

**Upper Missouri River Basin  
January 2020 Calendar Year Runoff Forecast  
January 7, 2020**

**U.S. Army Corps of Engineers, Northwestern Division  
Missouri River Basin Water Management  
Omaha, NE**

**Calendar Year Runoff Forecast**

**Explanation and Purpose of Forecast**

The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. The Calendar Year Runoff Forecast is available at <http://www.nwd-mr.usace.army.mil/rcc/reports/runoff.pdf>. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows in million acre-feet (MAF) from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri Basin above Sioux City (upper Basin). The Calendar Year Runoff Forecast is used in the Monthly Study simulation model to plan future system regulation in order to meet the authorized project purposes throughout the calendar year.

**Observed Runoff**

The 2019 calendar year runoff summation for the Missouri Basin above Sioux City, IA, was **60.9 MAF, 240% of average** and the **second highest** runoff year in 122 years of record. This runoff was exceeded only in 2011, when the upper Basin observed 61.0 MAF of runoff. In addition, four reaches received the following record high annual runoff:

- Garrison to Oahe reach – 9.2 MAF exceeds the previous record of 7.7 MAF in 2009
- Oahe to Fort Randall reach – 5.6 MAF exceeds the previous record of 3.4 MAF in 1997
- Fort Randall to Gavins Point reach – 5.3 MAF exceeds the previous record of 3.6 MAF in 1997
- Gavins Point to Sioux City reach – 14.8 MAF exceeds the previous record of 10.6 MAF in 2010

December 2019 runoff was 2.1 MAF, nearly three times the average runoff volume. It was the highest December runoff volume on record. December runoff was above normal due to warmer-than-normal temperatures, above-average precipitation, and of course, the very wet soil

conditions, particularly in South Dakota. Each of the lower four reaches received record highest December runoff volumes.

### **2020 Calendar Year Forecast Synopsis**

The 2020 calendar year runoff forecast for the upper Missouri Basin above Sioux City, IA is **36.3 MAF, 141% of average**. The 2020 calendar year runoff forecast for the Missouri Basin above Gavins Point is **29.7 MAF, 125% of average**.

Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next 12 months, expected inflow could range from the 51.2 MAF upper basic forecast to the 23.4 MAF lower basic forecast. The upper and lower basic forecasts are used in long-term regulation planning models to “bracket” the range of expected runoff given much wetter or drier conditions, respectively. Given that twelve months are being forecast for this January 1 forecast (0 months observed/12 months forecast), the range of possible wetter-than-expected (upper basic) and drier-than-expected (lower basic) conditions is very large, and is attributed to all six reaches for the entire year. The result is a range or “bracket” for each reach, and thus, for the total runoff forecast.

### **Current Conditions**

#### **Drought Analysis**

The National Drought Mitigation Center’s drought monitor for December 31, 2019 is shown in **Figure 1**. The drought monitor is available at <http://droughtmonitor.unl.edu/>. The U.S. Drought Monitor shows only Abnormally Dry (D0) conditions in the most distant headwater areas of the Missouri River and Yellowstone River in the upper Basin. Some D0 conditions also exist within western Kansas. The Seasonal Drought Outlook in **Figure 2**, which extends through the end of March, indicates no drought development within the Missouri River Basin during the outlook period.

# U.S. Drought Monitor

December 31, 2019  
 (Released Thursday, Jan. 2, 2020)  
 Valid 7 a.m. EST

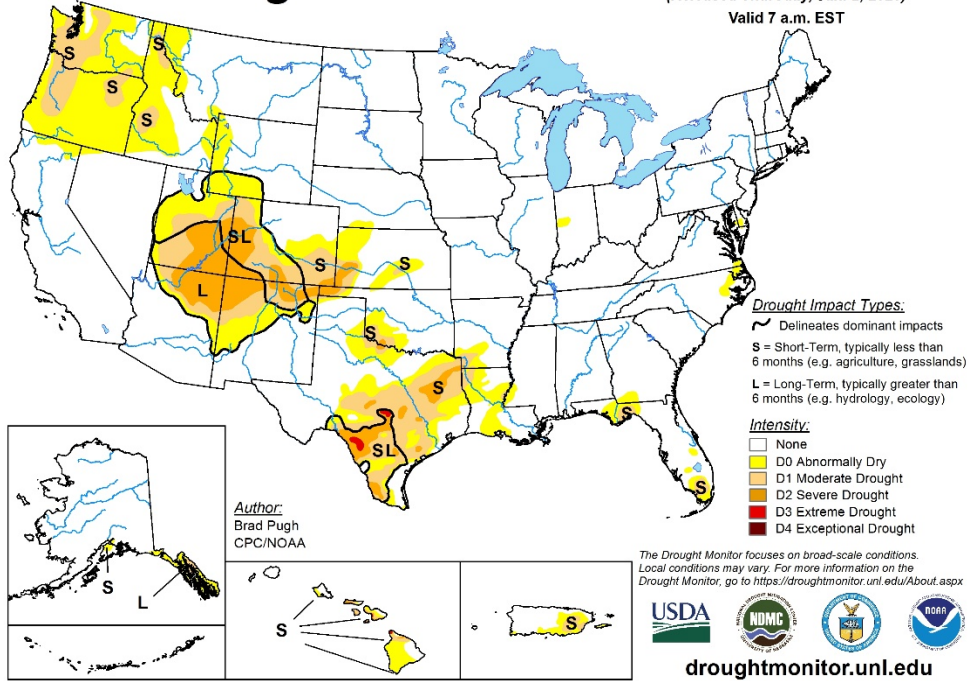


Figure 1. National Drought Mitigation Center U.S. Drought Monitor for December 31, 2019.

# U.S. Seasonal Drought Outlook

Valid for December 19, 2019 - March 31, 2020  
 Released December 19, 2019

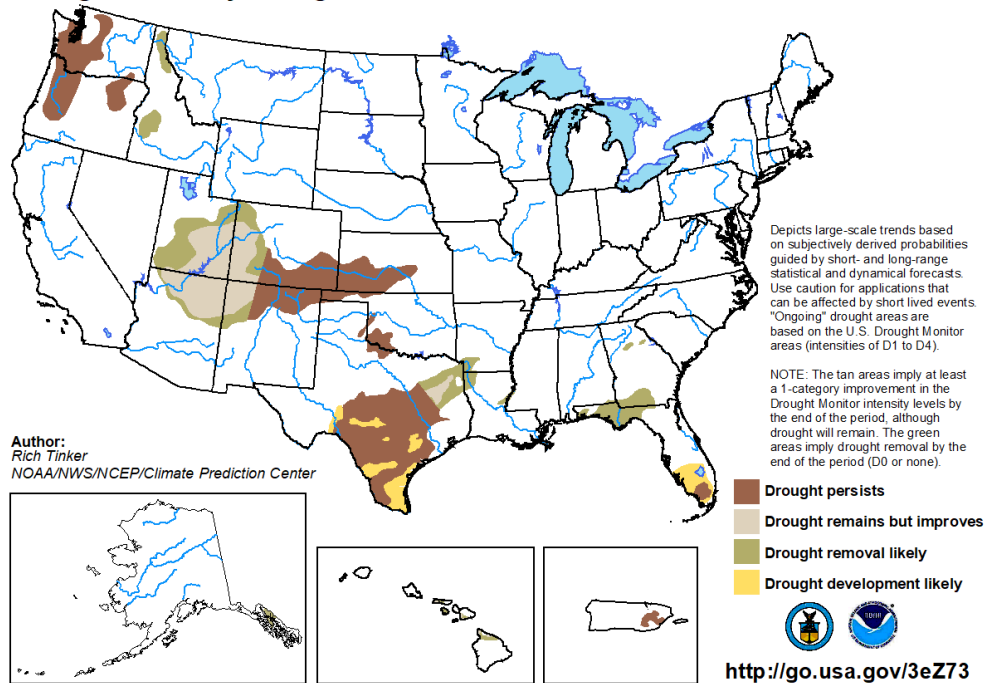


Figure 2. National Drought Mitigation Center U.S. Drought Seasonal Drought Outlook.

## Precipitation

Monthly precipitation accumulations are shown using High Plains Regional Climate Center images available at <http://www.hprcc.unl.edu/>. The December precipitation accumulations are shown in **Figure 3** as a percent of normal precipitation. December precipitation was generally below normal in Montana and northern Wyoming, and above normal in the Dakotas and Nebraska. Heavy precipitation exceeding 200 percent of normal occurred over large areas of Nebraska, South Dakota and eastern North Dakota. This precipitation was caused primarily by a large winter storm that traversed these areas from December 27 – 30. The storm produced a mix of rain, freezing rain, and snow as it developed in Nebraska, before mostly producing snow as it moved into South Dakota. Snowfall totals generally ranged from 6 to 12 inches; however some concentrated areas of northern South Dakota and southeastern North Dakota received 12 to 24 inches.

Precipitation as a percent of normal for the October-November-December period was also above normal in northern Montana, North Dakota, South Dakota, Nebraska and Iowa (**Figure 4**).

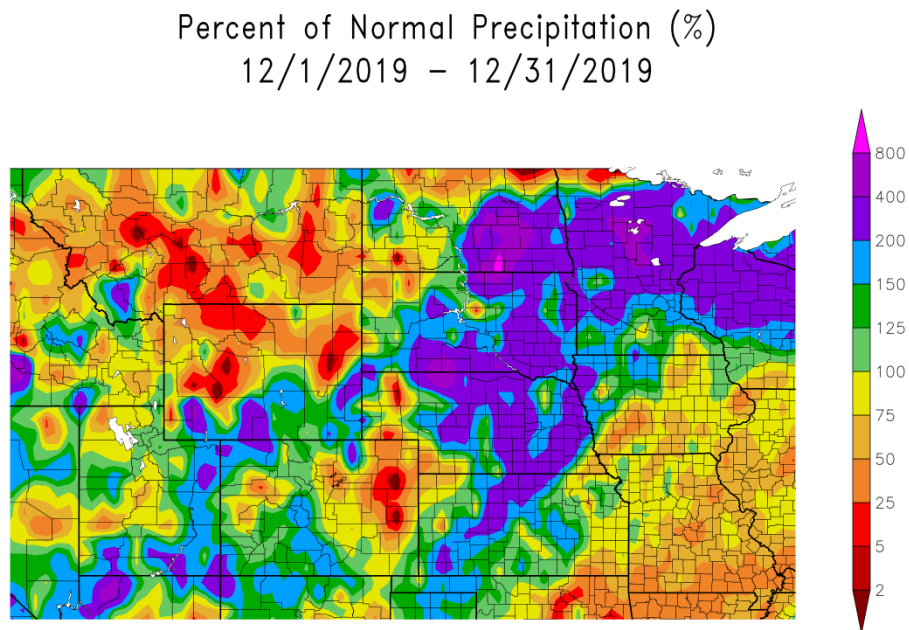


Figure 3. December 2019 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Percent of Normal Precipitation (%)  
10/1/2019 – 12/31/2019

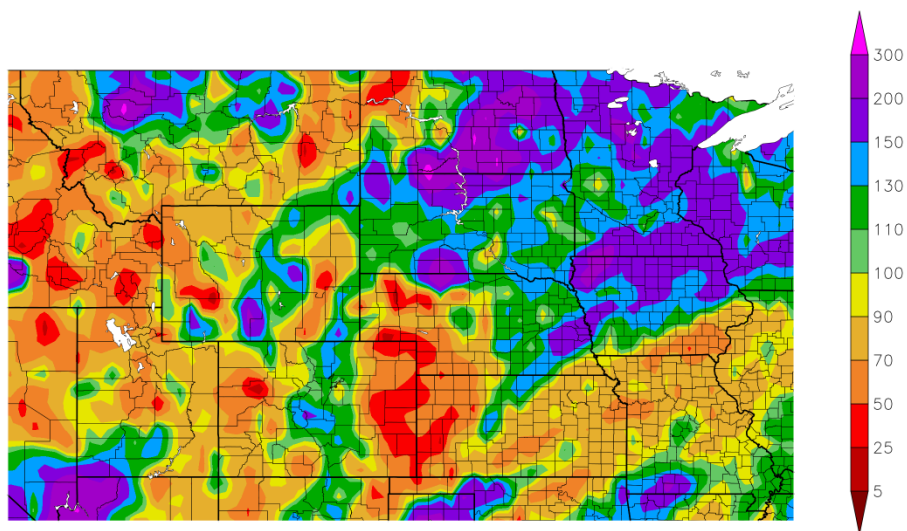


Figure 4. October, November, December 2019 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

## Temperature

December temperature departures in degrees Fahrenheit (deg F) in **Figure 5** indicate much warmer-than-normal temperatures over most of the Basin. December temperatures in Montana ranged from 4 to 8 deg F above normal. This warmth extended into northern Wyoming and the western Dakotas. Warmer-than-normal temperatures ranging from 4 to 8 deg F above normal also occurred in Nebraska, Kansas, Missouri and Iowa. These warmer-than-normal temperatures limited the formation of river ice and allowed Missouri River tributaries to flow freely in December. The Missouri River ice cover at Bismarck, ND actually melted in a small portion of the swiftest flowing portion of the channel, but maintained ice cover over a majority of the river at the Bismarck stream gage. The warmer temperatures also inhibited the formation of plains snowpack by causing winter precipitation to fall as rain, and by melting shallow snowpack several days after accumulation. October-November-December temperature departures are shown in **Figure 6**. In contrast to December departures, the three-month average departures were several degrees below normal in Montana, Wyoming, and the Dakotas, and about normal in the lower Basin. The below normal three-month temperatures were due to much colder-than-normal temperatures observed in October and November.

Departure from Normal Temperature (F)  
12/1/2019 – 12/31/2019

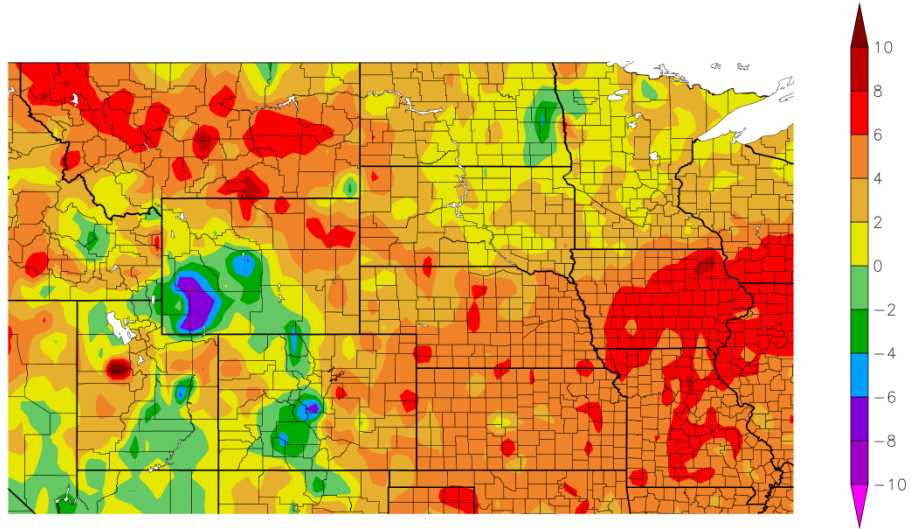


Figure 5. December 2019 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Departure from Normal Temperature (F)  
10/1/2019 – 12/31/2019

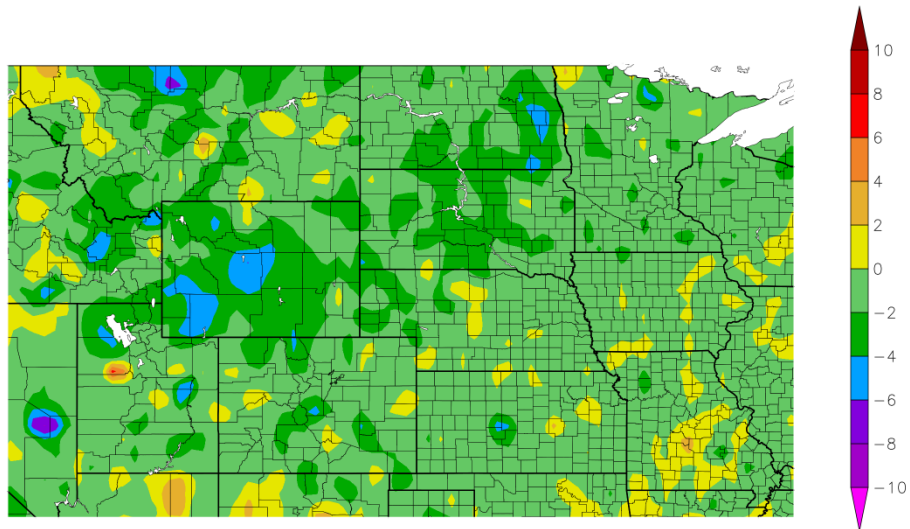


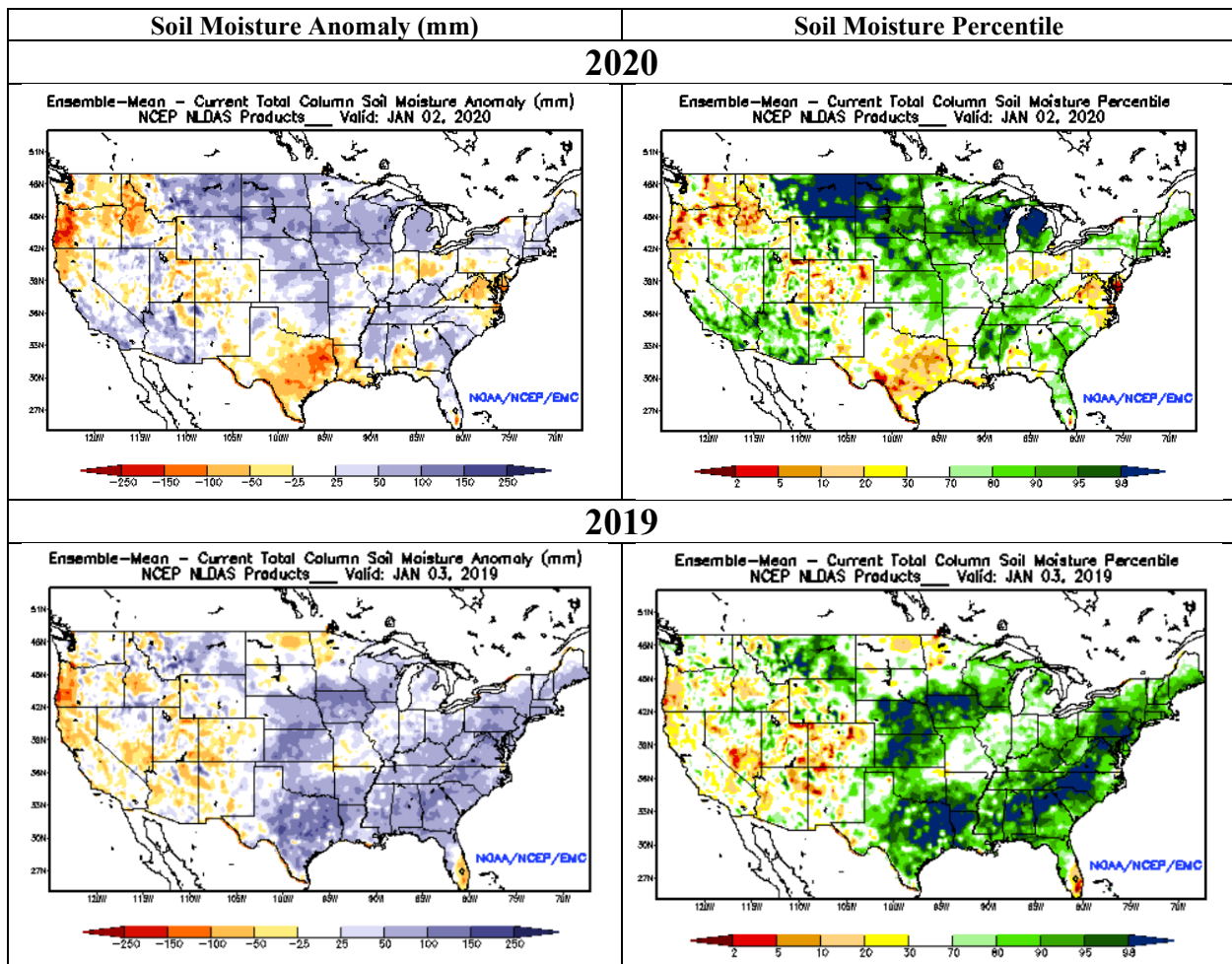
Figure 6. October-November-December 2019 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

### Soil Moisture

Soil moisture is factored into the forecast as an indicator of wet or dry hydrologic basin conditions. Typically when soil moisture conditions are wet or greater than normal, rainfall and snowmelt runoff is greater than when soil moisture is dry or less than normal. Not only is soil moisture a physical parameter that influences runoff, it can be used as an indicator of future

runoff. As the calendar year approaches winter, the soil moisture conditions will provide some insight into late winter and early spring runoff potential.

