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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, N.D.

The overall spring average temperature was 2.8 degrees colder than average, which would make it the 38th coldest spring on record. Precipitation-wise, the statewide accumulation was 3.09 inches more than average, which would make it the fourth wettest spring on record.

Overall, 316 records, including temperature- and precipitation-related occurrences across the state, were tied or broken. Thirty-eight significant storms also were reported in spring, including four tornados.

Detailed monthly climate summaries for March, April and May, along with several other local resources for climate and weather information, can be accessed at www.ndsu.edu/ndsco.

Dusty-Black Snow Pile in Fargo, N.D. (F.A. Akyüz)

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

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 spring season (March 1 through May 31, 2022) was 7.8 inches, which was 6.09 inches more than last season (winter 2021-22), 4.98 inches more than last spring (spring 2021) and 3.09 inches more than the 1991-2020 average spring precipitation (Table 1). This would rank the spring of 2022 as the 4th wettest spring since such records began in 1895.

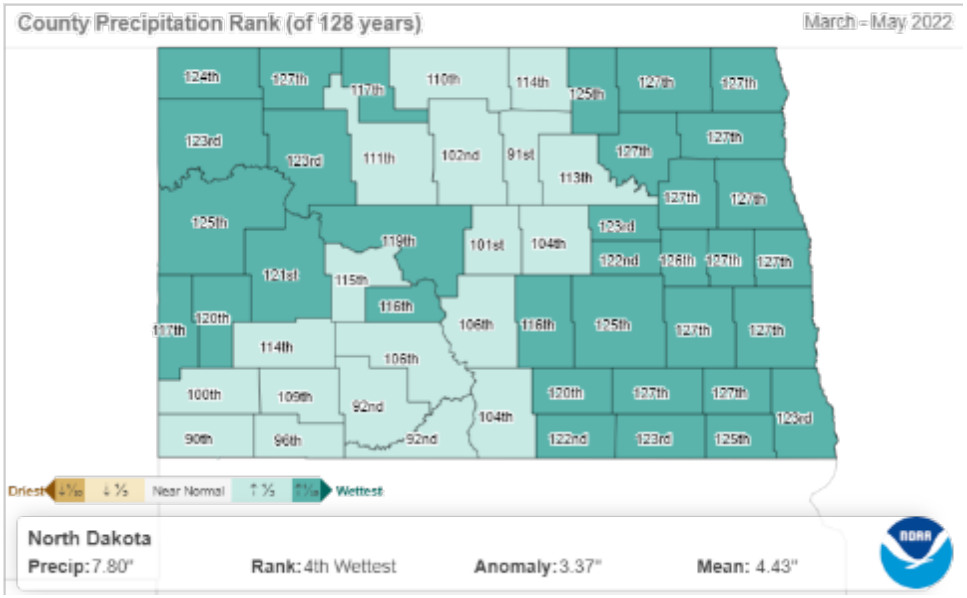


Figure 1. Precipitation percent of normal in spring of 2022 for North Dakota. (National Centers for Environmental Information, NOAA)

The counties shaded in green in Figure 1 indicate wetter-than-average conditions in spring 2022. The numbers inside the counties are the precipitation rankings, with 1 being the lowest ranking (driest) and 127 being the highest ranking (wettest).

The greatest seasonal precipitation accumulation of the season was 15.05 inches, recorded in Walhalla, Pembina County. The greatest seasonal snowfall accumulation was 65.5 inches, recorded in Kenmare, Ward County.

Based on historical records, the state average spring precipitation showed a positive long-term trend of 0.3 inches per century during this period of record since 1895. The highest and lowest seasonal spring average precipitation for the state ranged from 1.3 inches in 1934 to 9.64 inches in 1896. The "Historical Spring Precipitation for North Dakota" time series (Figure 2) shows a graphical depiction of these statistics.

