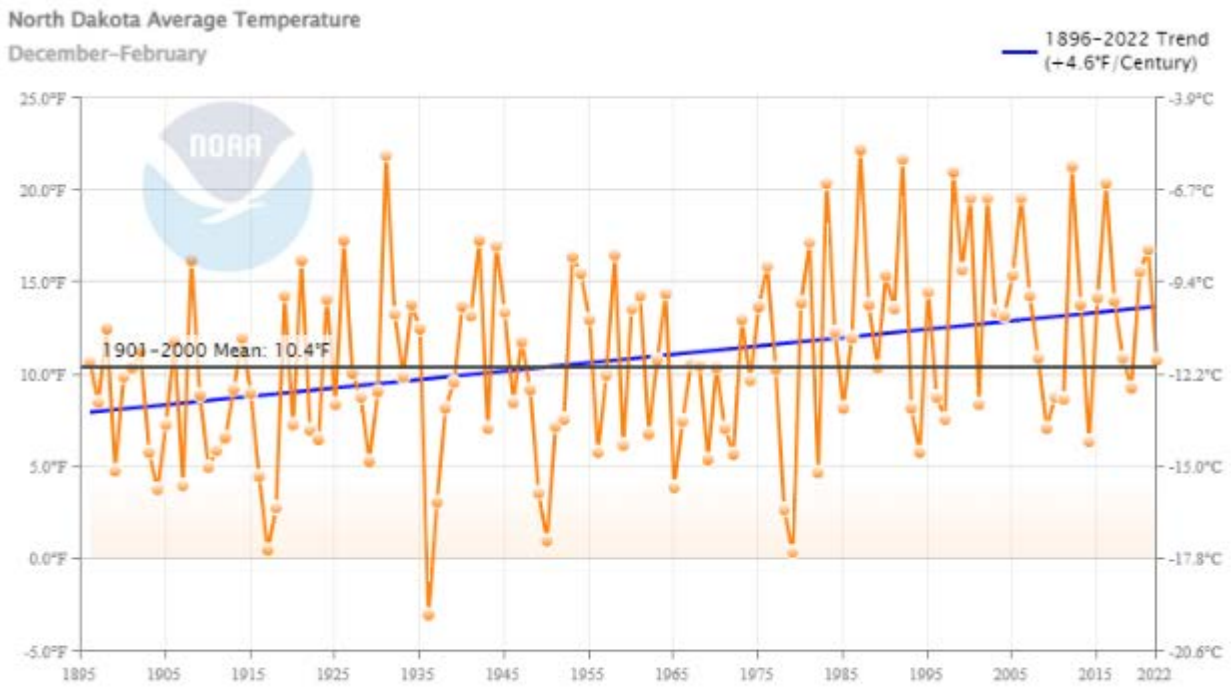


Figure 4. Historical winter temperature time series for North Dakota.

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

Period	Value	Normal	Anomaly	Rank	Warmest/Coolest Since	Record Year
Winter 2021-22	10.8 F	13.4 F	-2.6 F	69th coolest 59th warmest	Coolest since 2019 Warmest since 2021	-3 F (1936) 22.2 F (1987)

[2] NOAA National Centers for Environmental Information, Climate at a Glance: Statewide Time Series: www.ncdc.noaa.gov/cag.

Drought: The D3 (extreme drought) occupying 9% of the state at the beginning of the season was limited to the northwestern and west-central parts of the state. By the end of the season the areal coverage was only reduced to 5% of the state. Timely precipitation (mostly snow) helped eliminate drought conditions in the eastern half of the state throughout the season. As of March 1, 37% of the state was in drought, puting 128,824 North Dakota citizens vulnerable to the drought impact. There has been a growing concern for water quality in drought-stricken areas in western North Dakota as we get into the next growing season. Figure 5 below shows the drought conditions at the beginning and the end of the winter. Figure 6 shows the drought intensity and coverage on a time scale. Both of the figures show drought conditions spatially and temporally.