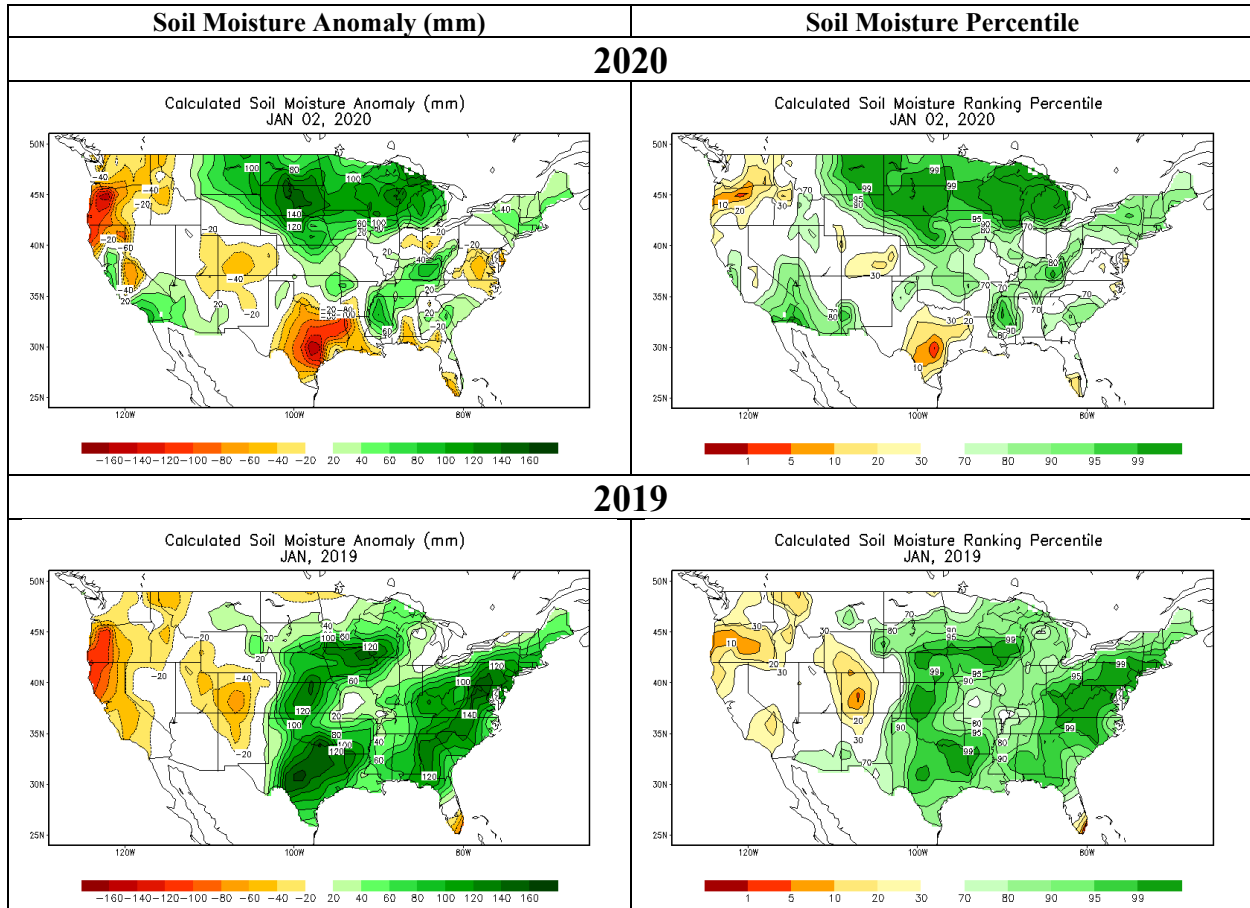
Soil moisture at the beginning of January 2020 is much wetter than normal. This is shown in soil moisture estimates from the NOAA National Land Data Assimilation System (NLDAS) and the Climate Prediction Center (CPC) in **Figure 7** and **Figure 8**, respectively. Both the soil moisture anomalies and the soil moisture percentiles are shown in these figures. Both figures indicate that early January 2020 soil moisture anomalies in the Missouri River Basin are well-above normal. Furthermore, the soil moisture percentiles rank very high; above the 98<sup>th</sup> and 99<sup>th</sup> percentiles based on both the NLDAS and CPC percentile maps. The 99<sup>th</sup> percentile indicates that soil moisture is at its wettest for this time of year, compared to long-term soil moisture simulations. Generally, when soil moisture is high during the winter, the potential for high March-April runoff is **much** higher.



**Figure 7.** NOAA NLDAS Soil Moisture Anomaly (mm) and Soil Moisture Percentile. Source: NOAA NLDAS Drought Monitor Soil Moisture. <http://www.emc.ncep.noaa.gov/mmb/nldas/drought/>

**Figures 7 and 8** also show soil moisture in early January 2019. Compared to January 2019 soil moisture, January 2020 soil moisture is much wetter in the upper Basin. In 2019, soil moisture

was wetter-than-normal in the lower Basin, but it ranged from normal to wetter-than-normal in the upper Basin. Based on soil moisture in January 2019, the potential for above-average runoff from the upper Basin is higher in 2020 than in 2019.



**Figure 8. NOAA CPC Soil Moisture Anomaly (mm) and Soil Moisture Percentile. Source: NOAA NLDAS Drought Monitor Soil Moisture. [https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)**

## Plains Snowpack

Plains snowpack is an important parameter that influences the volume of runoff occurring in the basin during the months of March and April. A common misperception is that the March-April runoff is a result of plains snowmelt only. Historically, about 25% of annual runoff occurs in March and April, during the time when plains snow is melting, due to both melting snowpack and rainfall runoff. Runoff occurs in March and April whether or not there is any plains snow to melt. Determining exact rainfall amounts and locations are nearly impossible to predict more than a week in advance. Thus, the March-April runoff forecast is formulated based on existing plains snowpack and existing basin conditions and hydrologic forecasts, which for this year primarily includes long-term precipitation outlooks. At this time of year, plains snowpack provides some indication of March-April runoff; however, as the snowpack reaches its ultimate peak accumulation, better forecasts of future runoff can be made.

The National Weather Service’s National Operational Hydrologic Remote Sensing Center (NOHRSC), modeled snow assessment from January 7, shown in **Figure 9**, indicates 1 to 2 inches of liquid content or SWE over the larger region, and 2 to 4 inches in southeastern North Dakota and in northern and eastern South Dakota. The plains snowpack is greater than it was at this time last year. In 2019, very little plains snowpack was present in early January.

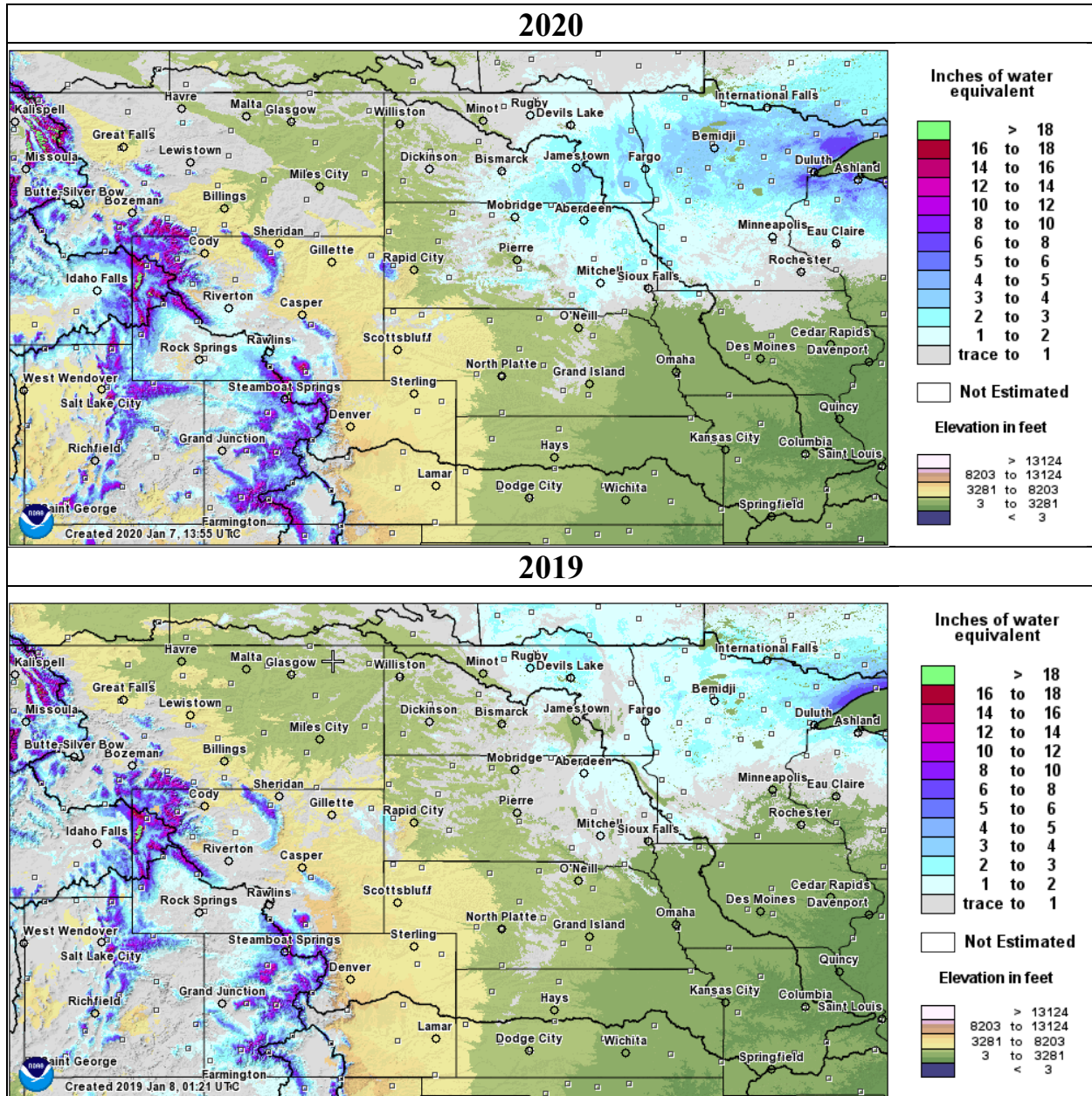


Figure 9. January 7, 2020 NOHRSC modeled plains snow water equivalent (top) and January 7, 2019 snow water equivalent (bottom). Source: NOAA National Operational Hydrologic Remote Sensing Center. <http://www.nohrsc.nws.gov/interactive/html/map.html>

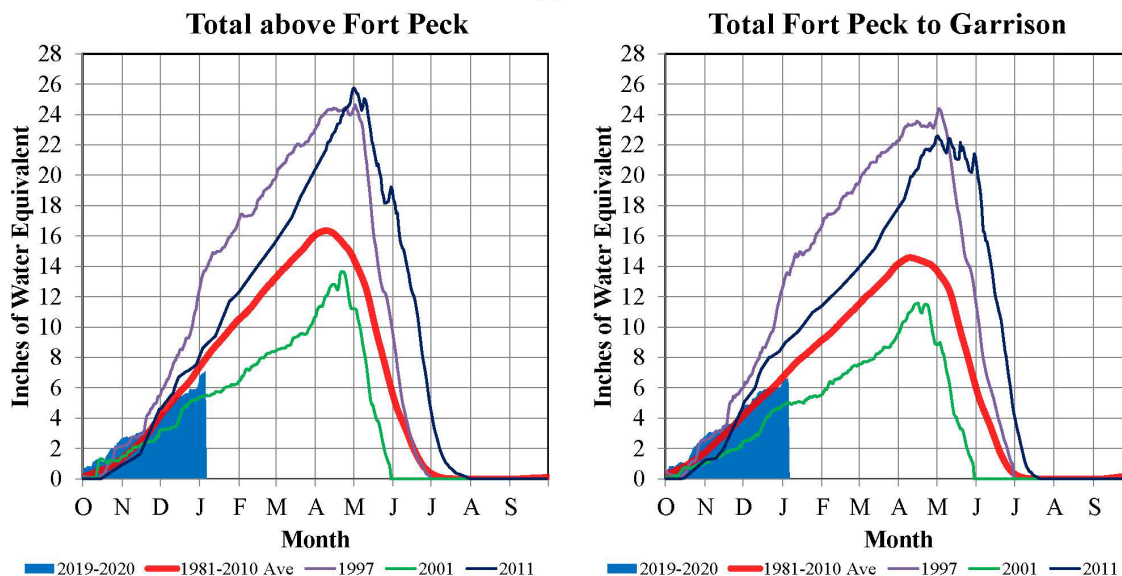
## Mountain Snowpack

Mountain snowpack is the primary factor used to predict May, June, and July runoff volumes in the Fort Peck and Fort Peck to Garrison mainstem reservoir reaches. May, June and July runoff in the Fort Peck and Garrison reaches has very little correlation to the January 1 snowpack, because less than half of the mountain snowpack has accumulated on January 1. A majority of the mountain snowfall typically occurs from January 1 to mid-April, when snowpack typically peaks, therefore, later measurements of mountain snowpack are better runoff indicators.

**Figure 10** includes time series plots of the average mountain SWE beginning on October 1, 2019 based on the NRCS SNOTEL data for the headwater basin above Fort Peck and the incremental basin from Fort Peck to Garrison. The current average SWE values (shaded blue area) are plotted against the 1981-2010 basin average SWE (bold red line), a recent low SWE year in 2001 (green line), and two historic high SWE years occurring in 1997 (purple) and 2011 (dark blue).

### Missouri River Basin – Mountain Snowpack Water Content 2019-2020 with comparison plots from 1997\*, 2001\*, and 2011

5-Jan-2020



The Missouri River Basin mountain snowpack normally peaks near April 15. On January 5, the mountain Snow Water Equivalent (SWE) in the "Total above Fort Peck" reach was 7.1", 90% of the January 5 average. On January 5, the mountain SWE in the Fort Peck to Garrison reach was 6.6", 93% of the January 5 average.

\*Generally considered the high and low year of the last 25-year period, respectively

Provisional data. Subject to revision.

**Figure 10. Mountain snowpack water content on January 5, 2020 compared to normal and historic conditions. Corps of Engineers - Missouri River Basin Water Management.**

As of January 5, 2020, the Corps of Engineers computed an average mountain SWE in the Fort Peck reservoir reach of 7.1 inches, which is 90% of average based on the 1981-2010 average SWE for the Fort Peck reach. In the reservoir reach between Fort Peck Dam and Garrison Dam, the Corps computed an average mountain SWE of 6.6 inches, which is 93% of average based on

the 1981-2010 average SWE for the Garrison reach. Typically by January 1, 44% of the total accumulation has occurred, and it typically peaks around April 15.

## **Climate Outlook**

MRBWM participates in the monthly North Central U.S. Climate/Drought Outlook Webinar coordinated through NOAA, the regional climate centers, and the American Association of State Climatologists (AASC). These webinars provide updates on near-term climate outlooks and impacts including the ENSO climate pattern and its implications on winter temperature and precipitation patterns in the Missouri Basin.

### **ENSO (El Niño Southern Oscillation)**

The latest ENSO Outlook indicates that neutral conditions are present, and will likely remain neutral during the Northern Hemisphere winter and spring. During ENSO neutral conditions there are no strong climate indicators to provide much certainty on the precipitation and temperature forecasts beyond the winter and early spring.

### **Temperature and Precipitation Outlooks**

The NOAA Climate Prediction Center (CPC) outlooks provide the forecasted probability (or chance) of occurrence of future weather conditions during periods ranging from 1 to 12 months into the future. The CPC outlooks are available at <http://www.cpc.ncep.noaa.gov/>.