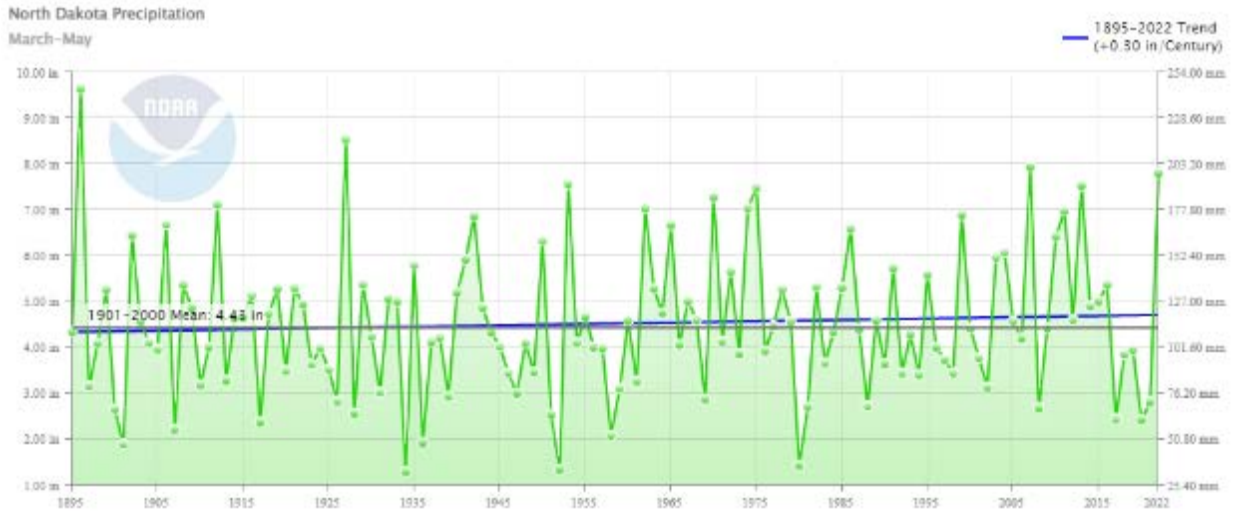


Figure 2. Historical spring precipitation time series for North Dakota.

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

Period	Value	Normal	Anomaly	Rank	Wettest/Driest Since	Record Year
Spring 2022	7.8"	4.71"	3.09"	125th driest 4th wettest	Driest since 2021 Wettest since 2007	1.3" (1934) 9.64" (1896)

[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 (March 1 through May 31, 2022) was 37.8 F, which was 27 degrees warmer than last season (winter 2021-22), but 5.2 degrees colder than last spring (spring 2021). It was also 2.8 degrees colder than the 1991-2020 average spring temperature, which would rank spring 2022 as the 38th coldest spring since such records began in 1895 (Table 2).

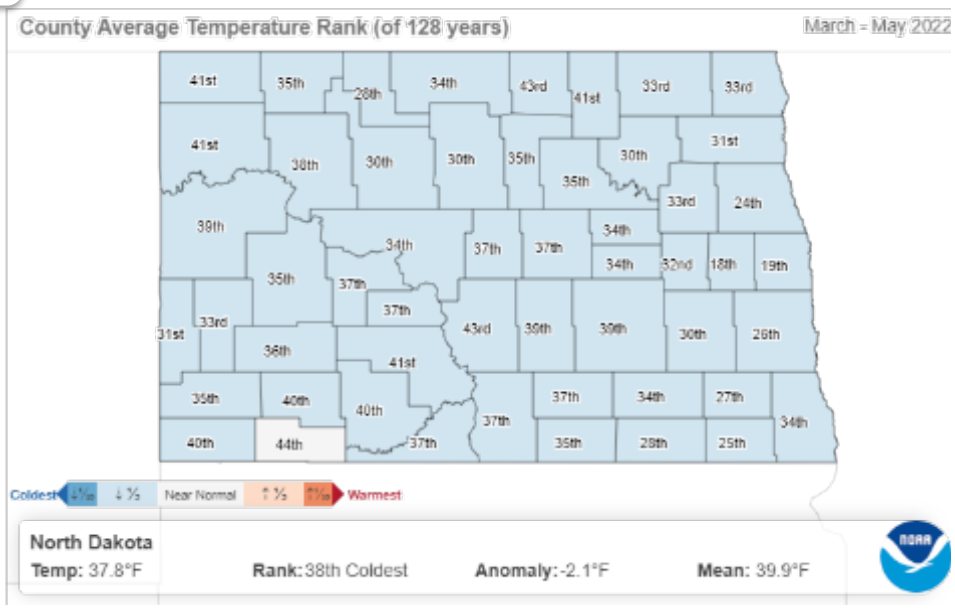


Figure 3. Temperature departure from normal in spring of 2022 for North Dakota. (National Centers for Environmental Information, NOAA).

The counties shaded in blue in Figure 3 indicate cooler-than-average conditions. The numbers inside the counties are the temperature rankings, with 1 being the lowest ranking (coldest) and 127 being the highest ranking (warmest).