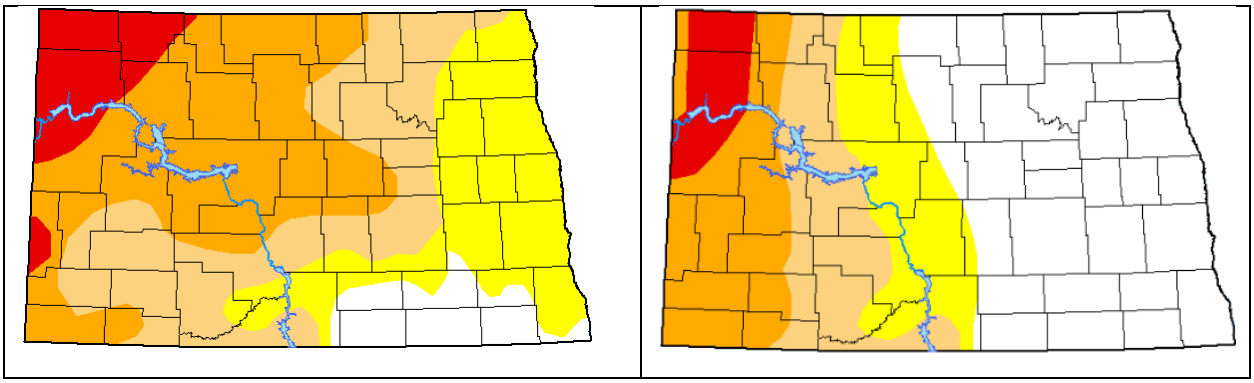


Figure 5. Drought Monitor map comparison for North Dakota in the beginning (on the left) and at the end (on the right) of winter 2021-22 season. (U.S. Drought Monitor)

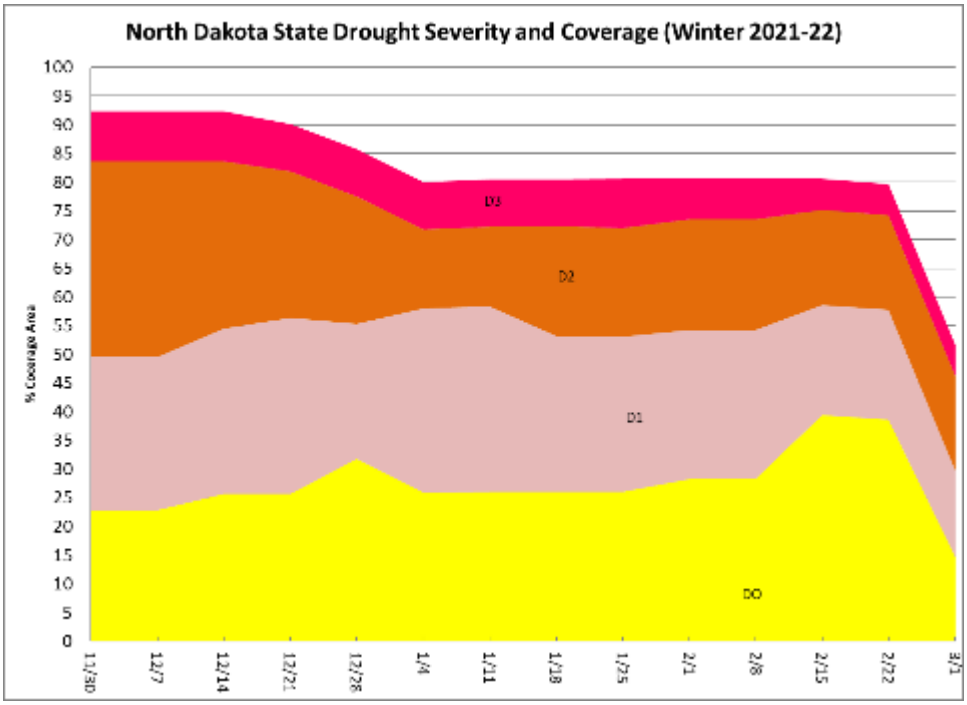


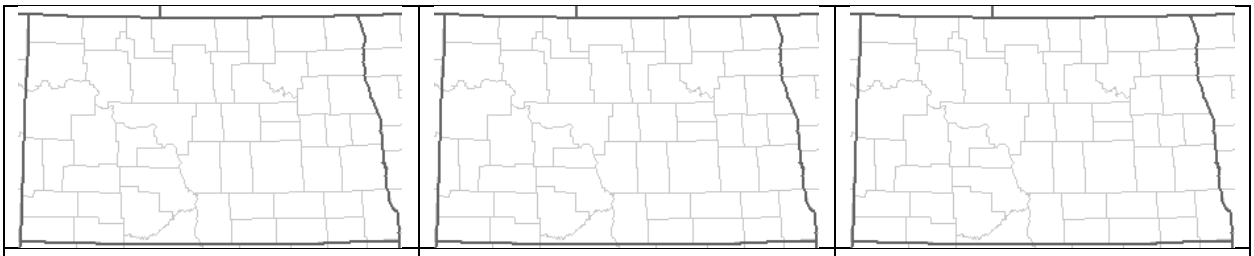
Figure 6. Statewide drought coverage in percentage and intensity (D0 through D4) in a time scale representing the state from the beginning to the end of the season, with a one-week resolution in winter 2021-22 season.