The CPC temperature outlook through January 20 (**Figure 11**) indicates increased chances for below-normal temperatures over the Basin. The precipitation outlook indicates a general increase in the chances for above-normal precipitation over the entire Missouri Basin. During this time period, temperatures are forecast to become very cold in much of the upper Basin.

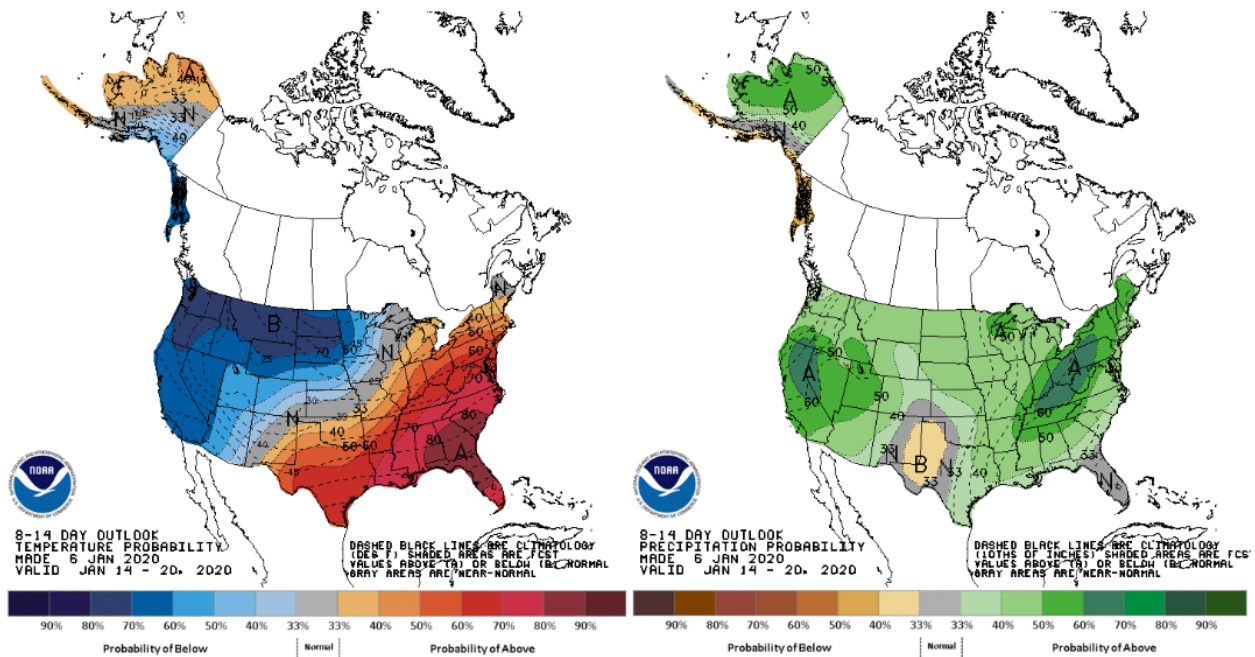


Figure 11. CPC 8-14 Day temperature and precipitation outlooks through January 20, 2020.

The January CPC outlooks in **Figure 12** indicate increased chances for below-normal temperatures in the mountainous areas of the Missouri Basin and equal chances for above-normal, normal, and below-normal temperatures in the plains. With regard to precipitation, there is a slight increase in chances for above-normal precipitation in Montana, northern Wyoming, and the western Dakotas.

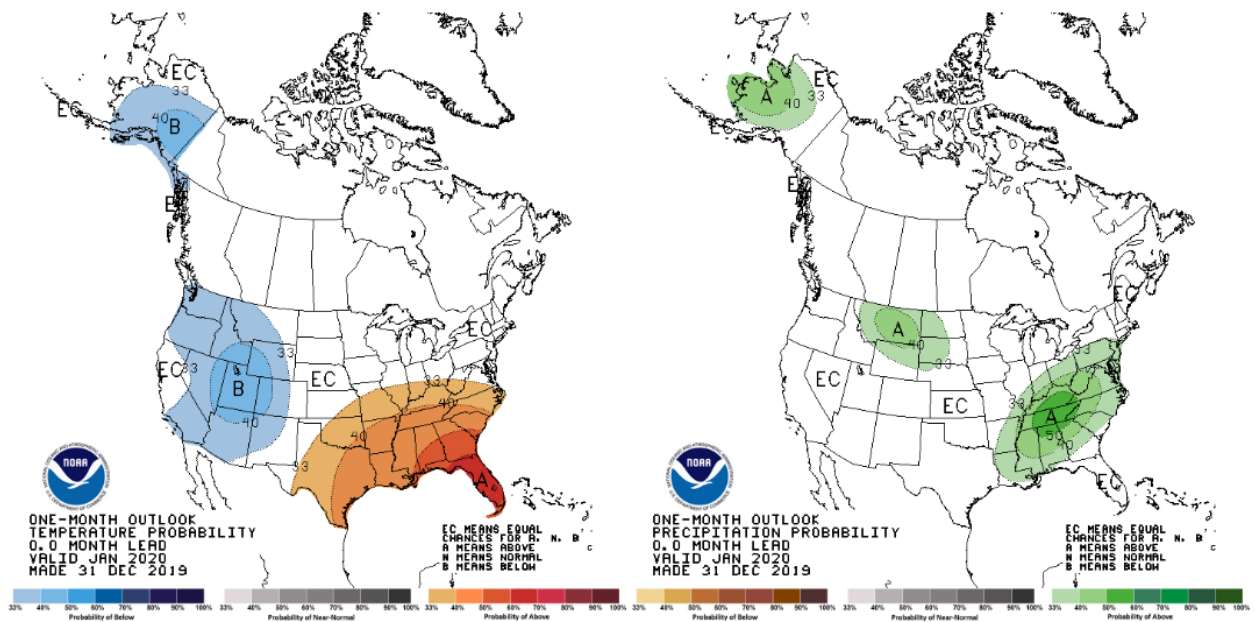
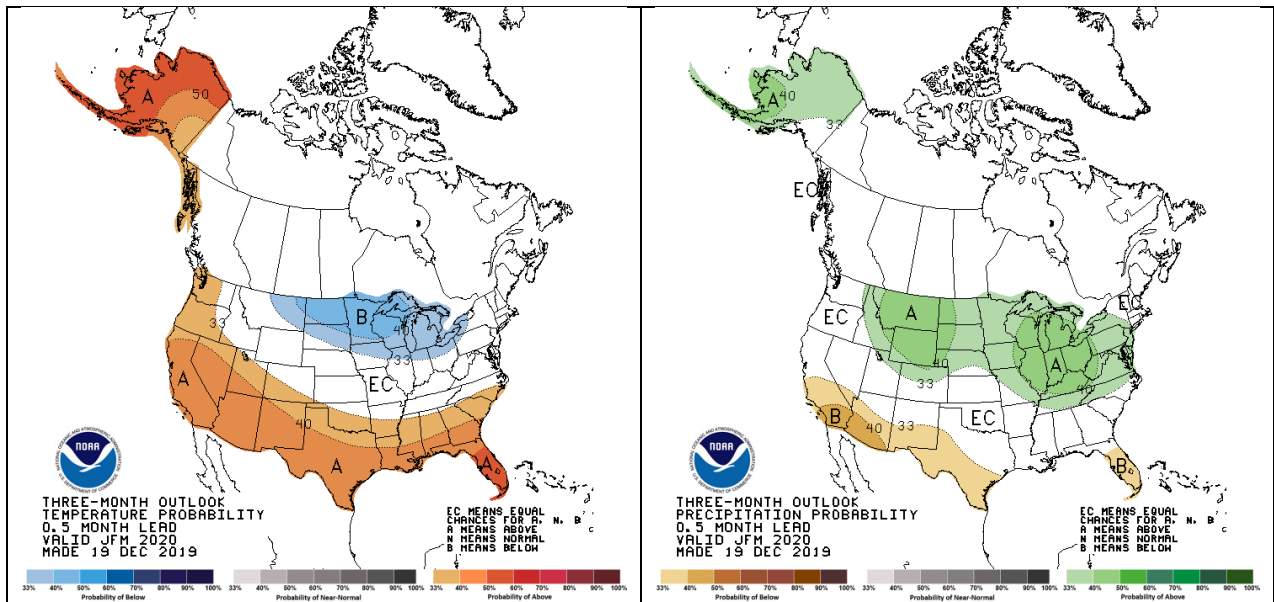


Figure 12. CPC January 2020 temperature and precipitation outlooks.

Three-month temperature and precipitation outlooks for four three-month periods in 2020 are shown below in **Figures 13-16**. During the January-February-March 2020 period (**Figure 13**), the CPC indicates increased chances for below-normal temperatures in the north central U.S., including northeastern Montana, North Dakota, South Dakota, and northern Iowa. Equal chances for above-normal, normal, and below-normal temperatures are indicated in all other areas of the Missouri Basin. With regard to precipitation, there is an increased probability for above-normal precipitation in the upper Basin, particularly in Montana, Wyoming and the western Dakotas.



**Figure 13. CPC January-February-March 2020 temperature and precipitation outlooks.**

During the April-May-June 2020 forecast period (**Figure 14**), there are equal chances for temperatures in the upper Basin; however, long-term outlooks begin transitioning to increased chances for warmer-than-normal temperatures in later periods (**Figures 15 and 16**). With regard to precipitation, there is a slight increase in the chances for above-normal precipitation in the eastern Dakotas and the upper Midwest during April-May-June, and equal chances to the west. During July-August-September, there is an increased chance for below-normal precipitation in the western half of the upper Basin, and equal chances during October-November-December. As previously noted, though, there is limited confidence in climate outlooks beyond the winter and early spring, therefore, the climate outlooks will likely change as the calendar progresses.

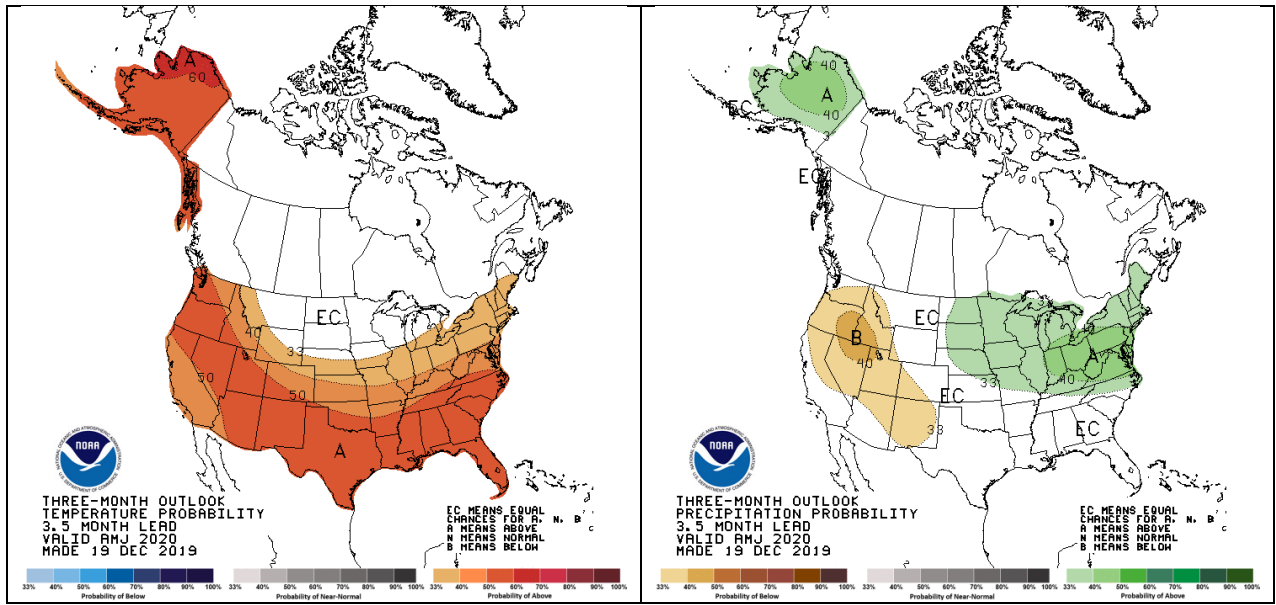


Figure 14. CPC April-May-June 2020 temperature and precipitation outlooks.

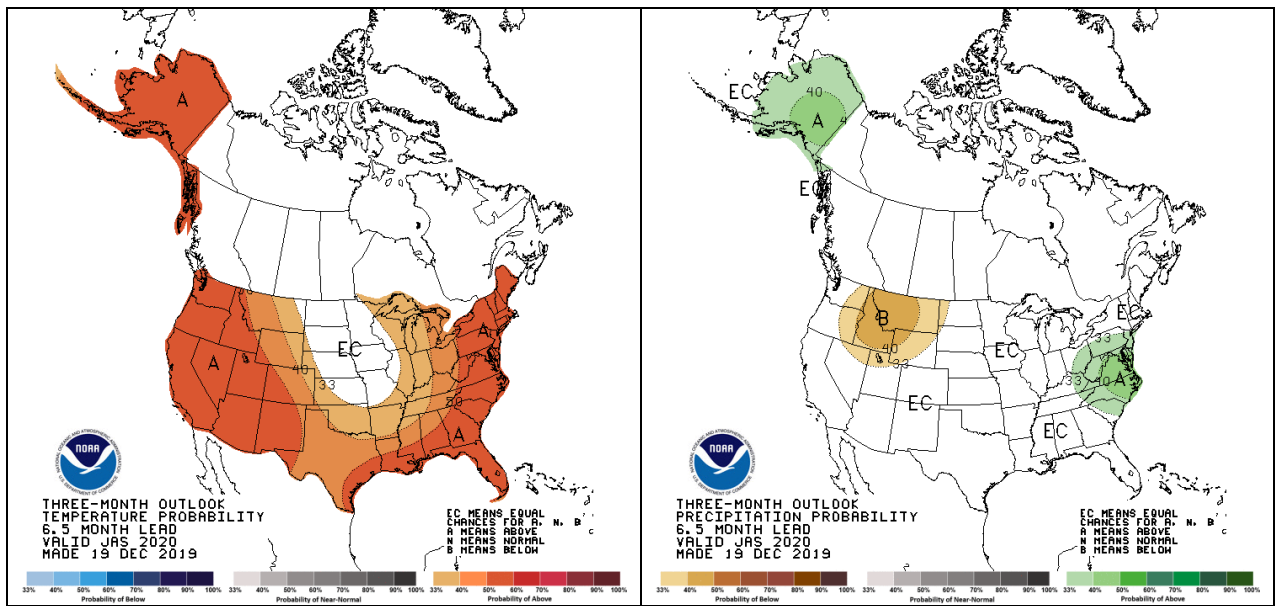


Figure 15. July-August-September 2020 temperature and precipitation outlooks.

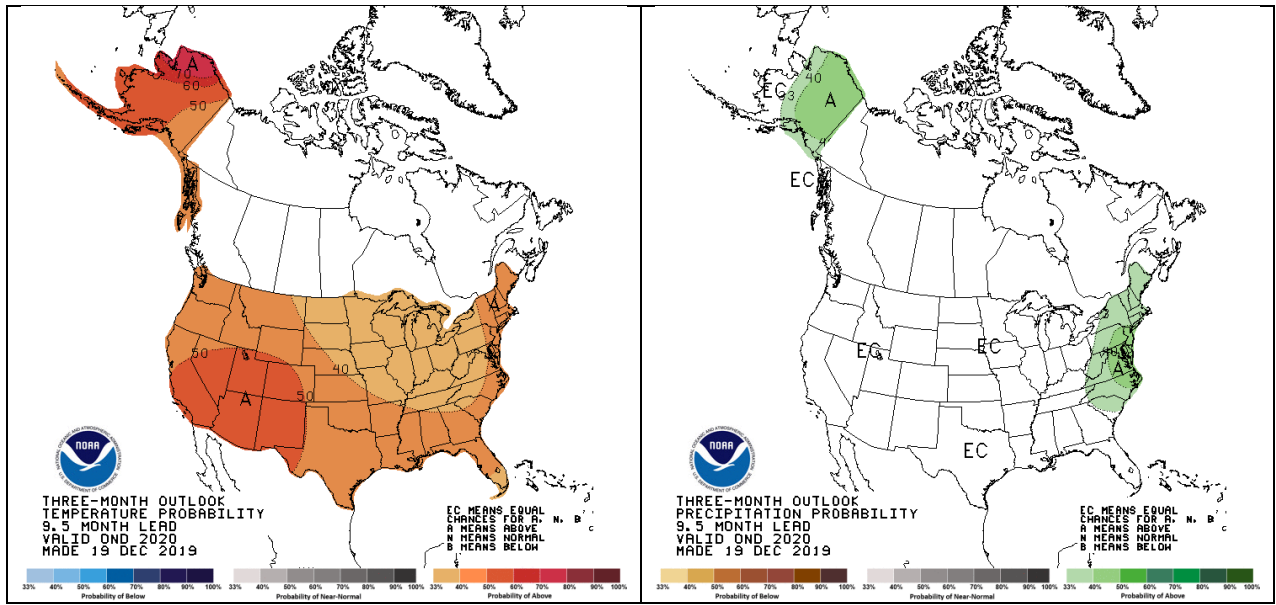


Figure 16. October-November-December 2020 temperature and precipitation outlooks.

## Summary

Given the very wet soil moisture conditions, high streamflow and the observed warmer-than-normal temperatures limiting plains snow accumulation and river ice formation in Montana, Wyoming and the western Dakotas, we expect runoff to be about two times average in January and February. March-April runoff potential is very high due to the very wet soil moisture conditions, but it will depend greatly on the accumulation of plains snowpack over the next two to three months. During May, June and July, Fort Peck and Garrison runoff is forecast to be slightly above average; however, the lower four reaches could continue to produce well above-average runoff in the spring and summer months.

In summary, the 2020 calendar year runoff forecast is **36.3 MAF (141% of average)**. Compared to all observed runoff years, the forecasted runoff volume ranks as the 9<sup>th</sup> highest annual runoff volume in 122 years of record-keeping.