Based on historical records, the average spring temperature showed a positive trend of 1.8 degrees per century since 1895. The highest and lowest seasonal spring average temperatures for North Dakota ranged from 31.5 F in 1899 to 48.1 F in 1977. The "Historical Spring Temperature for North Dakota" time series (Figure 4) shows a graphical depiction of these statistics.

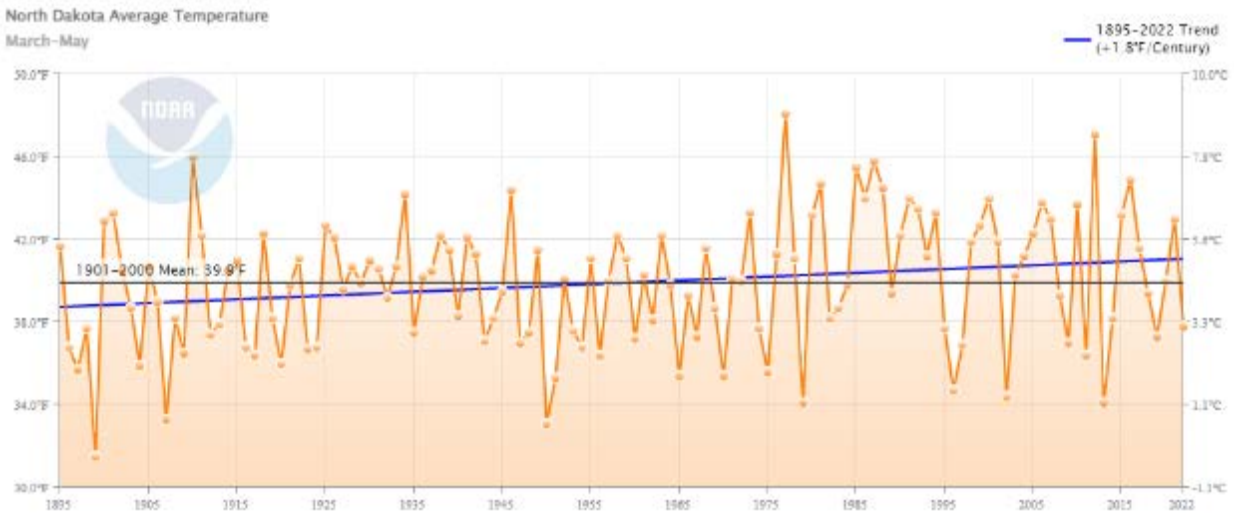


Figure 4. Historical spring temperature time series for North Dakota.

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

Period	Value	Normal	Anomaly	Rank	Warmest/Coolest Since	Record Year
Spring 2022	37.8 F	40.6 F	-2.8 F	38th coolest 91st warmest	Coolest since 2019 Warmest since 2021	31.5 F (1899) 48.1 F (1977)

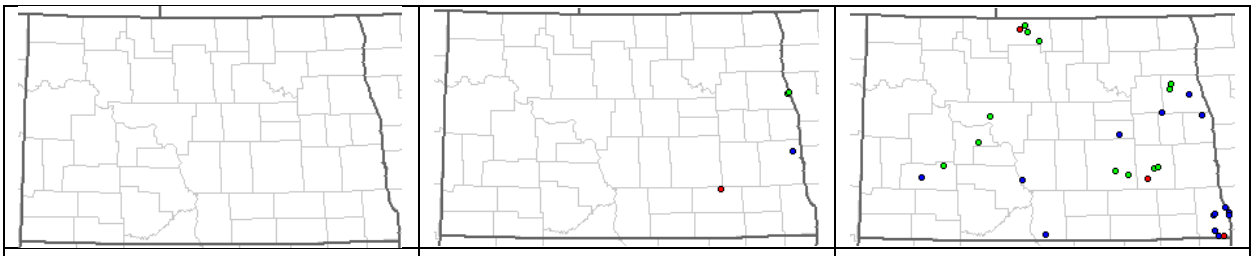
[2] NOAA National Centers for Environmental Information, Climate at a Glance: Statewide Time Series: www.ncdc.noaa.gov/cag.