Storms and Record Events

State Tornado, Hail and Wind Events for Winter 2021

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

	December 2021	January 2022	February 2022	Seasonal Total
Tornado	0	0	0	0
Hail	0	0	0	**0**
Wind	0	0	0	**0**
Total	**0**	**0**	**0**	**0**



December 2021 North Dakota Storm Events | January 2022 North Dakota Storm Events | February 2022 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 2021-22

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.	18	0	2	**20**
Highest daily min. temp.	19	5	7	**31**
Lowest daily max. temp.	4	25	34	**63**
Lowest daily min. temp.	10	13	10	**33**
Highest daily precipitation	29	10	12	**51**
Highest daily snowfall	37	13	12	**62**
Total	**117**	**66**	**77**	**260**

Seasonal Outlook

Spring 2022 Outlook

By R. Kupec[3]

The winter of 2021-22 played out mostly as predicted in the last climate outlook. Temperatures across much of North Dakota were three to five degrees below average. Precipitation came in at or slightly higher than normal in most areas. There were a couple of notable exceptions. Areas south and west of Bismarck had a drier and slightly warmer-than-average winter. The northern Red River Valley and Devils Lake Basin received more snowfall than other parts of the state. The winter forecast was based largely on the occurring La Niña ocean/weather pattern in the Pacific. This La Niña pattern is expected to remain through the spring of 2022.

Historically a La Niña in the spring tends toward average precipitation and average to slightly below average temperatures. Much of the Red River Valley and Devils Lake Basin have a healthy snowpack at the start of March, which will likely keep temperatures at the start of spring down. Last spring also saw similar La Niña conditions and temperatures ran one to three degrees below normal and precipitation was below average. March and April were particularly dry last year with an uptick in precipitation in May.

The current Climate Prediction Center (CPC) spring outlook calls for an equal chance of above- or below-average temperatures for nearly the entire state (see Figure 8a) and below-average precipitation for all of North Dakota (see Figure 8b). Given recent trends and past history, I would look for slightly below-average temperatures this spring with average to slightly below-average precipitation across North Dakota. It is likely that there will be a high degree of variability week to week and month to month while getting to these final seasonal numbers.

The next 90-day outlook from the CPC should be available on March 17 at www.cpc.ncep.noaa.gov/products/predictions/90day.

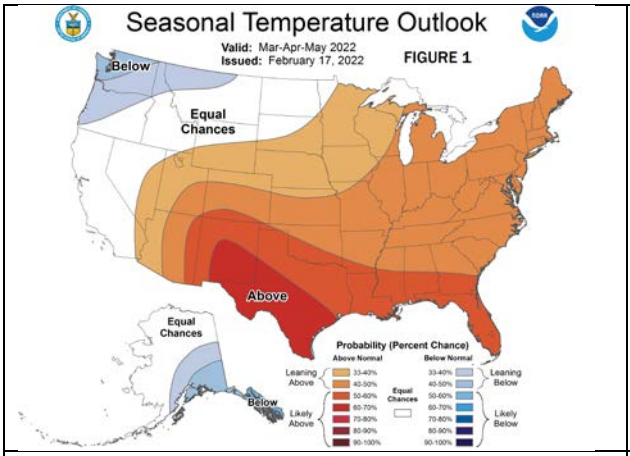


Figure 8a. Jan 2021 through Feb 2022 temperature outlook. (Climate Prediction Center, NOAA)

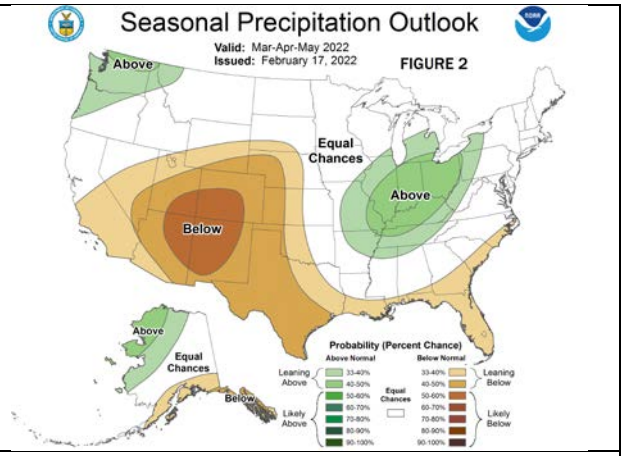


Figure 8b. Jan 2021 through Feb 2022 precipitation outlook. (Climate Prediction Center, NOAA)

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

Hydro-Talk

Spring is in the Air

By A. Schlag[4]

Time seems to be really flying by for me this year. While this is usually my far busiest time of the year due to spring flooding, it also holds true even in a fairly benign flood season. So let's take a look at what's going on around us right now and then we can see what Mother Nature most likely has in store for us going through the remainder of spring.