**Upper Missouri River Basin  
February 2020 Calendar Year Runoff Forecast  
February 5, 2020**

**U.S. Army Corps of Engineers, Northwestern Division  
Missouri River Basin Water Management  
Omaha, NE**

**Calendar Year Runoff Forecast**

**Explanation and Purpose of Forecast**

The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. The Calendar Year Runoff Forecast is available at <http://www.nwd-mr.usace.army.mil/rcc/reports/runoff.pdf>. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows in million acre-feet (MAF) from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri Basin above Sioux City (upper Basin). The Calendar Year Runoff Forecast is used in the Monthly Study simulation model to plan future system regulation in order to meet the authorized project purposes throughout the calendar year.

**Observed Runoff**

January 2020 runoff was 1.4 MAF, nearly two times average, continuing the high runoff trend from 2019. January runoff was above average in all reaches, and was nearly 8 times average in the Sioux City reach, 6 times average in the Oahe reach, and 4 times average in the Fort Randall reach.

**2020 Calendar Year Forecast Synopsis**

The 2020 calendar year runoff forecast for the upper Missouri Basin above Sioux City, IA is **36.3 MAF, 141% of average**. The 2020 calendar year runoff forecast for the Missouri Basin above Gavins Point is **29.0 MAF, 124% of average**.

Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next 11 months, expected inflow could range from the 50.7 MAF upper basic forecast to the 23.6 MAF lower basic forecast. The upper and lower basic forecasts are used in long-term regulation planning models to “bracket” the range of expected runoff given much wetter or drier conditions, respectively. Given that eleven months are being forecast for this February 1 forecast (1 month observed/11 months forecast), the range of possible wetter-than-expected (upper basic)

and drier-than-expected (lower basic) conditions is very large, and is attributed to all six reaches for the remaining 11 months of the year. The result is a range or “bracket” for each reach, and thus, for the total runoff forecast.

## Current Conditions

### Drought Analysis

The National Drought Mitigation Center’s drought monitor for January 28, 2020 is shown in **Figure 1**. The drought monitor is available at <http://droughtmonitor.unl.edu/>. The U.S. Drought Monitor shows only Abnormally Dry (D0) conditions in the most distant headwater areas of the Missouri River and Yellowstone River in the upper Basin. Some D0 conditions also exist within western Kansas. The Seasonal Drought Outlook in **Figure 2**, which extends through the end of April, indicates no drought development within the Missouri River Basin during the outlook period.

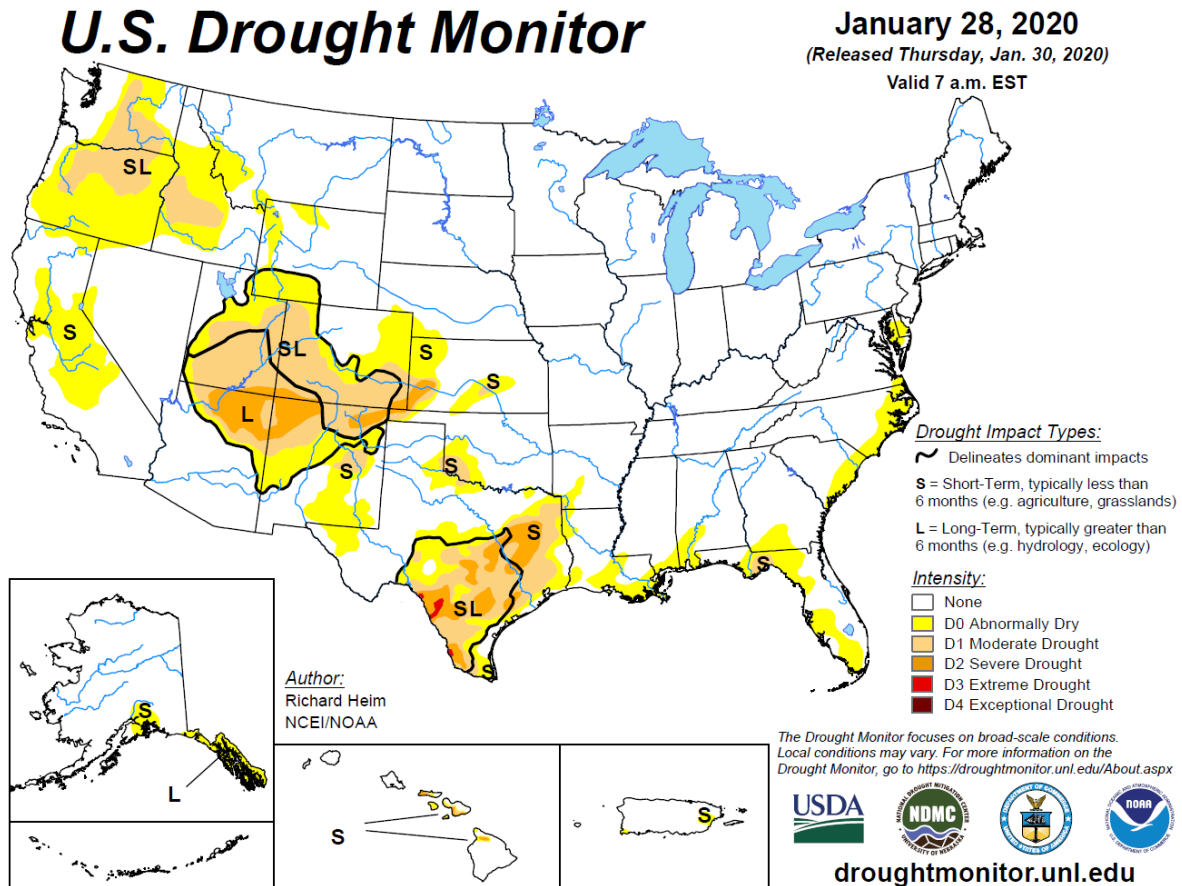


Figure 1. National Drought Mitigation Center U.S. Drought Monitor for January 28, 2020.

## U.S. Seasonal Drought Outlook Drought Tendency During the Valid Period

Valid for January 16 - April 30, 2020  
Released January 16

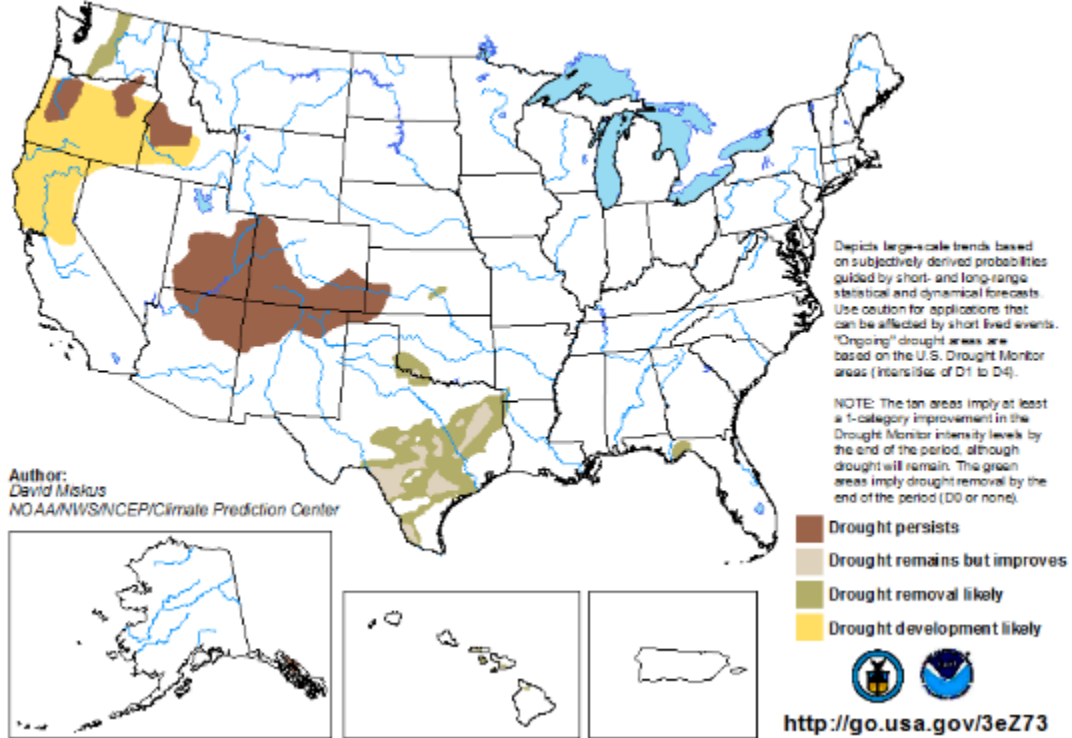


Figure 2. National Drought Mitigation Center U.S. Drought Seasonal Drought Outlook.

### Precipitation

Monthly precipitation accumulations are shown using High Plains Regional Climate Center images available at <http://www.hprcc.unl.edu/>. The January precipitation accumulations are shown in **Figure 3** as a percent of normal precipitation. January precipitation was well-above normal in the lower Basin, with areas of above- and below-normal precipitation throughout the upper Basin. Heavy precipitation exceeding 200 percent of normal occurred over large areas of the lower basin, including Nebraska, Iowa, Kansas, and Missouri.

Precipitation as a percent of normal for the November-December-January period was also above normal in Nebraska, Iowa, South Dakota, southeastern North Dakota, and northern Montana (**Figure 4**). There is a below-normal precipitation trend in southern and eastern Montana, western North Dakota, southern Iowa, eastern Kansas, and northern Missouri.

Percent of Normal Precipitation (%)  
1/1/2020 – 1/31/2020

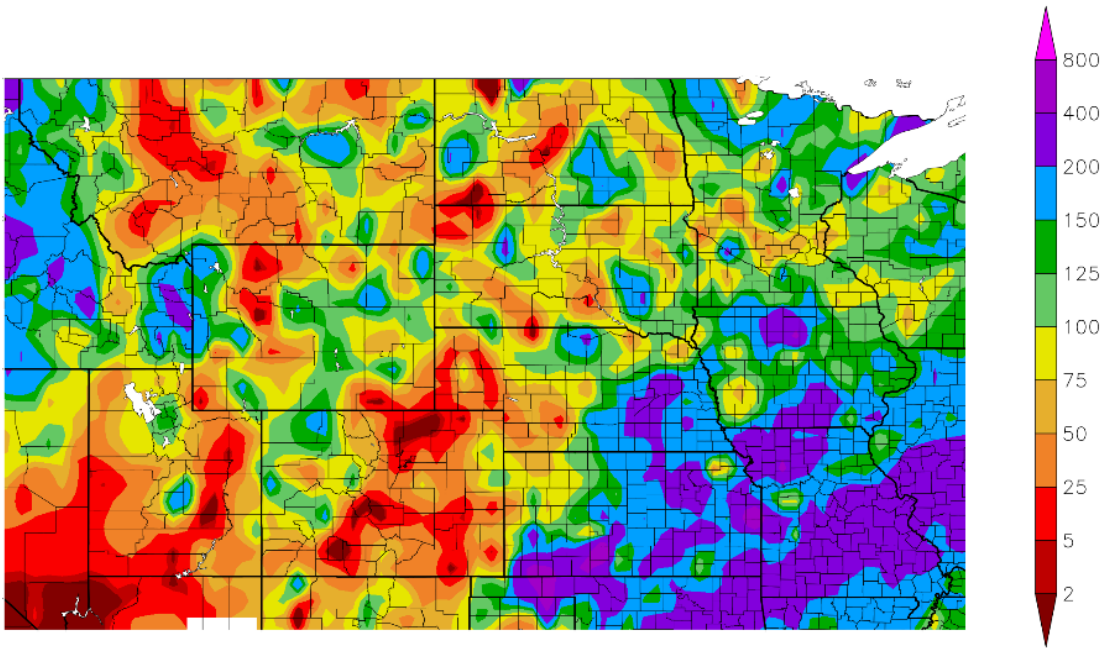


Figure 3. January 2020 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Percent of Normal Precipitation (%)  
11/1/2019 – 1/31/2020

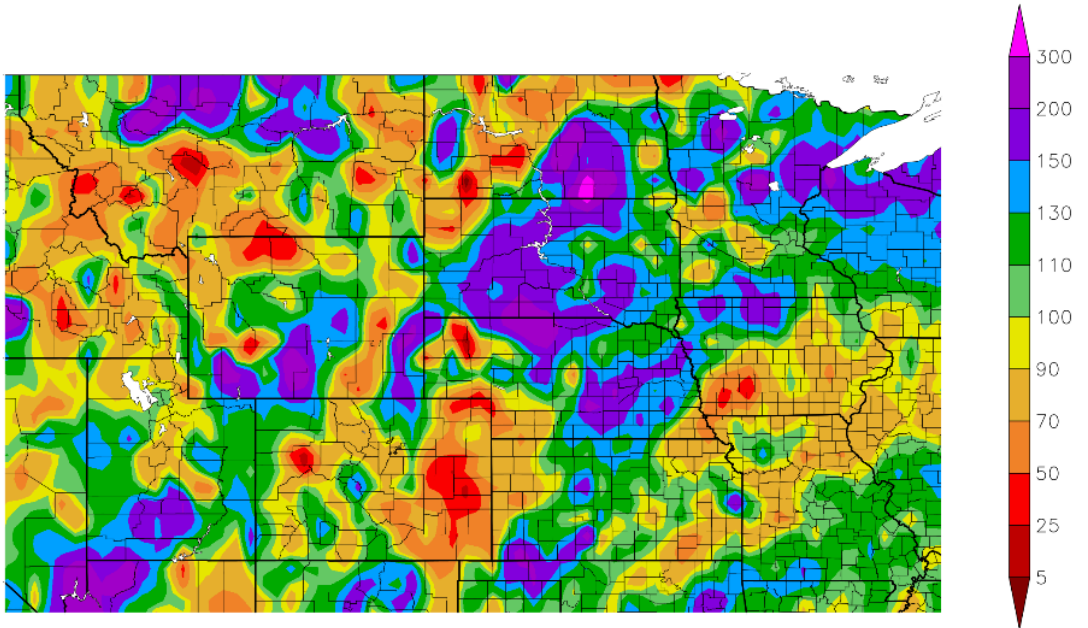


Figure 4. November, December 2019, January 2020 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

## Temperature

January temperature departures in degrees Fahrenheit (deg F) in **Figure 5** indicate average to much warmer-than-normal temperatures over most of the Basin, particularly in the western areas of the upper Basin and in most of the lower Basin. Northern Montana, central South Dakota, and northern Nebraska were exceptions, where temperatures were up to 4 deg F below normal in small areas. Temperatures were up to 10 degrees warmer than normal in an area of Wyoming, and around 4 to 6 deg F warmer than normal over the remainder of the Basin. November-December-January temperature departures are shown in **Figure 6**. The three-month average departures were very similar to the January departures, with the addition of below-normal areas in North Dakota.

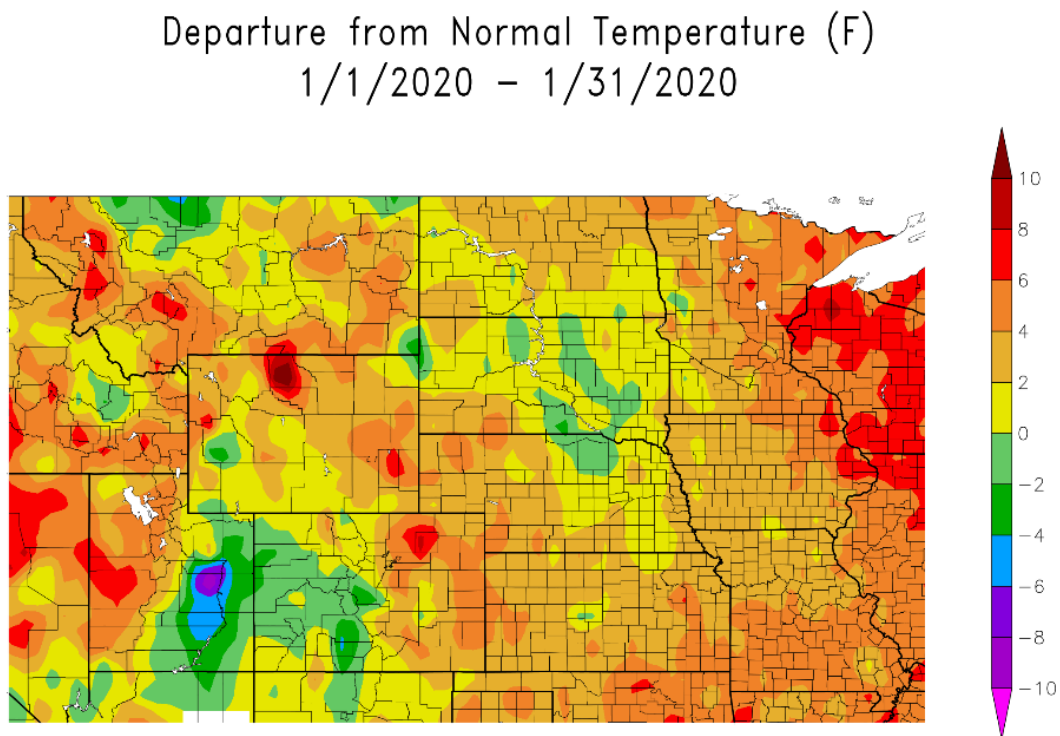


Figure 5. January 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Departure from Normal Temperature (F)  
11/1/2019 – 1/31/2020

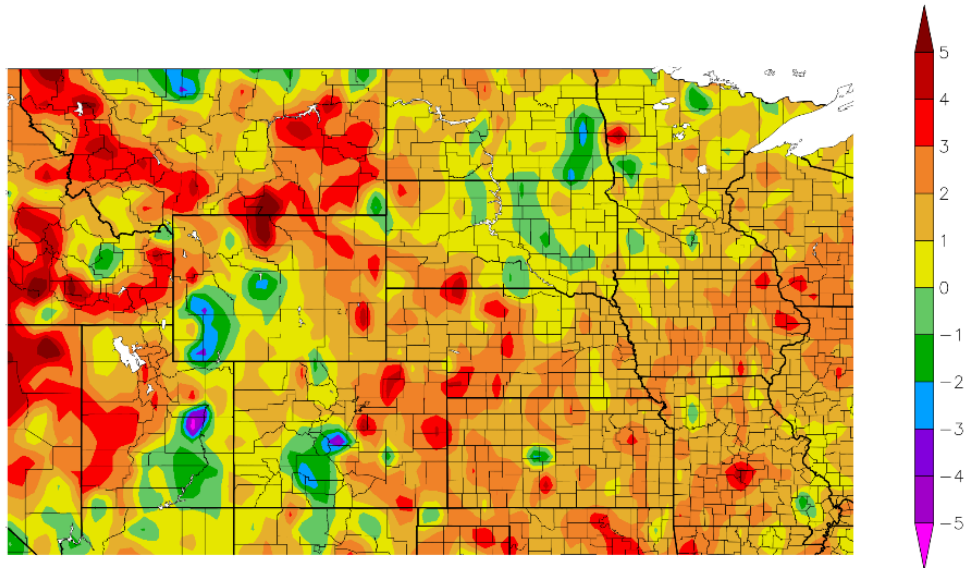


Figure 6. November-December 2019-January 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

### Soil Moisture

Soil moisture is factored into the forecast as an indicator of wet or dry hydrologic basin conditions. Typically when soil moisture conditions are wet or greater than normal, rainfall and snowmelt runoff is greater than when soil moisture is dry or less than normal. Not only is soil moisture a physical parameter that influences runoff, it can be used as an indicator of future runoff. As the calendar year approaches winter, the soil moisture conditions will provide some insight into late winter and early spring runoff potential.