Storms and Record Events

State Tornado, Hail and Wind Events for Spring 2022

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

	March 2022	April 2022	May 2022	Seasonal Total
Tornado	0	1	3	**4**
Hail	0	2	13	**15**
Wind	0	2	17	**19**
Total	**0**	**5**	**33**	**38**



March 2022
North Dakota Storm Events

April 2022
North Dakota Storm Events

May 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 Spring 2022

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	March	April	May	Seasonal Total
Highest daily max. temp.	1	0	0	**1**
Highest daily min. temp.	6	0	1	**7**
Lowest daily max. temp.	4	103	17	**124**
Lowest daily min. temp.	0	67	2	**69**
Highest daily precipitation	1	41	24	**66**
Highest daily snowfall	1	48	0	**49**
Total	**13**	**259**	**44**	**316**

Seasonal Outlook

Summer 2022 Outlook

By M. Ewens[3]

The spring of 2022 was colder and wetter than the outlook suggested. Temperatures across much of North Dakota were 3 to 5 degrees below average, with precipitation running 150% to 300% of normal in most areas. In general terms, it was a top ten wettest meteorological spring and in the lower third for temperatures in some locations. What was striking was the consistency and intensity of the "Clipper Pattern" that brought numerous systems across the region.

The spring forecast was based largely on the occurring La Niña ocean/weather pattern in the Pacific. The presence of a strongly negative Pacific Decadal Oscillation helped amplify the La Niña cool/wet spring forcing. This La Niña is favored to continue through the end of the year, with a 52% chance that La Niña will decrease into the Northern Hemisphere late summer (July-September) before slightly increasing through the Northern Hemisphere in the fall and early winter. Long-term trends become important factors as well in predicting the summer climate.

While the overall temperature regime has warmed across the northern Plains, much of that warming has come from an increase in nighttime minimums. There has been a gradual decrease in the frequency of extremely high temperatures, as well as a gradual decrease in the mean monthly summer maximums. This is in part attributed to the increases in summer convection, which has been postulated as a result of increased agricultural practices, specifically those plants that excel in transpiration.

The latest summer 2022 outlook from the Climate Prediction Center suggests equal chances for above-median, median and below-median temperatures for the whole of the June through August period. Below-median rainfall is the best outlook for North Dakota along and west of the Missouri River Basin with equal chances for above-median, median and below-median rainfall across the eastern third of the state.

Drought Outlook: The Constructed Analog on Soil Moisture (CAS) outlook suggests ample to excess soil moisture across most of North Dakota through July 2022. As a result, drought is not in the outlook for North Dakota through the 2022 meteorological summer.

The next 90-day outlook from the CPC is available beginning June 16 at www.cpc.ncep.noaa.gov/products/predictions/90day.

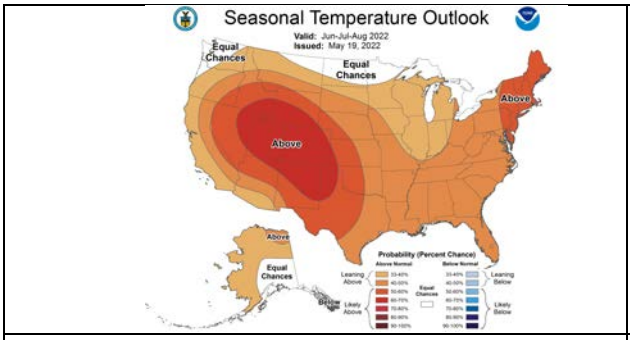


Figure 8a. March through May temperature outlook. (Climate Prediction Center, NOAA)

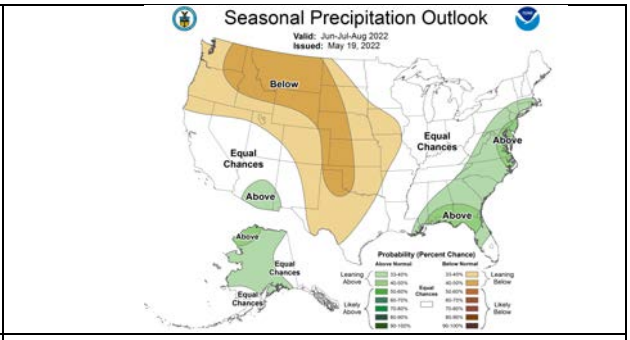


Figure 8b. March through May precipitation outlook. (Climate Prediction Center, NOAA)

[3] Corresponding author, Mark Ewens, Home on the Prairie Weather. Email: SLAPM7@msn.com

Hydro-Talk

What a welcome surprise!