First and foremost, the 900-pound gorilla in the room is still the persistant drought, which, while improved, is like that bad penny we just can't seem to lose. In Figure 9 we see the eastern half of North Dakota is now largely free of drought, while the westernmost counties are still in Moderate to Extreme levels of drought.The relief out east has been very welcome for our agricultural community,

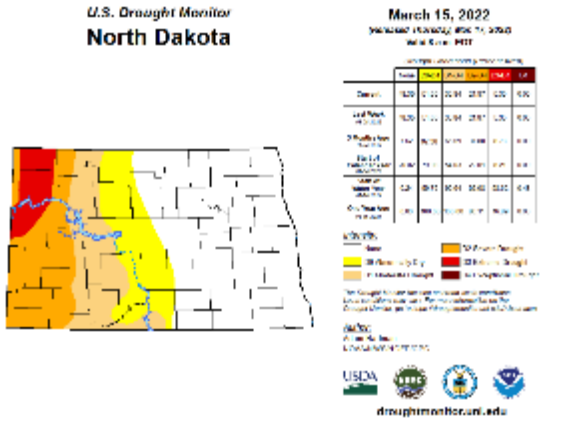


Figure 9. Most Recent USDM Map.

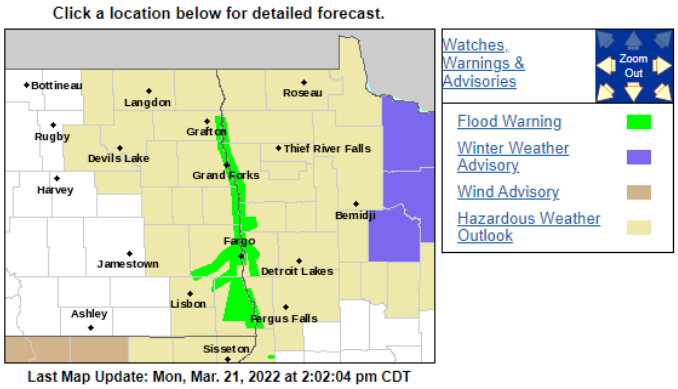


Figure 10. River Flood Warnings Across North Dakota.

but in the west the drought still presents significant challenges for our farmers and ranchers. On the flip side of the hydrologic coin, flooding has already started across areas that received near-normal to above-normal snow-water content this winter. Figure 10 shows the current watches, warnings and ddvisories map for the National Weather Service's office in Grand Forks. The green areas are river flood warnings that generally include the southern tributaries to the Red River of the North and reaches of the Red River itself. This will likely expand to include some of the northern tributaries and forecast points for our Grand Forks office over the coming days, but for now it's largely confined to the southern tributaries. It's been fairly quiet out in western and central North Dakota with the one spring flood warning due to runoff from melting snow having taken place along Beaver Creek near Linton in Emmons County. To be honest, this one was a little bit of a surprise as the countryside produced far more runoff than what was expected given the snow-water content on the ground, but frozen soils really enhanced runoff by limiting infiltration of meltwater during a fast melt. Overall though, while several streams have already hit their defined flood stage, and at least a few more are likely to do so in the next week or two, this is most likely going to go down as a fairly uneventful spring flood season unless some unexpectedly large rain events pop up in the next couple of weeks.

So this brings us to the point of wondering what's coming up after this brief spring flood season. Well, we still have our normal spring wildfire season ahead of the greening up of the countryside. In that sense, the very dry western tier of counties may likely bear the brunt of any unusual wildfire activity, but that's a

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topic best left to discuss on a day-to-day basis depending on the winds, relative humidity and dryness of the vegetation. So we will start to look at what the spring planting season and early summer are supposed to bring this year.

In Figure 11, the eight- to 14-day temperature and precipitation outlooks from the Climate Prediction Center suggest a sharp boundary between western and eastern North Dakota with respect to temperatures where warmer-than-normal temperatures are expected west of the Missouri River, while cooler-than-normal temperatures are favored for the Red River Valley. While most of North Dakota is generally favored for a slightly above-normal chance of moisture, that seems to wane as one gets closer to Pembina in the northern Red River Valley. After April and May when the state is generally in the Equal Chances