Soil moisture at the end of January and beginning of February is much wetter than normal. This is shown in soil moisture estimates from the NOAA National Land Data Assimilation System (NLDAS) and the Climate Prediction Center (CPC) in **Figure 7** and **Figure 8**, respectively. Both the soil moisture anomalies and the soil moisture percentiles are shown in these figures. Both figures indicate that early February soil moisture anomalies in the Missouri River Basin are well-above normal. Furthermore, the soil moisture percentiles rank very high; above the 98<sup>th</sup> and 99<sup>th</sup> percentiles based on both the NLDAS and CPC percentile maps. The 99<sup>th</sup> percentile indicates that soil moisture is at its wettest for this time of year, compared to long-term soil moisture simulations. Generally, when soil moisture is high during the winter, the potential for high March-April runoff is **much** higher.

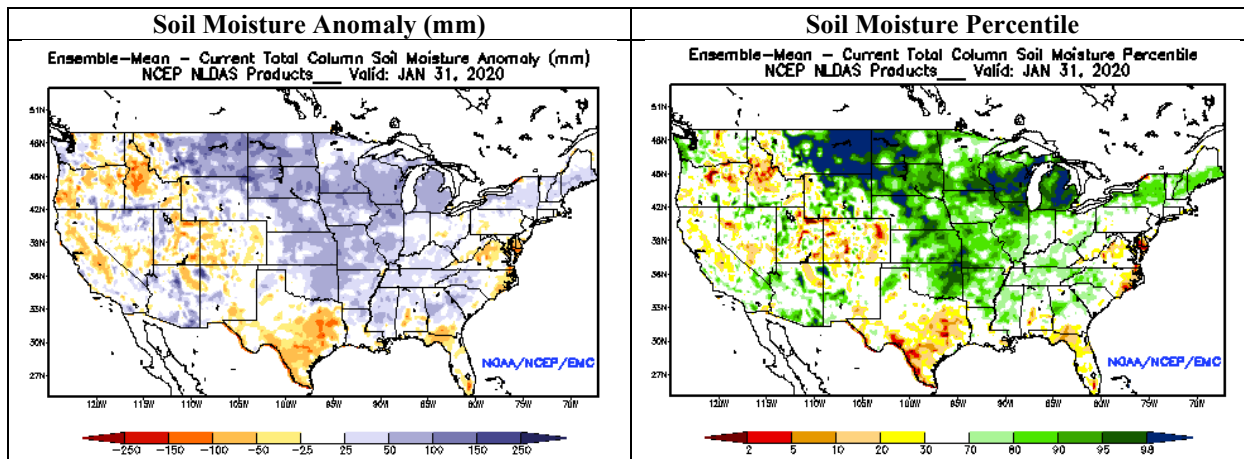


Figure 7. NOAA NLDAS Soil Moisture Anomaly (mm) and Soil Moisture Percentile. Source: NOAA NLDAS Drought Monitor Soil Moisture. <http://www.emc.ncep.noaa.gov/mmb/nldas/drought/>

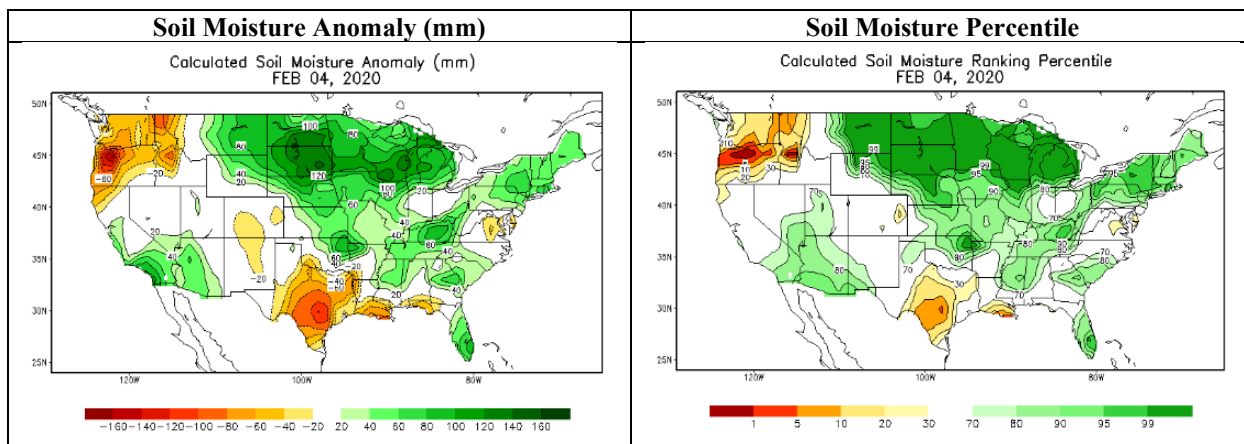


Figure 8. NOAA CPC Soil Moisture Anomaly (mm) and Soil Moisture Percentile. Source: NOAA NLDAS Drought Monitor Soil Moisture. [https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

## Plains Snowpack

Plains snowpack is an important parameter that influences the volume of runoff occurring in the basin during the months of March and April. A common misperception is that the March-April runoff is a result of plains snowmelt only. Historically, about 25% of annual runoff occurs in March and April, during the time when plains snow is melting, due to both melting snowpack and rainfall runoff. Runoff occurs in March and April whether or not there is any plains snow to melt. Determining exact rainfall amounts and locations are nearly impossible to predict more than a week in advance. Thus, the March-April runoff forecast is formulated based on existing plains snowpack and existing basin conditions and hydrologic forecasts, which for this year primarily includes long-term precipitation outlooks. At this time of year, plains snowpack provides some indication of March-April runoff; however, as the snowpack reaches its ultimate peak accumulation, better forecasts of future runoff can be made.

The National Weather Service’s National Operational Hydrologic Remote Sensing Center (NOHRSC), modeled snow assessment from February 5, shown in **Figure 9**, indicates 1 to 2

inches of liquid content or SWE over the larger region, and 2 to 4 inches in southeastern North Dakota and in northern and eastern South Dakota. The plains snowpack is a little less than it was at this time last year. In 2019, more widespread trace to 1-inch amounts of SWE were present across the Basin. There were also larger areas of 4 inch SWE amounts in North and South Dakota.

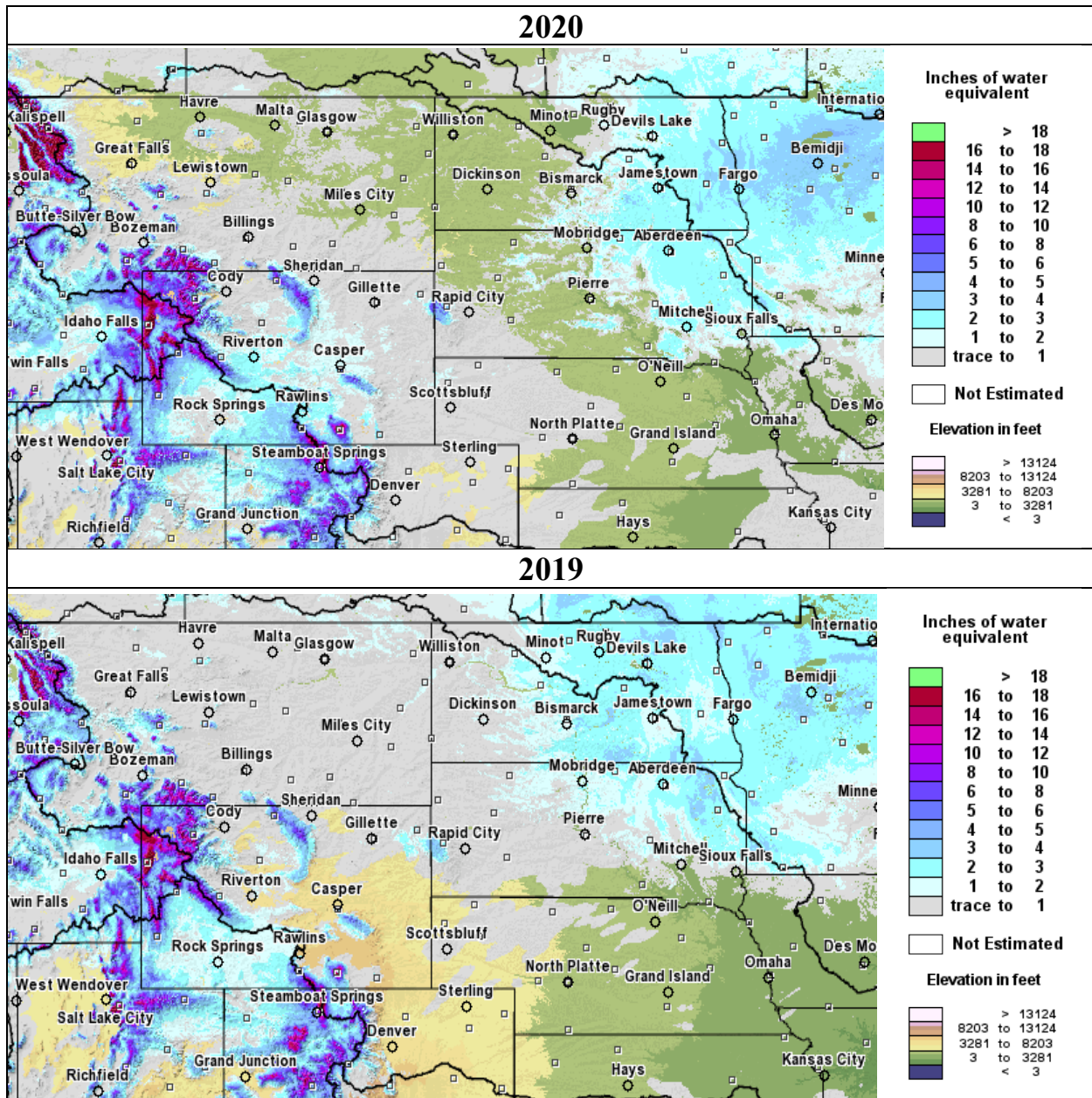


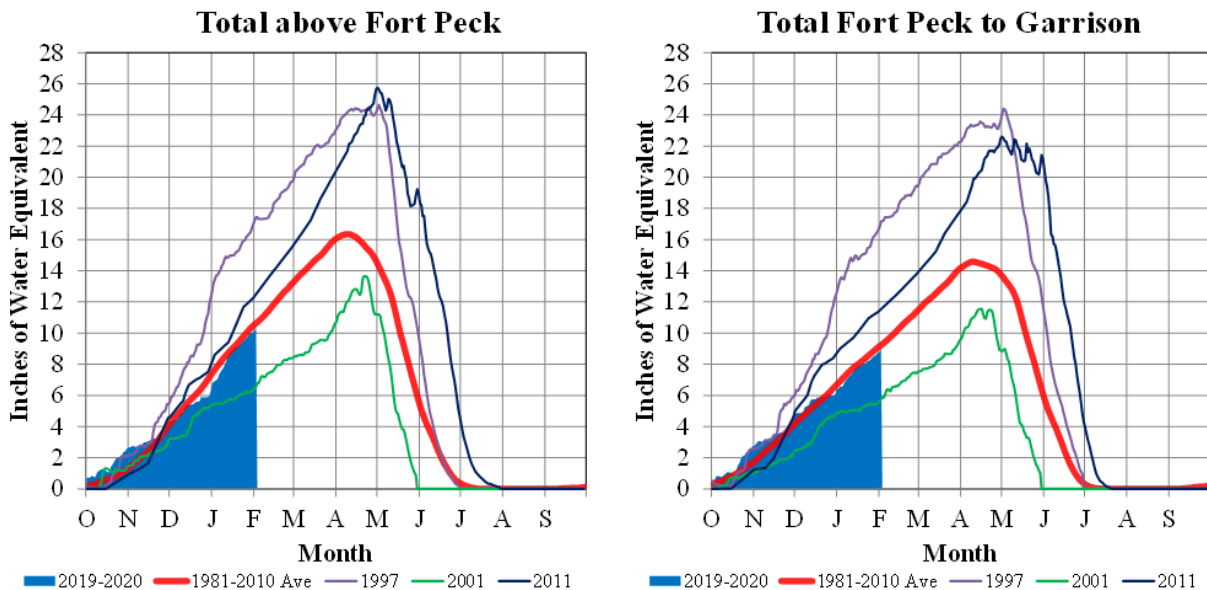
Figure 9. February 5, 2020 NOHRSC modeled plains snow water equivalent (top) and February 5, 2019 snow water equivalent (bottom). Source: NOAA National Operational Hydrologic Remote Sensing Center. <http://www.nohrsc.nws.gov/interactive/html/map.html>

## Mountain Snowpack

Mountain snowpack is the primary factor used to predict May, June, and July runoff volumes in the Fort Peck and Fort Peck to Garrison mainstem reservoir reaches. May, June and July runoff in the Fort Peck and Garrison reaches has very little correlation to the February 1 snowpack, because only about 60 percent has accumulated by February 1. Mountain snowfall typically peaks in mid-April. The March 1 and April 1 mountain snowpack measurement will be much better indicators for May, June and July runoff in these two reaches.

**Figure 10** includes time series plots of the average mountain SWE beginning on October 1, 2019 based on the NRCS SNOTEL data for the headwater basin above Fort Peck and the incremental basin from Fort Peck to Garrison. The current average SWE values (shaded blue area) are plotted against the 1981-2010 basin average SWE (bold red line), a recent low SWE year in 2001 (green line), and two historic high SWE years occurring in 1997 (purple) and 2011 (dark blue).

### Missouri River Basin – Mountain Snowpack Water Content 2019-2020 with comparison plots from 1997\*, 2001\*, and 2011 2-Feb-2020



\*Generally considered the high and low year of the last 25-year period, respectively

Provisional data. Subject to revision.

**Figure 10. Mountain snowpack water content on February 2, 2020 compared to normal and historic conditions. Corps of Engineers - Missouri River Basin Water Management.**

As of February 2, 2020, the Corps of Engineers computed an average mountain SWE in the Fort Peck reservoir reach of 10.5 inches, which is 98% of average based on the 1981-2010 average SWE for the Fort Peck reach. In the reservoir reach between Fort Peck Dam and Garrison Dam, the Corps computed an average mountain SWE of 9.1 inches, which is 98% of average based on the 1981-2010 average SWE for the Garrison reach.

## Climate Outlook

MRBWM participates in the monthly North Central U.S. Climate/Drought Outlook Webinar coordinated through NOAA, the regional climate centers, and the American Association of State Climatologists (AASC). These webinars provide updates on near-term climate outlooks and impacts including the ENSO climate pattern and its implications on winter temperature and precipitation patterns in the Missouri Basin.

### **ENSO (El Niño Southern Oscillation)**

The latest ENSO Outlook indicates that neutral conditions are present, and will likely remain neutral during the Northern Hemisphere spring 2020 and summer 2020. During ENSO neutral conditions there are no strong climate indicators to provide much certainty on the precipitation and temperature forecasts beyond the winter and early spring.

### **Temperature and Precipitation Outlooks**

The NOAA Climate Prediction Center (CPC) outlooks provide the forecasted probability (or chance) of occurrence of future weather conditions during periods ranging from 1 to 12 months into the future. The CPC outlooks are available at <http://www.cpc.ncep.noaa.gov/>.

The CPC temperature outlook through February 19 (**Figure 11**) indicates increased chances for below-normal temperatures over the Basin. The precipitation outlook indicates a slight increase in the chances for above-normal precipitation over the entire Missouri Basin. During this time period, temperatures are forecast to become very cold in much of the upper Basin.