By A. Schlag[4]

Well, so much for a benign spring flood season. Mother Nature always seems to have a mind of her own. We had little in the way of an active flood season for western and central North Dakota. Nonetheless, a memorable April brought impressive rain and snow totals across the state, which changed the narrative for several weeks as widespread flooding hit central and eastern North Dakota. The slow-melting snow and widespread rains also reset much of the discussion over the ongoing drought concerns that have plagued North Dakota for a little over two years. As noted in Figure 9, much of western North Dakota was still under at least a Moderate (D1) level drought designation back in March. One of the biggest concerns was the relative lack of soil moisture, as shown in Figure 10. Soil

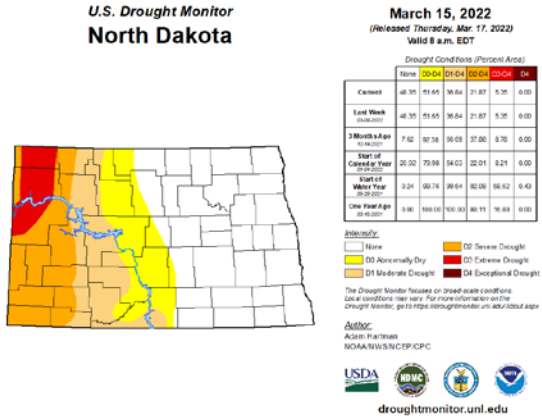


Figure 9. USDM Map for March 15, 2022.

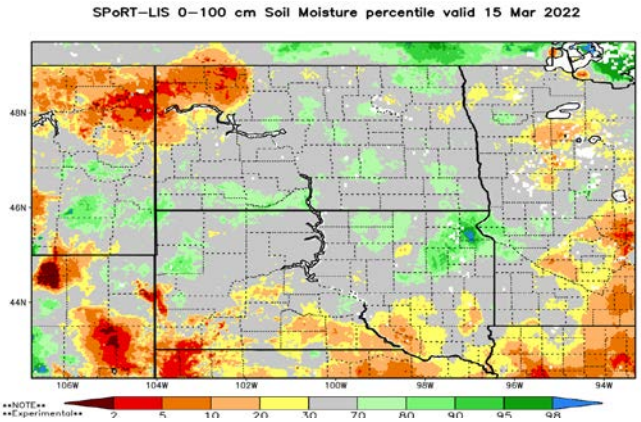


Figure 10. Root Zone Soil Moisture on March 15, 2022.

moisture values were not necessarily terrible except in the very northwestern corner of the state. Nonetheless, after two full years of drought, even in areas with near-average soil moisture, it was generally accepted that at least normal amounts of spring precipitation would be needed to ward off the hangover effect from the most recent drought. Fast forward to now (early June), and a very different depiction of the conditions facing the agricultural community exists.

[4] The corresponding author, Allen Schlag, is the service hydrologist at the NOAA's National Weather Service in Bismarck, North Dakota. Email: Allen.Schlag@noaa.gov

A Memorial Day weekend trip through western North Dakota revealed far greener conditions than expected. Indeed, too much moisture was now the problem as farmers were having to plant around low areas due to standing water in every county I traversed. While this is truly an anecdotal observation, a quick look at updated soil moisture levels, shown in Figure 11, also supports a continuation of the trend for improving drought designations. Indeed, I cannot remember the last time I've seen this much of the state in the 90+ percentile for soil moisture, especially for this time of year. The importance of soil moisture cannot be overstated for this part of the country. A slightly later than normal entry into the growing season due to the unusually heavy snowpack received in April may still be holding back the growth in native vegetation to some degree, but with this much soil moisture available, it is also what will help pastures, crops, and streamflow limp through any prolonged dry spells this summer.

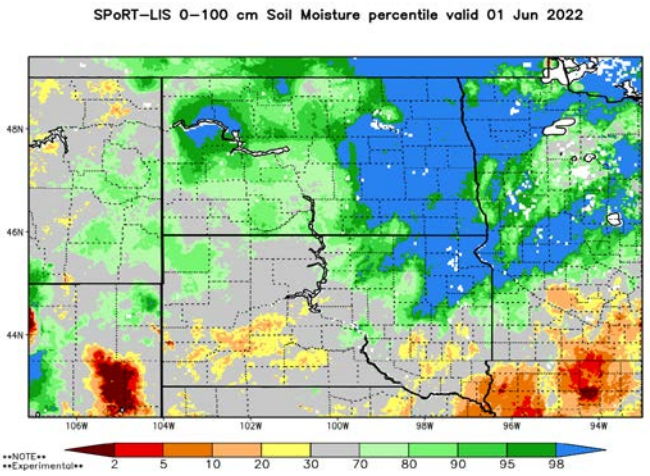


Figure 11. Root Zone Soil Moisture on June 1st, 2022.