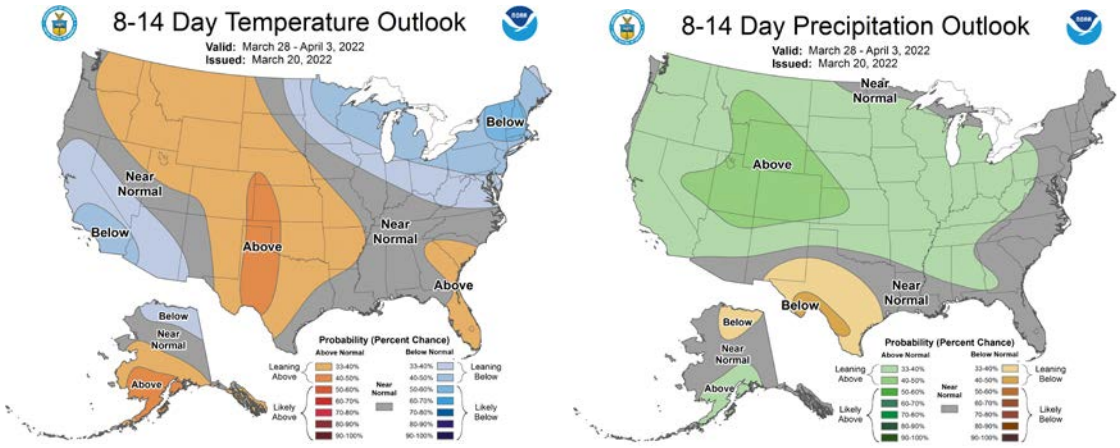

Figure 11. Temperature and Precipitation Outlooks for the end of March and Early April.

designation for both temperature and precipitation, things start getting a bit more depressing when we look at the outlooks for the upcoming summer. In Figure 12, these outlooks for the months of June, July

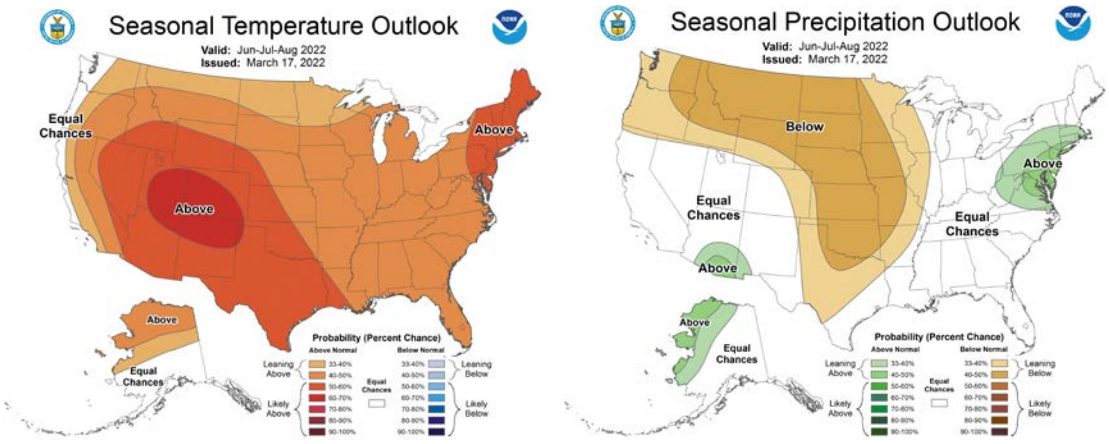

Figure 12. Temperature and Precipitation Outlooks for the Summer; June, July and August.

and August are less than encouraging. Warmer- and drier-than-normal would suggest we will see a reversal in the recent drought improvements made over central and eastern North Dakota, up to and including the distinct possibilty of returning drought designations to locations east of the Missouri River corridor. In a nutshell, what we have to look forward to is the finishing up of a fairly benign spring flood season followed by the eventual return to warm and dry. Suffice to say, I'd really like to be wrong on the latter part of this prognostication.

Science Bits

The Windiest Winter Ever? By G. Gust[5]

Of Blizzard, Ground Blizzards and just plain High Winds.

The recent winter season (December, January and February) ranks as the windiest/stormiest in the past 33 years!

As the winter season 2021-2022 (hopefully) draws to a close, there may be few in North Dakota that mourn its passing. After all, it has certainly *seemed* like it's been an incredibly stormy, windy, cold and downright miserable winter season, especially compared to last year's incredibly mild, dry and short winter season. As it turns out, it just might rank as the overall stormiest, windiest (perhaps the wind-chilliest) winter season ever – at least for the core December, January and February (DJF) winter-season months.