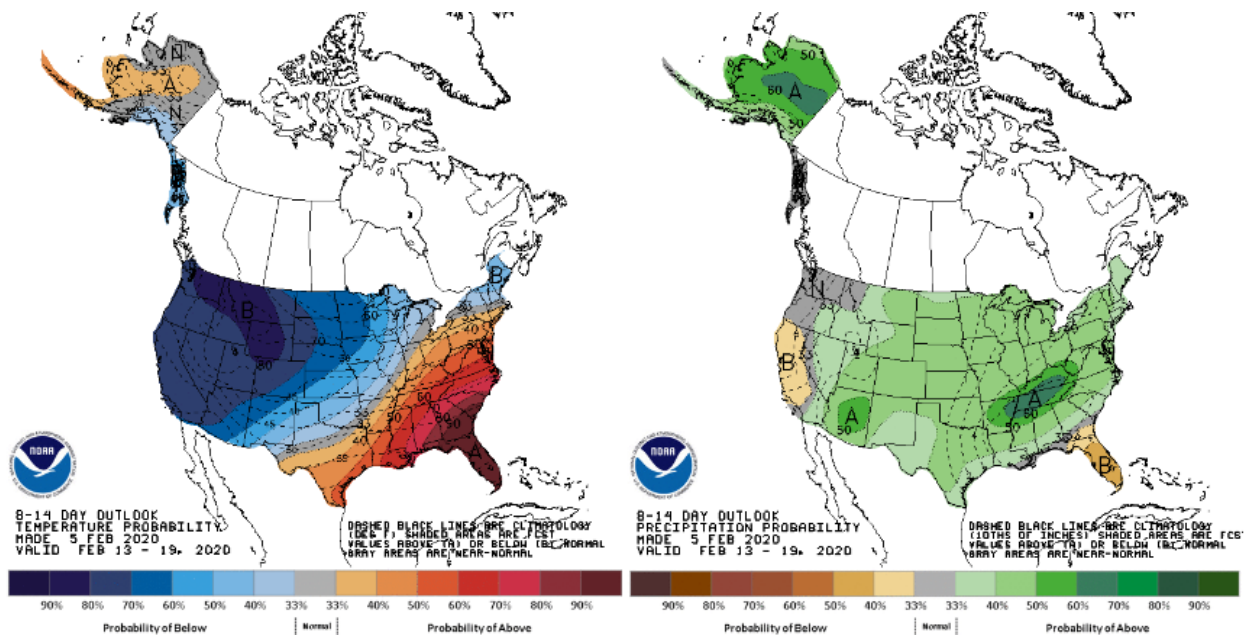
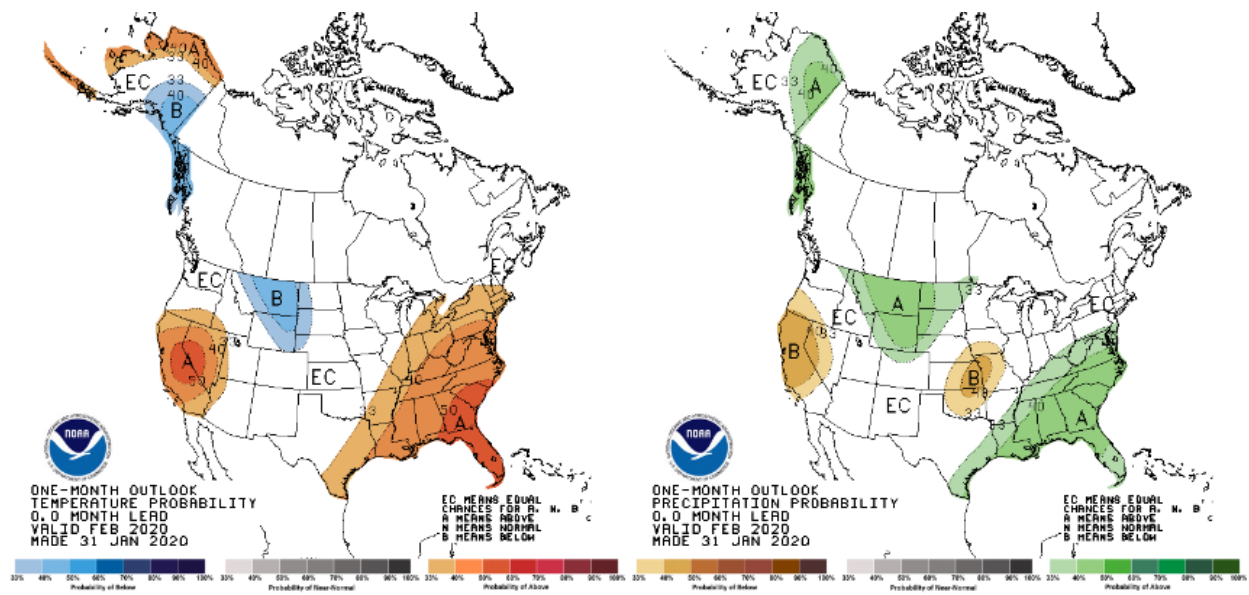


Figure 11. CPC 8-14 Day temperature and precipitation outlooks through February 19, 2020.

The February CPC outlooks in **Figure 12** indicate increased chances for below-normal temperatures in the mountainous areas of the Missouri Basin and equal chances for above-normal, normal, and below-normal temperatures in the plains. With regard to precipitation, there is a slight increase in chances for above-normal precipitation in Montana, Wyoming, and the western Dakotas.



**Figure 12. CPC February 2020 temperature and precipitation outlooks.**

Three-month temperature and precipitation outlooks for four three-month periods in 2020 are shown below in **Figures 13-16**. During the February-March-April 2020 period (**Figure 13**), the CPC indicates increased chances for below-normal temperatures in the north central U.S., including northeastern Montana, North Dakota, South Dakota, and northern Iowa. Equal chances for above-normal, normal, and below-normal temperatures are indicated in all other areas of the Missouri Basin. With regard to precipitation, there is an increased probability for above-normal precipitation in the upper Basin, particularly in Montana, Wyoming and the western Dakotas.

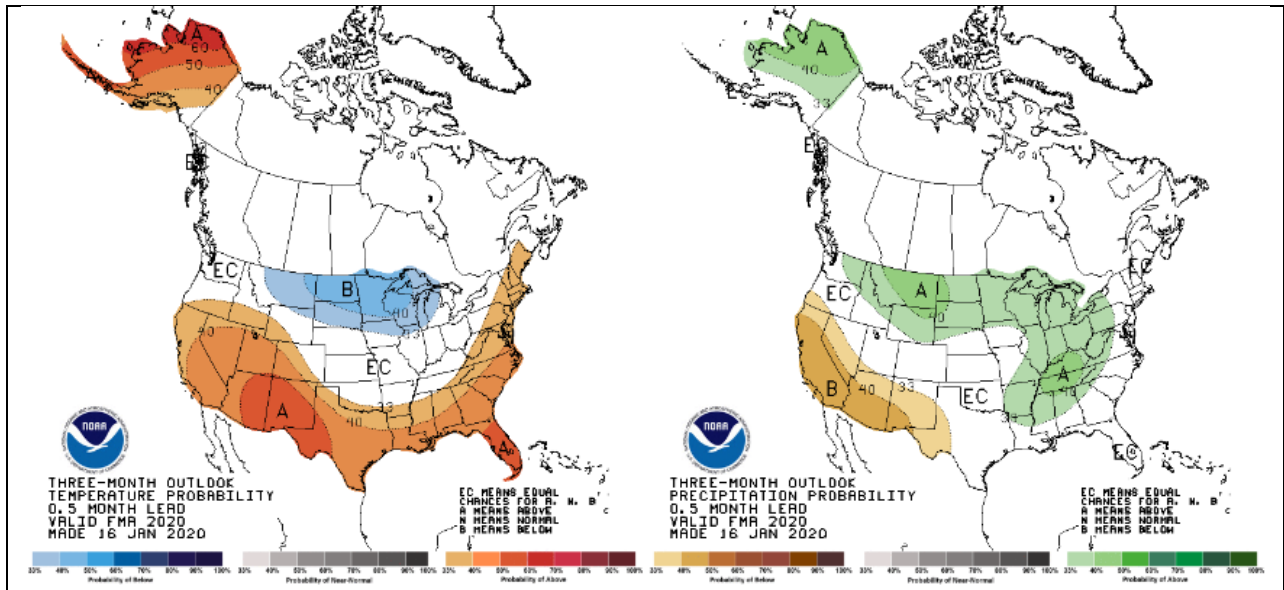


Figure 13. CPC February-March-April 2020 temperature and precipitation outlooks.

During the May-June-July 2020 forecast period (Figure 14), there are equal chances for temperatures in the upper Basin; however, long-term outlooks begin transitioning to increased chances for warmer-than-normal temperatures in later periods (Figures 15 and 16). With regard to precipitation, there are equal chances for above-normal, normal, and below-normal precipitation across the Basin through the end of October. During November-December 2020-January 2021, there is an increased chance for above-normal precipitation in the western half of the upper Basin. As previously noted, though, there is limited confidence in climate outlooks beyond the winter and early spring, therefore, the climate outlooks will likely change as the calendar progresses.

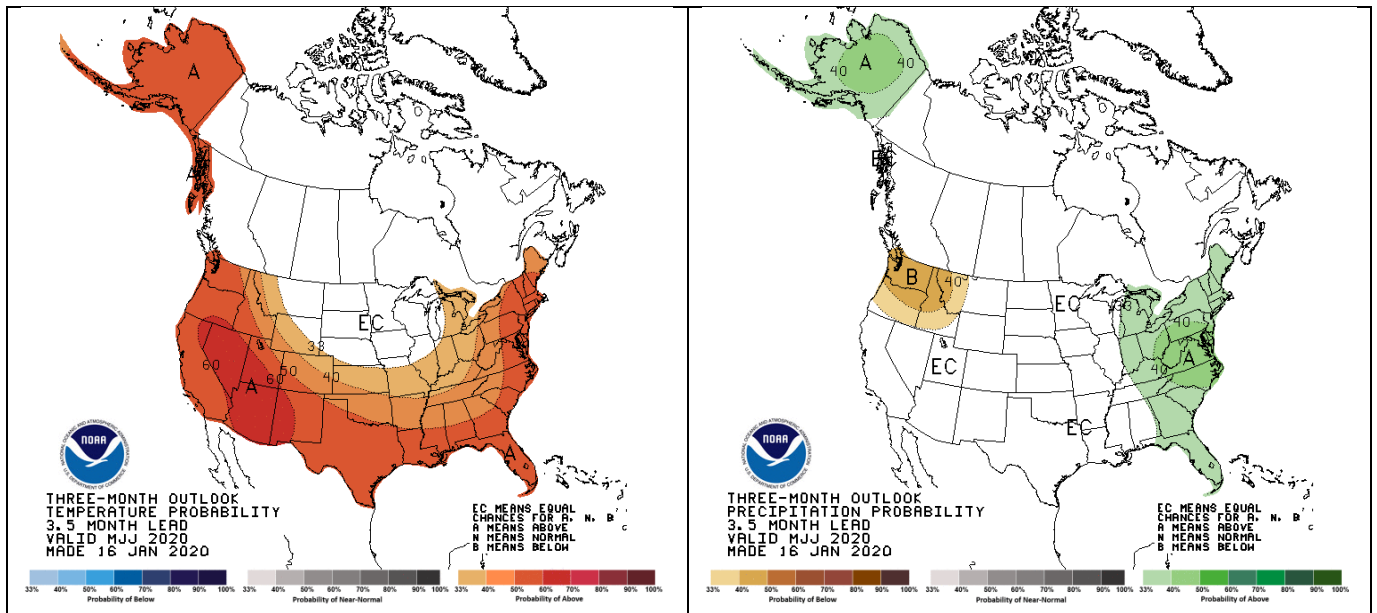


Figure 14. CPC May-June-July 2020 temperature and precipitation outlooks.

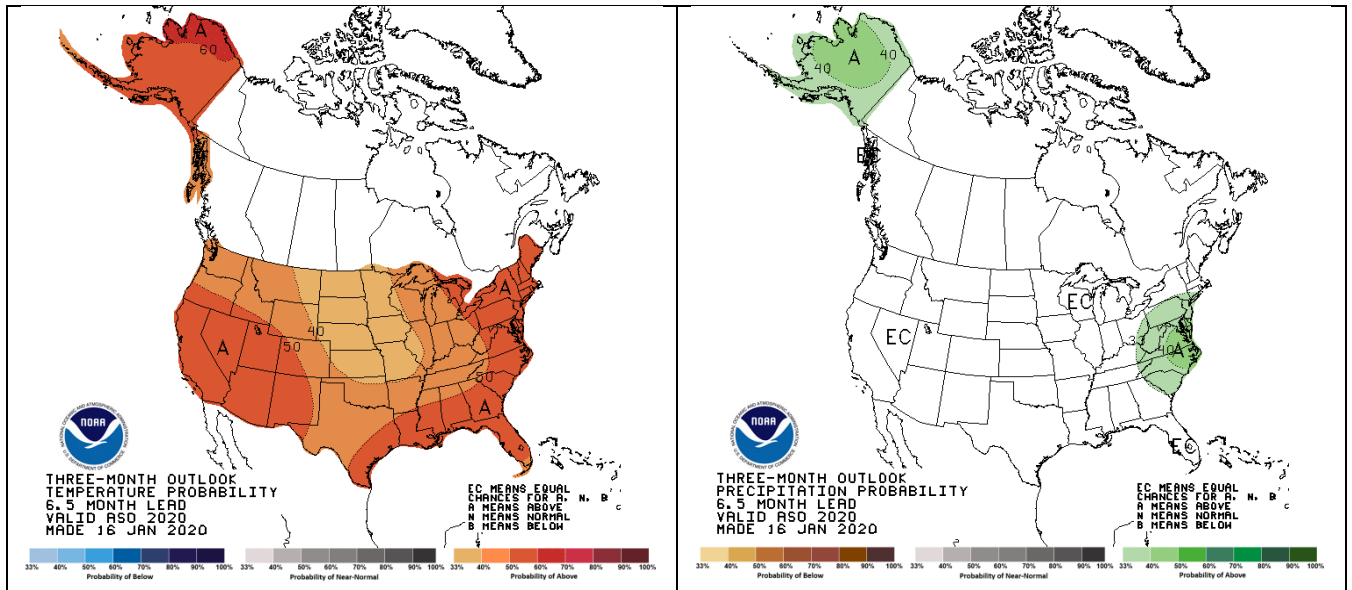


Figure 15. August-September-October 2020 temperature and precipitation outlooks.

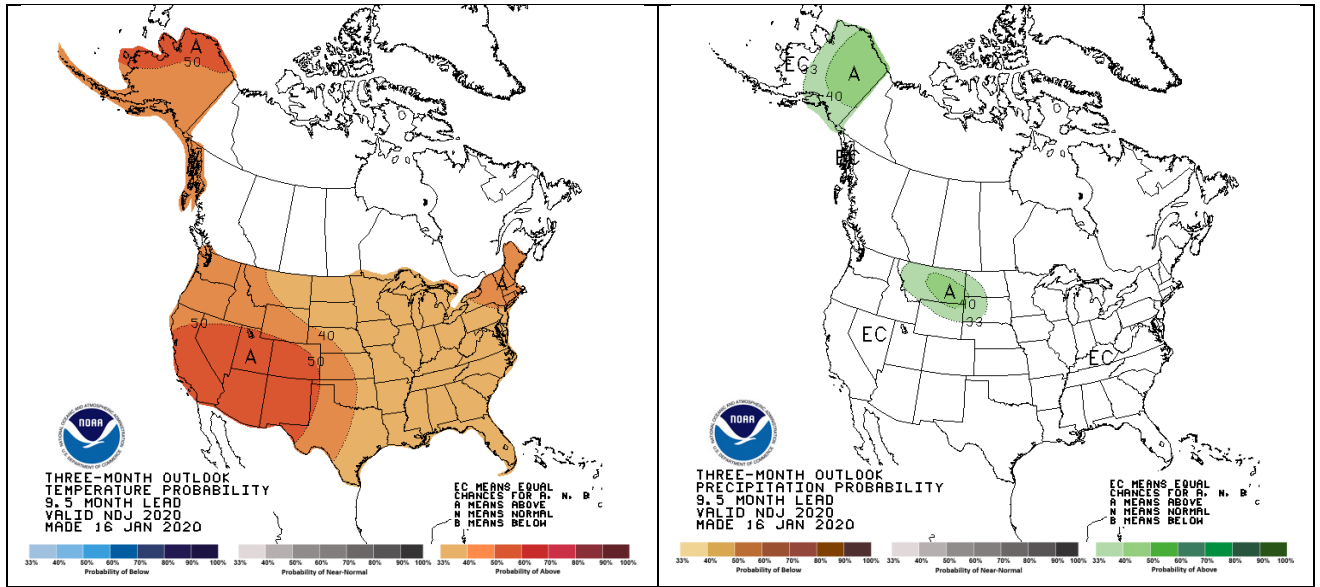


Figure 16. November-December 2020-January 2021 temperature and precipitation outlooks.

## **Summary**

Given the very wet soil moisture conditions, high streamflow, the observed plains snowpack and outlooks, we expect runoff to be about 2 times the normal amount in February. March-April runoff potential is very high due to the very wet soil moisture conditions, but it will depend greatly on the accumulation of plains snowpack over the next few months. During May, June and July, Fort Peck and Garrison runoff is forecast to be slightly above average; however, the lower four reaches could continue to produce well above-average runoff in the spring and summer months.

In summary, the 2020 calendar year runoff forecast is **36.3 MAF (141% of average)**. Compared to all observed runoff years, the forecasted runoff volume ranks as the 9<sup>th</sup> highest annual runoff volume in 122 years of record-keeping.