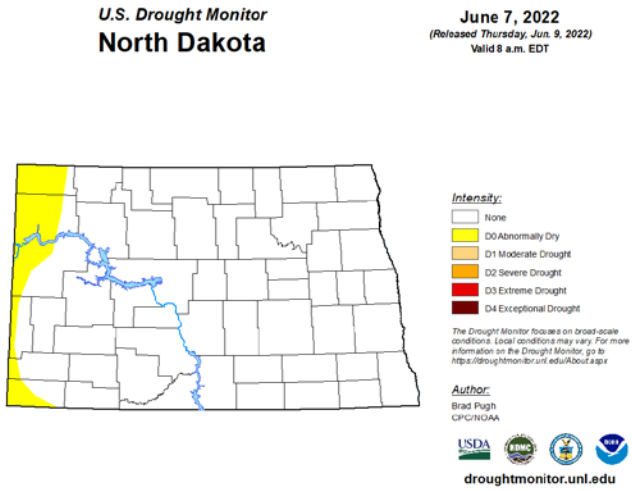


Figure 12. USDM Map of North Dakota, June 7, 2022.

So this brings us to where we currently are with respect to the USDM depiction of North Dakota and the expectations going forward. First of all, as shown in Figure 12, the USDM has reflected the much better conditions observed across the western half of the state. Only roughly one-half a county-wide sliver of D0 (Unusually Dry) designation remains along the Montana border. The current trend for improvements would suggest an eventual removal of even this over the coming weeks, given the near-term weather forecast and outlooks. However, what is probably of more interest are the seasonal outlooks, and in particular, the summer outlook for June, July, and August.

In Figure 9, the most recent renditions of the summer outlooks are shown. While these don't offer a lot of hope for continuing to ward off the return of drought-like conditions for much of the continental United States, these are actually an improvement over previous renditions of the same months as North Dakota has largely been removed for the expectation of warmer than normal conditions, and where previous editions had N.D. entirely covered by a drier than normal expectation, there has been some shrinkage in that coverage for North Dakota. Overall, this, along with the much wetter than normal root zone across most of the state, suggests there is hope that this reprieve granted by Mother Nature may not be as fleeting as once feared. The two places where long-term effects of the drought remain are on North Dakota's two largest lakes. Lakes Sakakawea and Oahe remain well below normal for this time of year as they are still a reflection of the well below normal snowpack observed during the 2021-22 winter over in the mountains of Montana. They will not likely recover this summer, and it's far too early to ponder if 2023 will be any better for them.

Science Bits

April Blizzards and Colorado Lows

By C. Schultz[5]

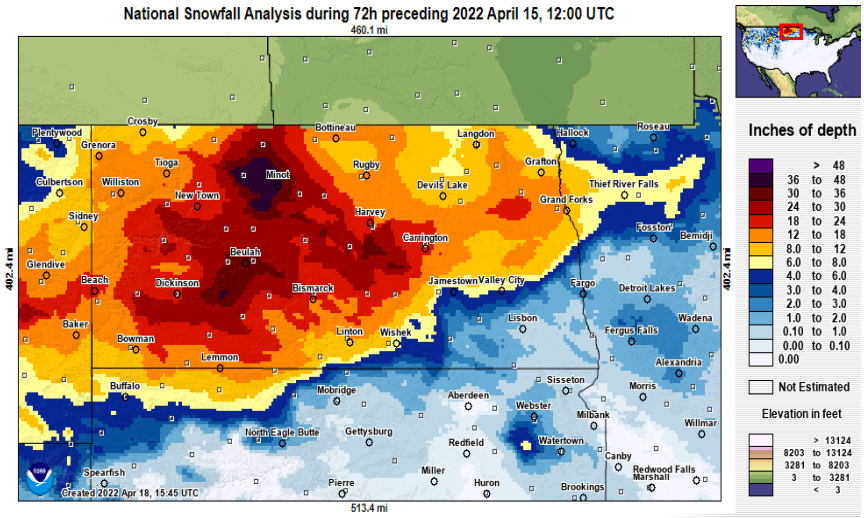


Figure 13. Storm total snowfall analysis for the mid-April 2022 blizzard.