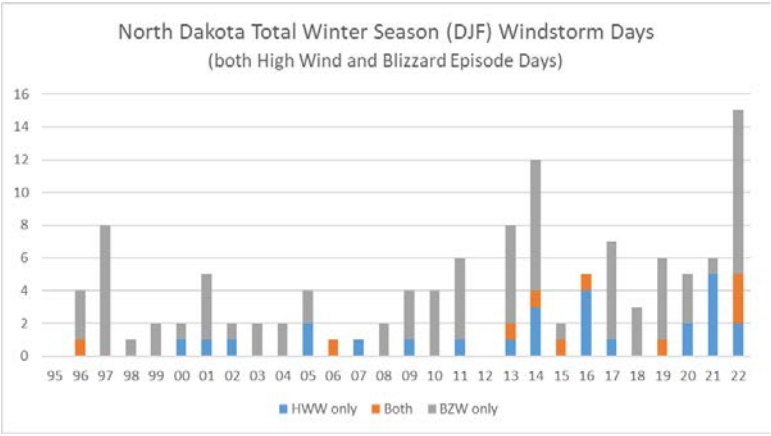

Figure 13. North Dakota's total number of winter season (DJF) windstorm days, for the 27 winter seasons 1995-96 through 2021-22, based on StormData* reports of days with either High Winds, Blizzard conditions, or both having occurred within the state. Note that preliminary data was used to complete the 2021-22 winter season. Otherwise data courtesy of NOAA National Centers for Environmental information, Storm Events Database, retrieved on March 14, 2022. from https://www.ncdc.noaa.gov/stormevents/ .

It was the stormiest winter since 1989. There was quite a stir in the eastern part of the state around mid-February when numerous local storm watchers noticed that we were once again bumping up against the record blizzard count that had amassed during the fabled and historic 1996-97 winter (10) and the more recent blizzard/ground blizzard tally amassed during the 2013-14 winter (also 10). Granted, the winter of 1996-97 had so much snow that every passing storm system seemed able to push conditions into full blizzard mode. Yet old hats in the office recalled that the winter of 1995-96 also had a huge amount of snow but less than half the number of blizzards as the following year.

And in more recent years, the winter of 2013-14 had much less snow than either of those winters but came in with a high number of both blizzards and ground blizzards for a total of 10 such storms occurring somewhere in the state – an overall winter season quite similar to the 2021-22 winter season. So when

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

blizzards #10 and #11 of this latest winter season occurred in rapid succession, on Feb. 21 and 22, it was time to do some deep digging as to relative windiness.

Figure 13 shows the total number of windstorm days during each of the past 27 winter seasons (DJF) back to the 1995-96 season when such information became more easily accessible. The wind storm tally includes days in which either high wind or blizzard/ground blizzard conditions were met somewhere in the state.

This method was chosen since any of these individual storms or storm types could stretch over one, two or even three days, such that the actual number of storm-impacted days should serve as a more uniform measure than one based solely on the number of warnings issued. Also, please note that this study only looked at winter wind-based storms that occurred during the core winter season (DJF) and does not include such storms that may have occurred in either the late fall or early spring months.

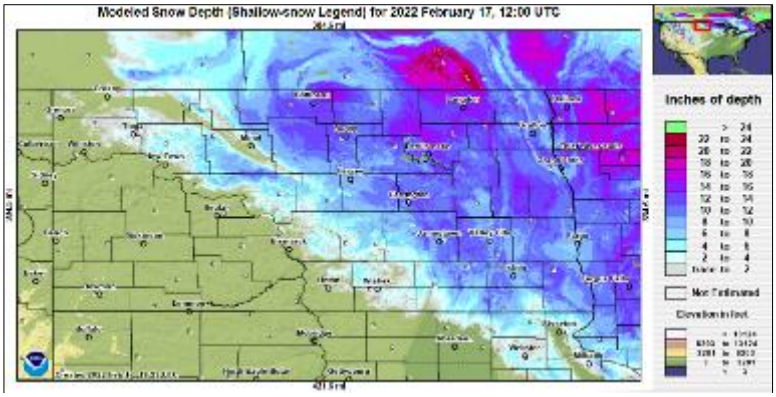

Figure 14. The shallow snow depth analysis, as provided by National Operational Hydrologic Remote Sensing Center's SNODAS Model, shows the snowcover conditions at 12 UTC on Feb. 17, 2022, which preceded the Feb. 18 storm system. Data courtesy of NOAA's National Snow Analysis at https://nohrsc.noaa.gov/nsa.

For this recent DJF period, there were a total of 15 windstorm days, the highest number recorded in the past 27 years. Of these, there were 13 days with blizzard conditions reported in parts of the state and five days with high winds (not in blizzards), with three of those days having part of the state experiencing primarily high winds and another part of the state experiencing full blizzard conditions (see example below from mid-February).