## Water Supply Forecasts

USDA NRCS National Water & Climate Center

\* - DATA CURRENT AS OF: February 06, 2020 10:18:28 AM

- Based on February 01, 2020 forecast values

### PRELIMINARY MISSOURI RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
Hebgen Lake Inflow (2)	APR-JUL	335	91	415	365	305	255	370
	APR-SEP	430	91	530	470	390	330	470

### PRELIMINARY YELLOWSTONE RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
West Rosebud Ck nr Roscoe (2)	APR-JUL	59	100	68	63	55	49	59
	APR-SEP	74	100	87	79	69	62	74
Wind R ab Bull Lake Ck	APR-JUL	455	100	610	520	390	300	455
	APR-SEP	485	99	655	555	415	315	490
Bull Lake Ck nr Lenore (2)	APR-JUL	125	90	159	139	112	92	139
	APR-SEP	152	90	192	168	136	112	169
Boysen Reservoir Inflow (2)	APR-JUL	555	91	920	700	410	194	610
	APR-SEP	590	89	970	740	435	205	665
Greybull R at Meeteetse	APR-JUL	129	98	186	152	107	73	131
	APR-SEP	175	99	240	200	148	109	177
Shell Ck nr Shell	APR-JUL	58	105	73	64	52	43	55
	APR-SEP	69	105	86	76	62	52	66
Bighorn R at Kane (2)	APR-JUL	795	95	1300	1000	590	290	840
	APR-SEP	830	92	1370	1050	615	290	905
NF Shoshone R at Wapiti	APR-JUL	495	108	600	535	450	385	460
	APR-SEP	550	107	665	595	500	430	515
SF Shoshone R nr Valley	APR-JUL	215	100	275	240	192	157	215
	APR-SEP	250	102	315	275	220	180	245
Buffalo Bill Reservoir Inflow	APR-JUL	705	104	895	780	625	510	675
	APR-SEP	785	105	990	865	700	575	745
Bighorn R nr St. Xavier (2)	APR-JUL	1350	98	1970	1600	1090	725	1380
	APR-SEP	1400	96	2090	1680	1130	720	1460
Tongue R nr Dayton (2)	APR-JUL	82	95	111	93	70	53	86
	APR-SEP	94	96	125	106	81	62	98
Tongue River Reservoir Inflow (2)	APR-JUL	175	91	280	215	133	72	193
	APR-SEP	198	92	305	240	153	89	215
NF Powder R nr Hazelton	APR-JUL	10.9	120	14.2	12.2	9.6	7.6	9.1
	APR-SEP	11.7	118	15.1	13.1	10.3	8.3	9.9
Powder R at Moorhead	APR-JUL	205	116	340	260	151	71	177
	APR-SEP	225	115	360	280	170	90	196

### PRELIMINARY RAPID VALLEY UNIT FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
Deerfield Reservoir Inflow (2)	MAR-JUL	7.0	113	10.8	8.5	5.5	3.3	6.2
	APR-JUL	5.8	112	9.2	7.2	4.4	2.4	5.2
Pactola Reservoir Inflow (2)	MAR-JUL	27	108	43	33	20	10.8	25

APR-JUL 23 105 39 30 17.3 8.3 22

PRELIMINARY PLATTE RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
North Platte R nr Northgate (2)	APR-JUL	210	93	340	260	156	79	225
	APR-SEP	230	92	370	285	173	89	250
Encampment R nr Encampment (2)	APR-JUL	146	113	205	170	121	86	129
	APR-SEP	155	112	215	180	130	93	138
Rock Ck ab King Canyon Cnl nr Arlington	APR-JUL	59	120	77	66	52	41	49
	APR-SEP	62	119	81	70	54	43	52
Seminole Reservoir Inflow (2)	APR-JUL	805	113	1190	960	650	420	715
	APR-SEP	865	112	1270	1030	700	465	770
Sweetwater R nr Alcova	APR-JUL	28	47	64	42	13.8	1.00	59
	APR-SEP	31	48	69	46	15.5	1.00	64
La Prele Ck nr Douglas	APR-JUL	24	121	41	31	16.4	5.8	19.9
	APR-SEP	24	121	42	31	16.7	5.9	19.9
North Platte R bl Glendo Reservoir (2)	APR-JUL	815	99	1350	1030	600	285	820
	APR-SEP	850	100	1400	1070	630	300	850
North Platte R bl Guernsey Reservoir (2)	APR-JUL	815	99	1370	1040	595	265	820
	APR-SEP	850	100	1420	1080	620	285	850
Laramie R and Pioneer Cnl nr Woods Lg (2)	APR-JUL	108	94	167	132	84	49	115
	APR-SEP	118	94	181	144	92	55	126
Little Laramie R nr Filmore	APR-JUL	66	129	88	75	57	44	51
	APR-SEP	71	129	94	80	62	48	55

Max (10%), 30%, 50%, 70% and Min (90%) chance that actual volume will exceed forecast.  
 Averages are for the 1981-2010 period.  
 All volumes are in thousands of acre-feet.

footnotes:

- 1) Max and Min are 5% and 95% chance that actual volume will exceed forecast
- 2) streamflow is adjusted for upstream storage
- 3) median value used in place of average

**Upper Missouri River Basin  
March 2020 Calendar Year Runoff Forecast  
March 5, 2020**

**U.S. Army Corps of Engineers, Northwestern Division  
Missouri River Basin Water Management  
Omaha, NE**

**Calendar Year Runoff Forecast**

**Explanation and Purpose of Forecast**

The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. The Calendar Year Runoff Forecast is available at <http://www.nwd-mr.usace.army.mil/rcc/reports/runoff.pdf>. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows in million acre-feet (MAF) from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri Basin above Sioux City (upper Basin). The Calendar Year Runoff Forecast is used in the Monthly Study simulation model to plan future system regulation in order to meet the authorized project purposes throughout the calendar year.

**Observed Runoff**

February 2020 runoff was 2.5 MAF, over two times the average February runoff volume, continuing the high runoff trend from 2019. The above-average runoff was a direct result of warmer-than-normal temperatures in the upper Basin, resulting in some snowmelt runoff in the upper Basin.

**2020 Calendar Year Forecast Synopsis**

The 2020 calendar year runoff forecast for the upper Missouri Basin above Sioux City, IA is **36.9 MAF, 143% of average**. The 2020 calendar year runoff forecast for the Missouri Basin above Gavins Point is **29.8 MAF, 128% of average**.

Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next 10 months, expected inflow could range from the 50.7 MAF upper basic forecast to the 24.6 MAF lower basic forecast. The upper and lower basic forecasts are used in long-term regulation planning models to “bracket” the range of expected runoff given much wetter or drier conditions, respectively. Given that ten months are being forecast for this March 1 forecast (2 month observed/10 months forecast), the range of possible wetter-than-expected (upper basic)

and drier-than-expected (lower basic) conditions is very large, and is attributed to all six reaches for the remaining 10 months of the year. The result is a range or “bracket” for each reach, and thus, for the total runoff forecast.

## Current Conditions

### Drought Analysis

The National Drought Mitigation Center’s drought monitor for February 25, 2020 is shown in **Figure 1**. The drought monitor is available at <http://droughtmonitor.unl.edu/>. The U.S. Drought Monitor shows only Abnormally Dry (D0) conditions in an area of western Montana. The Seasonal Drought Outlook in **Figure 2**, which extends through the end of May, indicates no drought development within the Missouri River Basin during the outlook period.

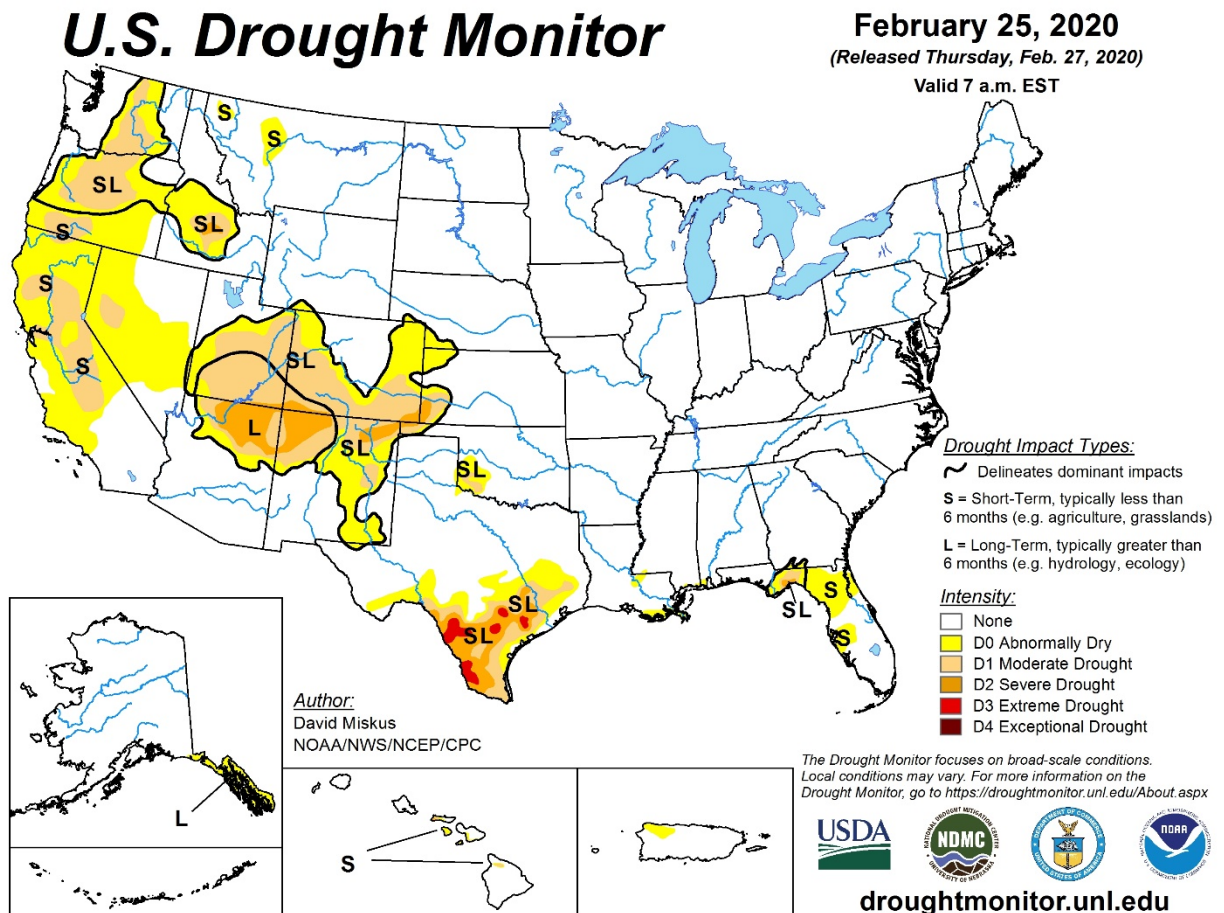


Figure 1. National Drought Mitigation Center U.S. Drought Monitor for February 25, 2020.

# U.S. Seasonal Drought Outlook Drought Tendency During the Valid Period

Valid for February 20 - May 31, 2020  
Released February 20

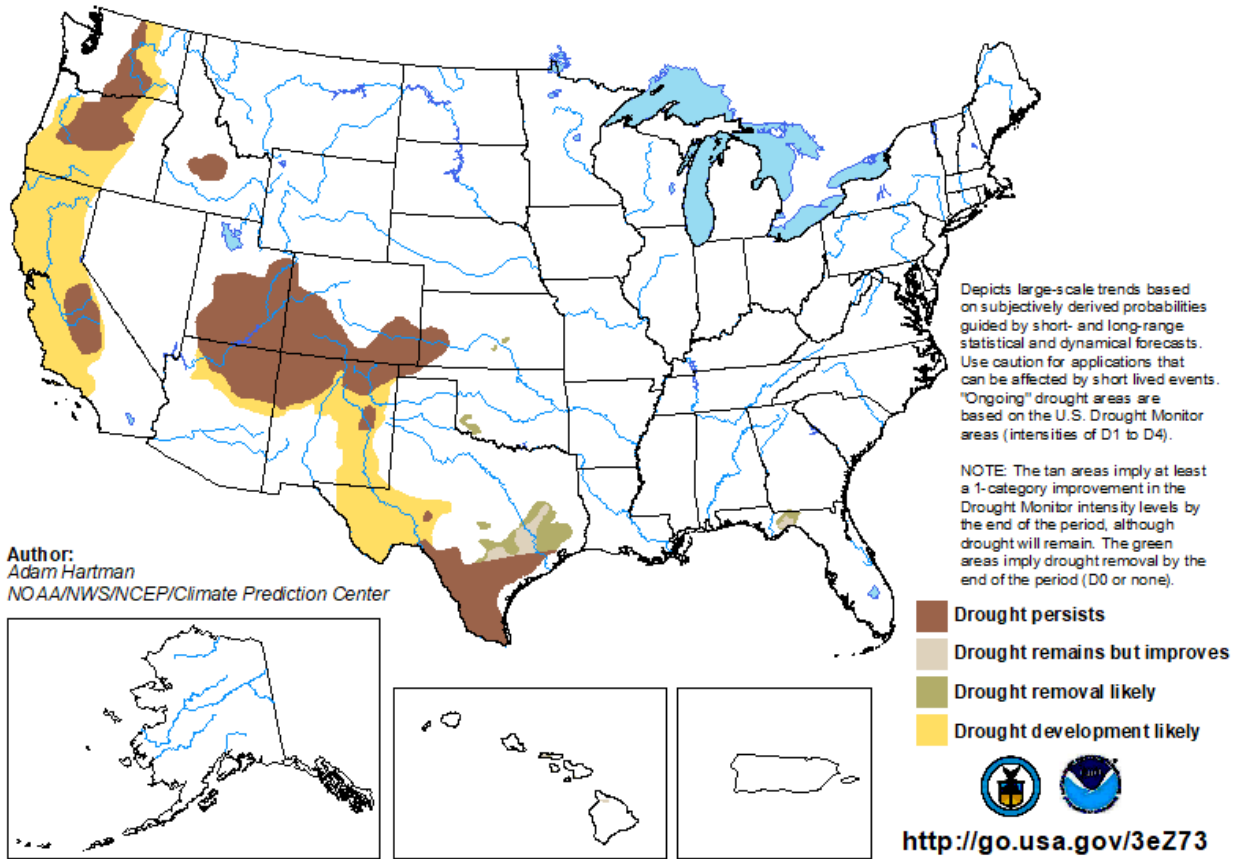


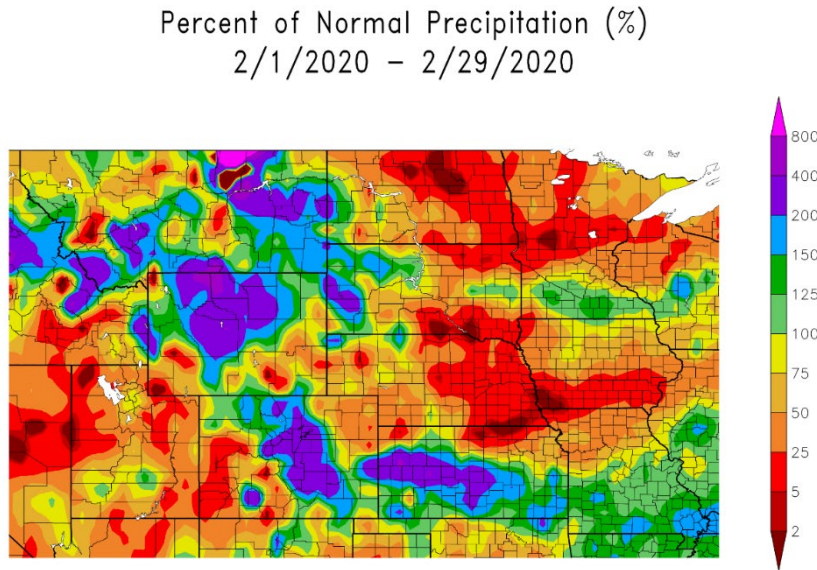
Figure 2. National Drought Mitigation Center U.S. Drought Seasonal Drought Outlook.

## Precipitation

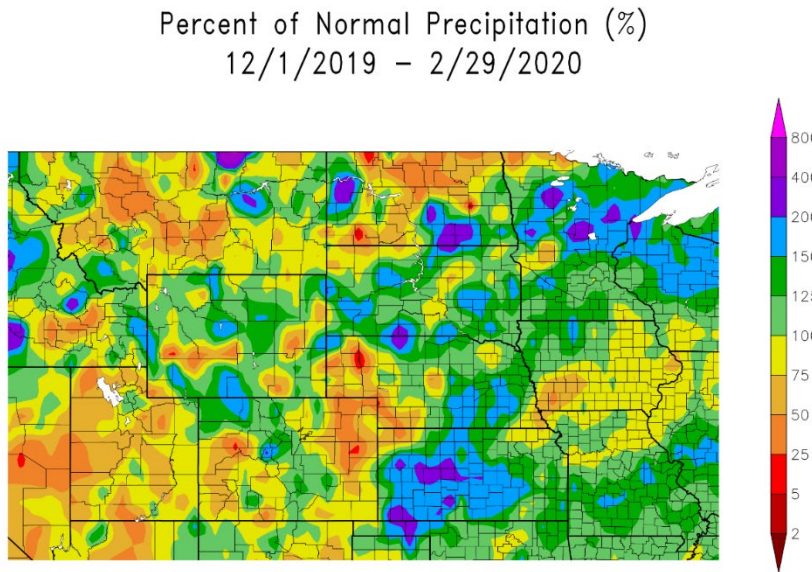
Monthly precipitation accumulations are shown using High Plains Regional Climate Center images available at <http://www.hprcc.unl.edu/>. The February precipitation accumulations are shown in **Figure 3** as a percent of normal precipitation. February precipitation was over 200 percent of normal in areas of Montana and Wyoming. The above-normal precipitation in Wyoming led to a rapid increase in mountain snowpack in the upper Missouri and Yellowstone Basins. The mountain snowpack increased from about 98 percent of average on February 1 to about 104 percent of average in the Fort Peck reach and 105 percent of average in the Garrison reach on March 1. In contract, precipitation was below normal in the plains, and as low as 25 percent of normal in eastern North Dakota, eastern South Dakota, eastern Nebraska, southwestern Iowa, and northeastern Kansas.

Precipitation as a percent of normal for the December-January-February period (**Figure 4**) varies throughout the Missouri Basin. Precipitation has been below normal in much of Montana, and above normal in southwestern Montana and throughout most of Wyoming. With the exception

of northern North Dakota, which received below-normal precipitation, precipitation has been above normal throughout the plains areas in southeastern North Dakota, South Dakota, northwestern Iowa, Nebraska, Kansas, and central and southern Missouri.



**Figure 3. February 2020 Percent of Normal Precipitation.** Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.



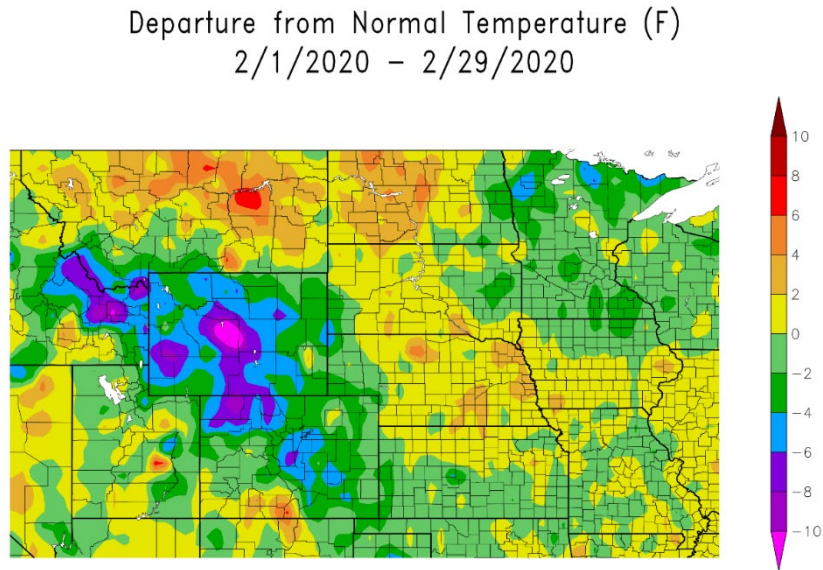
**Figure 4. December 2019-January-February 2020 Percent of Normal Precipitation.** Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

## Temperature

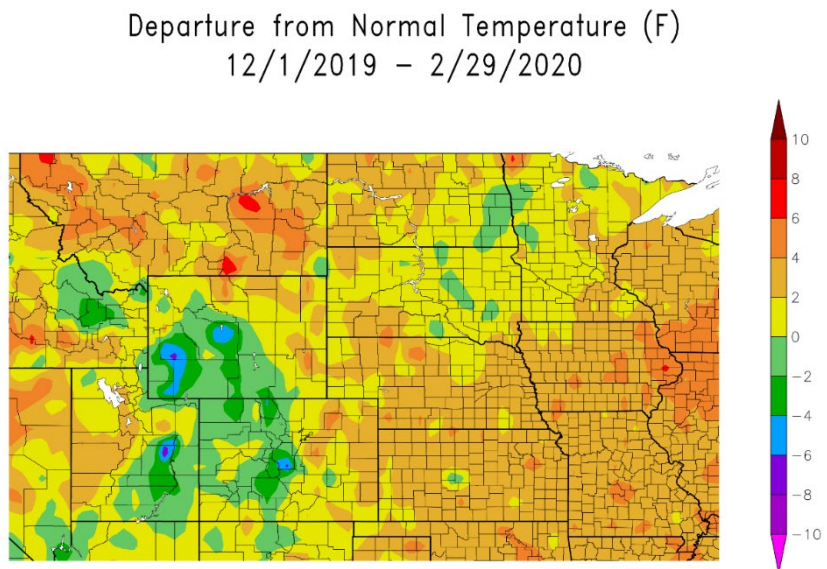
February temperature departures in degrees Fahrenheit (deg F) in **Figure 5** were 2 to 6 deg F above normal in much of Montana and 2 to 4 deg F above normal over central and western North Dakota. February temperatures were near to slightly above normal in South Dakota, Nebraska

Kansas and Missouri. In contrast, temperatures were 2 to 8 deg F below normal in the Rocky Mountains, including much of Wyoming and southwestern Montana, enabling the rapid accumulation of mountain snow during the middle of February.