Springtime in North Dakota sure has a way of reminding us that we're never really that far away from winter's grip, with some of the most memorable blizzards in our history coming in March and April. The fabled March 1966 and April 1997 blizzards both strike immediate memories in the minds of long-time North Dakota residents, and for a good reason. These springtime blizzards usually come in the form of what meteorologists call "Colorado Lows," so-named for the location of their birth over the state of Colorado. If conditions are just right, these "Colorado Lows" can strengthen and move northeastward, impacting the northern Plains with strong winds and heavy precipitation that's often (but not always) in the form of heavy, wet snow if enough cold air can be pulled into the system. This spring brought the region a pair of "Colorado Lows" that generated significant winter weather. The first system brought widespread heavy snow totals from 1 to 3 feet and winds gusting to 60 mph to much of western, central and northeastern North Dakota from April 12 through April 14. The epicenter of the heaviest snowfall, from 24 to 36 inches, extended from the Dickinson and Beulah/Hazen areas northeast to the Minot area, as shown in Figure 13.

One-Day County Snowfall Records

County / Location	Amount (Inches) / Date	Previous Record / Date / Location
Dunn / Dunn Center 1E	26.0 / 04-13	broke 22.3 / 03-25-2009 at Halliday
Grand Forks / Larimore 0.4SE	18.9 / 04-13	broke 18.0 / 03-06-1995 at Grand Forks NWS
Mercer / Hazen 0.4SW	18.0 / 04-13	tied 18.0 / 04-07-1997 at Zap
Sheridan / McClusky	12.0 / 04-12	tied 12.0 / 12-26-2016 at McClusky

Figure 14. One-day county snowfall records set during the April 2022

The combination of heavy snow and high winds caused drifts exceeding 8 feet in some areas! The storm also set several one-day county snowfall records, as seen in Figure 14.

[5] The corresponding author, Chauncy Schultz, is the science and operation officer at the National Weather Service, Bismarck, North Dakota. Email: chauncy.schultz@noaa.gov

Figure 15. Satellite image on April 23, 2022.

If that weren't enough, another "Colorado Low" impacted the area from April 22 through 24. This system had a dramatic temperature contrast with a wintry mix of rain, freezing rain, sleet and snow in western and central North Dakota and thunderstorms in eastern North Dakota. At one point on Saturday, April 23, blizzard warnings were ongoing in western North Dakota while a tornado watch was posted in the eastern part of the state! The cloud pattern of this intense system was captured by satellite imagery, as shown in Figure 15, which revealed clouds wrapping around the low-pressure system spinning in the northern Plains.

The surface weather maps with the first storm system revealed a classic pattern for a "Colorado Low" blizzard, with a strengthening low-pressure system initially over northeastern Colorado on Tuesday, April 12, which rapidly shifted northeast to near Fargo by Wednesday, April 13 (Figure 16). Once these lows reach the upper Midwest, they often slow down and linger for multiple days, prolonging impacts. What causes these strong low-pressure systems to form and strengthen? Well, the battleground between warmer temperatures developing over the southern United States in the spring and lingering wintertime cold air at higher latitudes often leads to strong frontal boundaries over the Plains in March and April. This "clash of air masses" often extends to higher levels of the atmosphere, which leads to strong jet stream winds at high altitudes. If a particularly strong jet stream passes over one of these fronts at the surface, it tends to cause rapid "lift" in the atmosphere, essentially causing a large-scale vacuum cleaner effect that generates rising air through the atmosphere. This leaves less air near the ground,