Figure 14 shows that much of southwest through far southcentral North Dakota was nearly snow-free on the morning of Feb. 17, while an extensive and fairly fresh snowpack stretched across northcentral through southeastern North Dakota. Thus, the incoming storm system with a forecast for very strong winds but fairly low new snowfall production would have little chance to generate full-scale blizzard conditions over the entire high wind-impacted area.

On this day, the airport at Oakes, North Dakota, (K2D5) recorded near-blizzard conditions for an hour or two but several hours of sustained high winds at 40 mph or greater with peak winds of 54 to 56 mph. In contrast, the airport at Langdon, North Dakota, (KD55) recorded slightly lesser winds, still blizzard force, but also had the requisite several hours of visibilities at or below a quarter mile in snow and blowing snow.

Recall that a blizzard is defined as sustained or frequent wind gusts of 35 mph or greater with visibilities frequently below a quarter mile in snow and/or blowing snow for a period of three hours or more. High winds are sustained winds of 40 mph or greater or any non-thunderstorm winds gusting to 58 mph or greater.

It was the windiest winter since 1989. A detailed analysis was made of the monthly average winds for the three winter-season months (DJF) at the four largest airports (BIS, FAR, GFK and MOT) for the years dating from December of 1989 through February of 2022, using data available via the Iowa Environmental Mesonet online data service, at https://mesonet.agron.iastate.edu/.

Of note:
First, all four airports recorded their **windiest DJF period for the past 33 years** during this most recent winter season, 2021-22. The average windspeed of all four airports over this past DJF period was 13.57 mph, some 2.27 mph faster than the current 30-year average for all these combined locations. The second-place windiest winter season was 2013-14, which as Figure 13 indicates, was the second stormiest with 12 windstorm days during its DJF period.

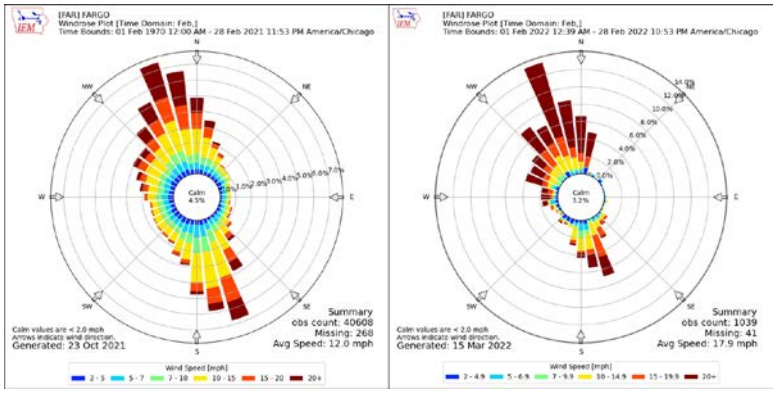

Figure 15. Windrose plots for the Fargo, North Dakota, airport (KFAR) for the long-term February period 1970 through 2021 (left side) and the most recent February 2022 period (right side). The right side plot shows a markedly higher frequency of strong northwesterly winds during the Feb. 22 period, along with an average windspeed nearly 50% higher than the long-term February average. Data and analyses courtesy of the Iowa Environmental Mesonet, Site Windroses: North Dakota ASOS/AWOS analyses, retrieved on March 14, 2022 from https://mesonet.agron.iastate.edu/sites/locate.php?network=ND_ASOS.

Second, all four airports recorded their **windiest winter month in February 2022** for all DJF months for the past 33 years. Fargo came in as the fastest with an average Feb. 22 windspeed of 17.9 mph, some 5.7 mph faster than its recent 30-year average and 5.9 mph faster than its longer-term average from 1970 through 2021 (Figure 15).

Grand Forks came in at second place with a Feb. 22 average windspeed of 16.7 mph, some 5.2 mph faster than its recent 30-year average and 4.9 mph faster than its longer-term average from 1972 through 2021.

Minot came in at third place with a Feb. 22 average windspeed of 15.5 mph, some 3.5 mph faster than its recent 30-year average and 3.4 mph faster than its longer-term average from 1970 through 2021. And Bismarck came in at fourth place with a Feb. 22 average windspeed of 12.2 mph, some 2.7 mph faster than its recent 30-year average and 2.8 mph faster than its longer-term average from 1970 through 2021.

North Dakota's daily climate records, including maximum and minimum temperatures, snowfall and total precipitation, extend back to the late 1800s and early statehood. More detailed weather information, including hourly reports of wind direction and speed, became available as air travel developed and permanent airports were established, mostly after World War II. The Bismarck airport (BIS) has the longest record of hourly aviation observations in the state, dating back to 1936, while Fargo (FAR), Grand Forks (GFK) and Minot (MOT) date back to the 1947-48 timeframe with full 24-hour-a-day wind records for most locales dating from the early 1970s.

It was not the coldest winter ever. Based on statewide winter-season (DJF) temperature data provided by the NOAA National Centers for Environmental Information, the 2021-22 winter season ranked as the 11th coldest of the past 33 winter seasons, and some 2.8 degrees F colder than the most recent (1990-2019) set of 30-year normal; however, with an average temperature of 10.8 F, it was still 0.4 F warmer than the 1901-2000 base period.

It was not the wind-chilliest winter ever: It was both colder-than-normal and very much windier-than-normal, and thus there were a high number of extremely cold wind chill periods throughout the past winter season. In order to gauge the relative wind chill for the entire DJF period, we normalized the

seasonal average temperature and seasonal average windspeed and then calculated a normalized seasonal wind chill temperature for each of the winter seasons (DJF) in our 33-year study period.

Figure 16 shows that the recent 2021-22 winter season (DJF), though windiest for the study period and substantially colder than normal, ranked only 11th "chilliest" of the 33 seasons in the study period. The winter season 2013-14, which came in as the second stormiest and second windiest winter season, was hands down the wind chilliest winter season, given the fact that it was also more than 4.4 degrees F colder than the 2021-22 winter season.

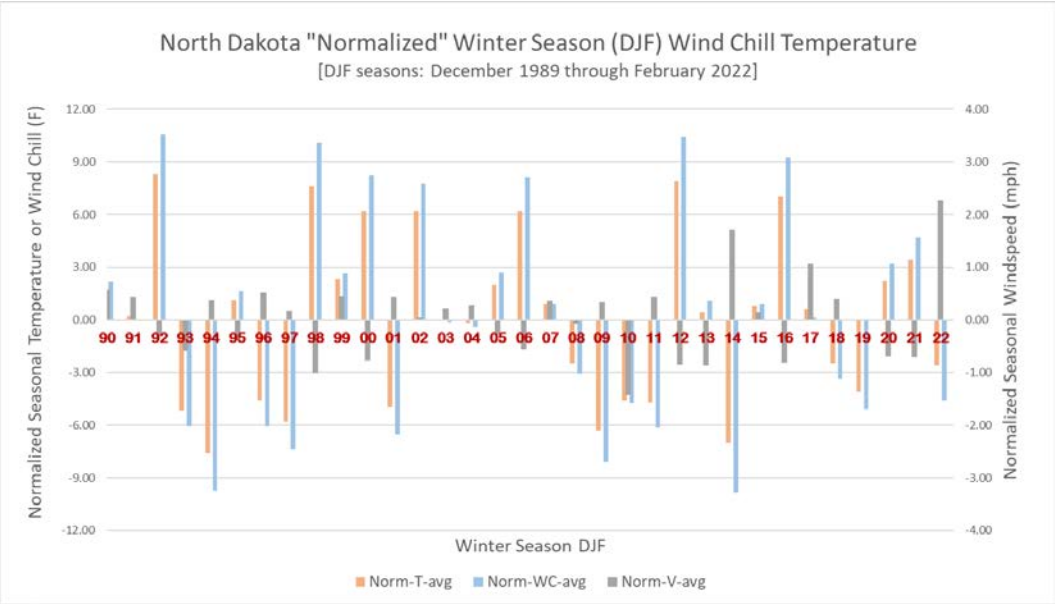

Figure 16. North Dakota normalized winter season (DJF) wind chill temperature, winter seasons 1990 through 2022, ranged from +10.57F (warmer: less wind chill) in 1991-92 to -9.85F (colder: more wind chill) in 2013-14. Temperature data courtesy of the NOAA National Centers for Environmental information, Climate at a Glance: Statewide Time Series, published March 2022, retrieved on March 14, 2022 from https://www.ncdc.noaa.gov/cag/, and the Iowa Environmental Mesonet as previously sited.

The 25th Anniversary of the Brutal Winter of 1996-97.

This article investigated the past 33 winter seasons to determine how this most recent December-January-February period stacked up in terms of winter wind-related phenomena such as wind storms, average wind speeds and even wind chills. However, we didn't consider other significant winter phenomena such as overall snowfall, the occurrence of ice storms, or the prevalence of otherwise nasty but sub-warningcriteria weather phenomena. We also didn't consider the potential length of our winter shoulder seasons, which in these Northern Plains can range from early-October through late-April, and depending on the year can nearly double the impactful winter weather one encounters during the core DJF winter season. Thus, the fabled and historic 1996-97 "full" winter season, October through April, still ranks as likely the most substantial and impactful winters of both the past and current centuries.

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[6].

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