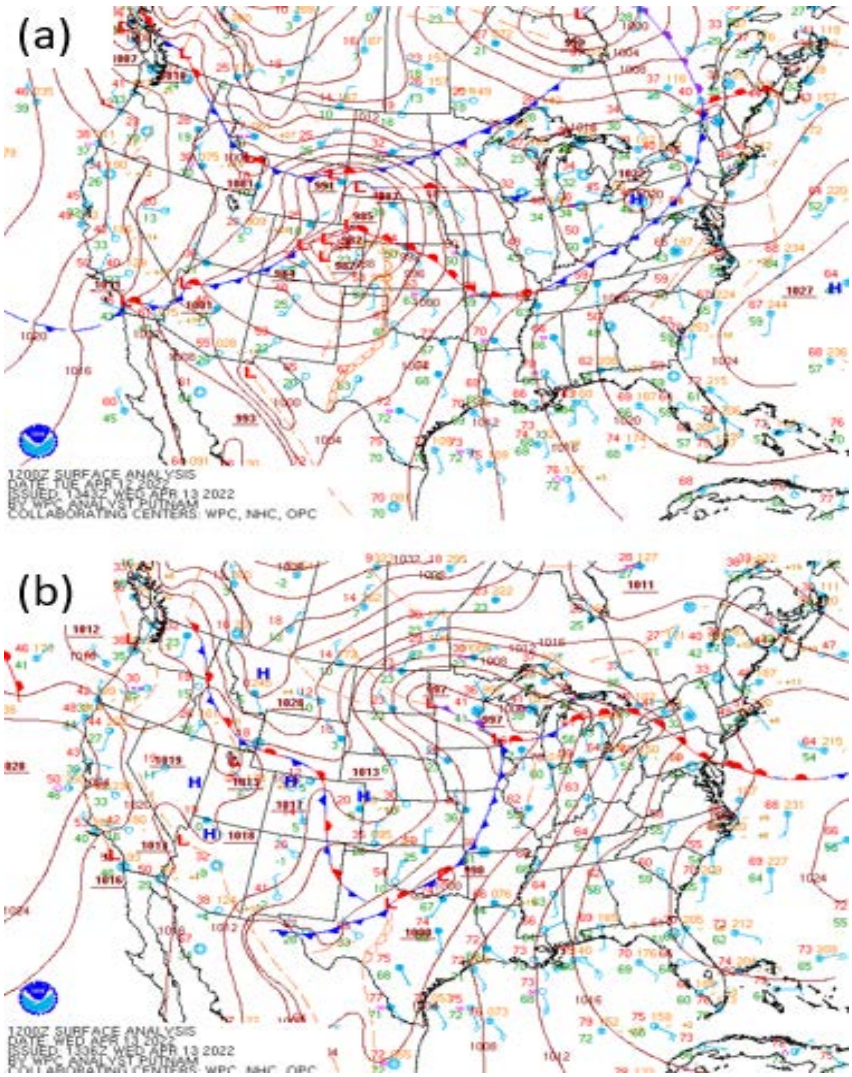


Figure 16. Surface weather maps for (a) April 12, 2022, and (b) April 13, 2022.

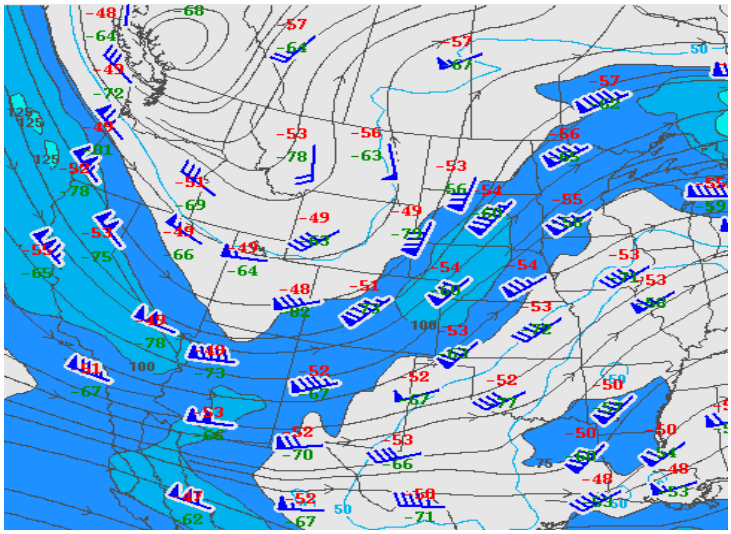


Figure 17. Jet stream winds the evening of April 12, 2022.

which, by definition, is an area of low pressure! This scenario is intensified if the air at high altitudes has a broad spin to it in the form of large, curved jet stream winds, which can lead to rapidly strengthening areas of low pressure that then move along fronts and are carried northeastward with the strong jet stream winds above the ground. If we look at the map showing winds at roughly 35,000 feet above ground level on the evening of April 12 (Figure 17), we see a river of strong jet stream winds close to 100 mph. These winds were situated aloft over the developing surface low-pressure system in Colorado. We also see a large curve in the jet stream winds over the western United States (forming what meteorologists call a trough). This all came together perfectly to produce one of the most memorable blizzards the region has experienced in many years!

Many things have to come together to cause these intense "Colorado Lows," which is why we don't see them too often. Large contrasts in temperature are common in the spring, but it takes the right combination and strength of jet stream winds crossing frontal zones with enough "lift" in the atmosphere to generate these really strong low-pressure systems. However, when these ingredients all come together, they can bring us some of our highest-impact blizzards, just as they did this April.

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