December-January-February temperature departures are shown in **Figure 6**. The three-month temperature pattern shows above-normal temperatures throughout most of the Missouri Basin, in particular the plains, and an area of below-normal temperatures in central Wyoming.



**Figure 5. February 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.**

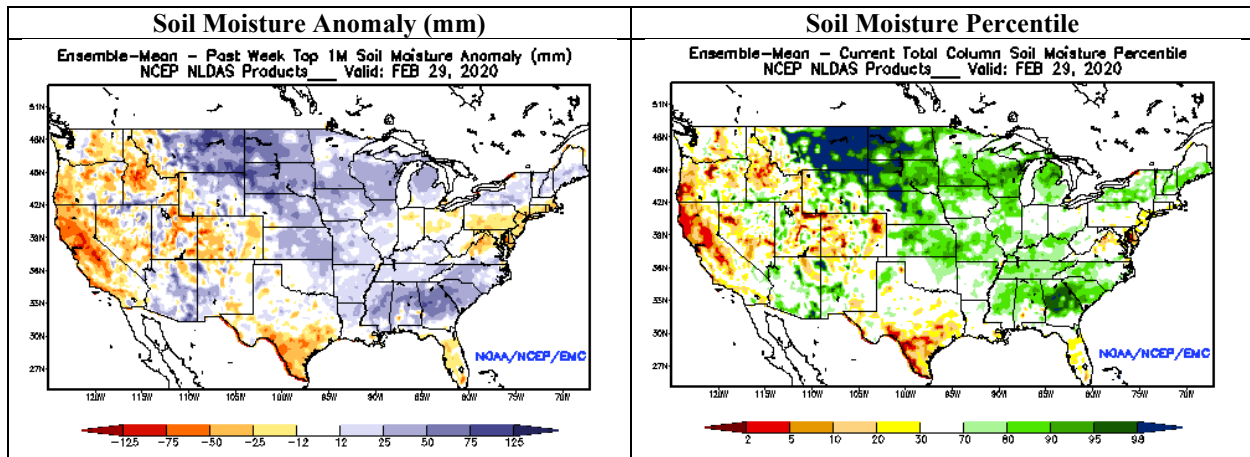


**Figure 6. December 2019-January-February 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.**

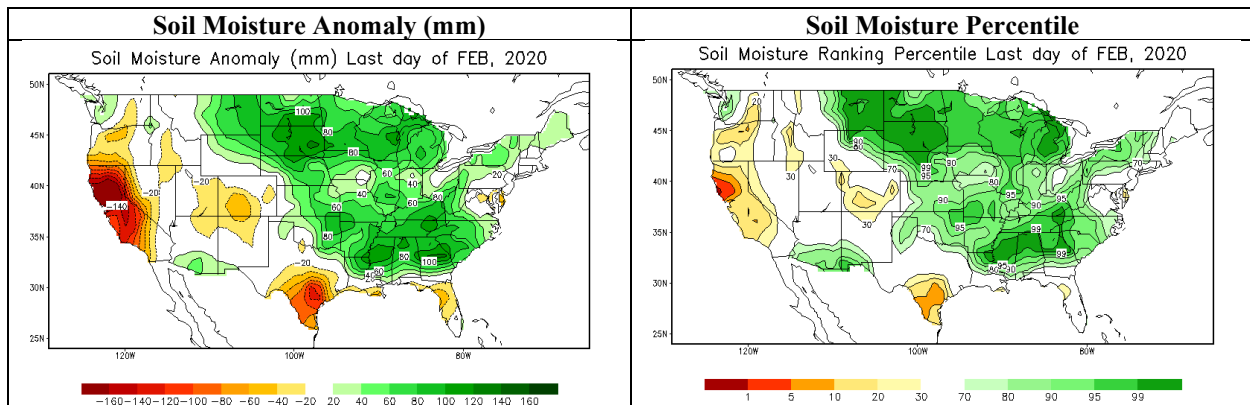
## Soil Moisture

Soil moisture is factored into the forecast as an indicator of wet or dry hydrologic basin conditions. Typically when soil moisture conditions are wet or greater than normal, rainfall and snowmelt runoff is greater than when soil moisture is dry or less than normal. Not only is soil moisture a physical parameter that influences runoff, it can be used as an indicator of future runoff.

Soil moisture at the end of February is much wetter than normal as shown in the soil moisture estimates from the NOAA National Land Data Assimilation System (NLDAS) and the Climate Prediction Center (CPC) in **Figure 7** and **Figure 8**, respectively. The soil moisture anomalies and the soil moisture percentiles are shown in these figures. Both figures indicate that end of February soil moisture anomalies in the Missouri River Basin are well-above normal. The soil moisture percentiles rank very high; above the 98<sup>th</sup> and 99<sup>th</sup> percentiles based on both the NLDAS and CPC percentile maps. The 99<sup>th</sup> percentile indicates that soil moisture is at its wettest for this time of year, compared to long-term soil moisture simulations. Generally, when soil moisture is high during the winter, the potential for high March-April runoff is **much** higher.



**Figure 7.** NOAA NLDAS Soil Moisture Anomaly (mm) and Soil Moisture Percentile. Source: NOAA NLDAS Drought Monitor Soil Moisture. <http://www.emc.ncep.noaa.gov/mmb/nldas/drought/>



**Figure 8.** NOAA CPC Soil Moisture Anomaly (mm) and Soil Moisture Percentile. Source: NOAA NLDAS Drought Monitor Soil Moisture. [https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

## Plains Snowpack

Plains snowpack is an important parameter that influences the volume of runoff occurring in the basin during the months of March and April. A common misperception is that the March-April runoff is a result of plains snowmelt only. Historically, about 25% of annual runoff occurs in March and April, during the time when plains snow is melting, due to both melting snowpack and rainfall runoff. Runoff occurs in March and April whether or not there is any plains snow to melt. Determining exact rainfall amounts and locations are nearly impossible to predict more than a week in advance. Thus, the March-April runoff forecast is formulated based on existing plains snowpack and existing basin conditions and hydrologic forecasts, which for this year primarily includes long-term precipitation outlooks. At this time of year, plains snowpack provides some indication of March-April runoff; however, as the snowpack reaches its ultimate peak accumulation, better forecasts of future runoff can be made.

The National Weather Service's National Operational Hydrologic Remote Sensing Center (NOHRSC), modeled snow assessment from March 2, shown in **Figure 9**, indicates the remaining plains snowpack is confined to eastern South Dakota and eastern North Dakota. SWE in these areas generally ranges from 2 to 3 inches with some pockets of 4 inches in the upper Big Sioux basin of South Dakota and the James River basin in North Dakota. At this time no consistent plains snow cover is present west of the Missouri River and south of I-90 in South Dakota. In comparison to 2020, the plains snowpack on March 2, 2019 was widespread throughout the entire Missouri Basin, and much heavier with SWE amounts ranging from 1 to 3 inches over a very large area in 2019, and from 3 to 5 inches in the central and eastern Dakotas. The deepest amounts of SWE in 2019 exceeded 6 inches in the Big Sioux and James basins.

During the week of March 2, 2020 the Corps collected additional SWE measurements from its cooperative observers and from an Omaha District team measuring SWE in eastern South Dakota and the James Basin in North Dakota. This information will be shared with the NWS NOHRSC office, which produces and validates the NOHRSC snow maps shown in **Figure 9**.

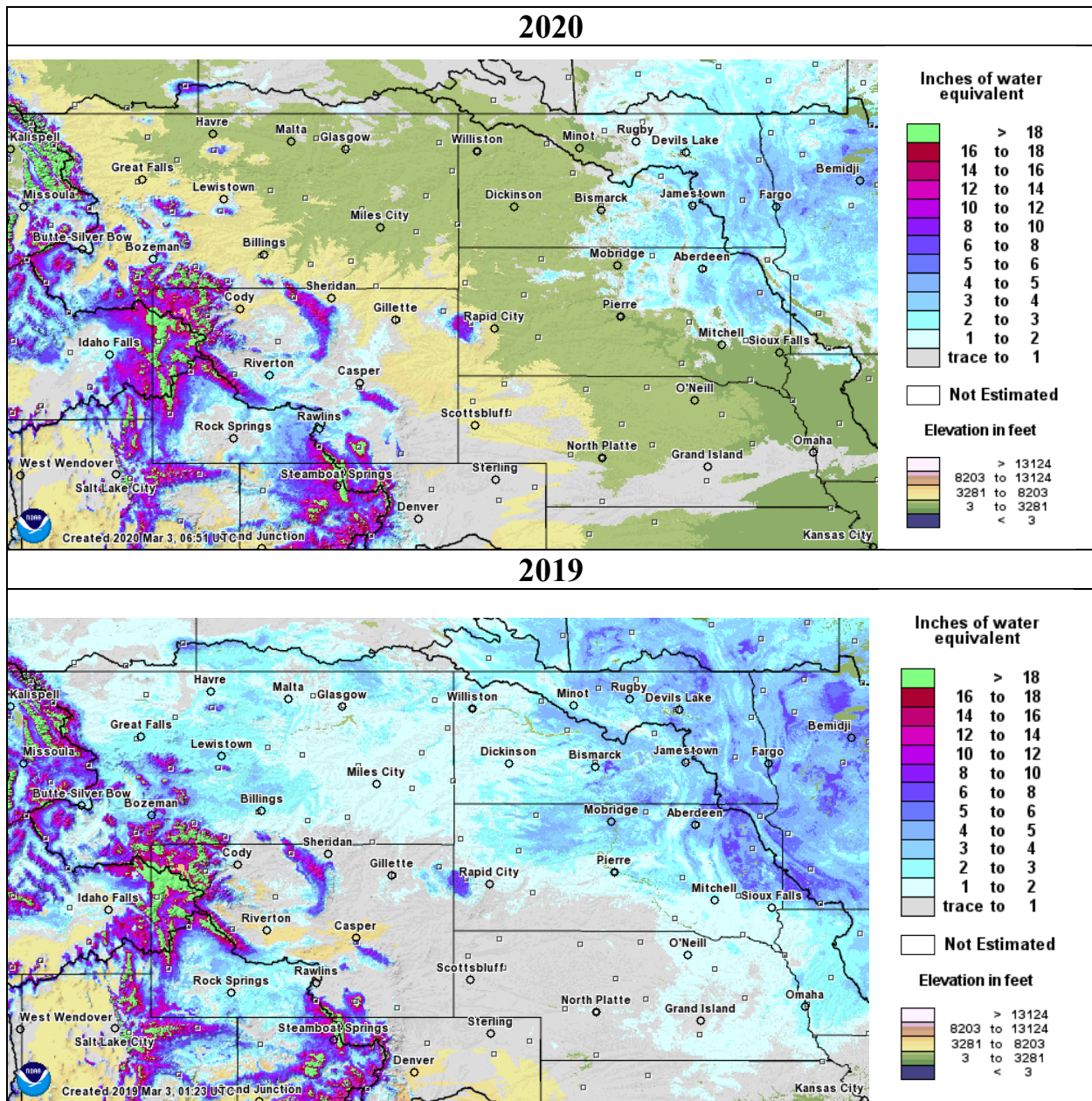
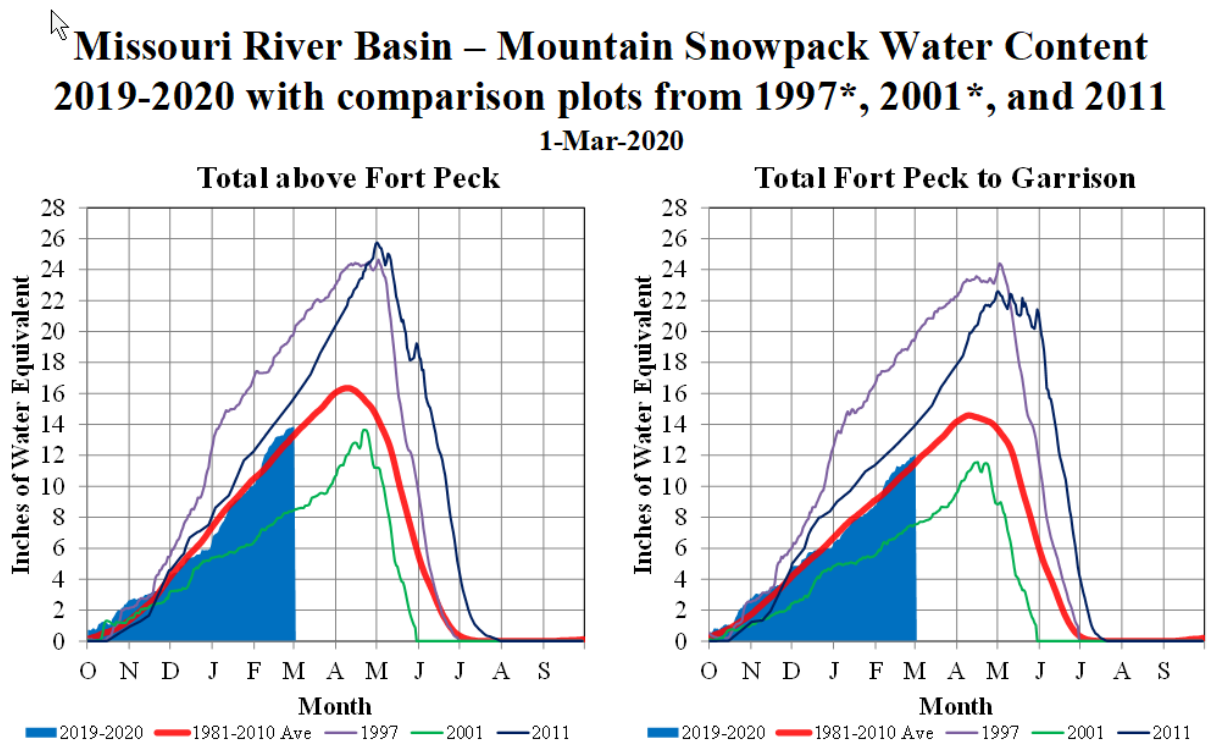


Figure 9. March 2, 2020 NOHRSC modeled plains snow water equivalent (top) and March 2, 2019 snow water equivalent (bottom). Source: NOAA National Operational Hydrologic Remote Sensing Center. <http://www.nohrsc.nws.gov/interactive/html/map.html>

## Mountain Snowpack

Mountain snowpack is the primary factor used to predict May, June, and July runoff volumes in the Fort Peck and Fort Peck to Garrison mainstem reservoir reaches. As the date a peak snowpack accumulation, usually around April 15, approaches, the correlation between the level of mountain snowpack and May, June and July runoff increases; therefore, mountain snowpack becomes a better predictor of Fort Peck and Garrison reach runoff.

**Figure 10** includes time series plots of the mountain SWE beginning on October 1, 2019 based on the NRCS SNOTEL data for the headwater basin above Fort Peck and the incremental basin from Fort Peck to Garrison. The current average SWE values (shaded blue area) are plotted against the 1981-2010 basin average SWE (bold red line), a recent low SWE year in 2001 (green line), and two historic high SWE years occurring in 1997 (purple) and 2011 (dark blue).



\*Generally considered the high and low year of the last 25-year period, respectively

Provisional data. Subject to revision.

**Figure 10. Mountain snowpack water content on February 2, 2020 compared to normal and historic conditions. Corps of Engineers - Missouri River Basin Water Management.**

Mountain snowpack as of March 1 was 104% above Fort Peck and 105% from Fort Peck to Garrison. As a result of the increase in mountain snowpack from February 1 to March 1, the May-June-July runoff forecast for the Fort Peck and Garrison reaches has been increased slightly to account for the additional moisture present in the mountains.

## **Climate Outlook**

MRBWM participates in the monthly North Central U.S. Climate/Drought Outlook Webinar coordinated through NOAA, the regional climate centers, and the American Association of State Climatologists (AASC). These webinars provide updates on near-term climate outlooks and impacts including the ENSO climate pattern and its implications on winter temperature and precipitation patterns in the Missouri Basin.

### **ENSO (El Niño Southern Oscillation)**

The latest ENSO Outlook indicates that neutral conditions are present, and will likely remain neutral during the Northern Hemisphere spring 2020 and summer 2020. During ENSO-neutral conditions there are no strong climate indicators to provide much certainty on the precipitation and temperature forecasts beyond the winter and early spring seasons.

### **Temperature and Precipitation Outlooks**

The NOAA Climate Prediction Center (CPC) outlooks provide the forecasted probability (or chance) of occurrence of future weather conditions during periods ranging from 1 to 12 months into the future. The CPC outlooks are available at <http://www.cpc.ncep.noaa.gov/>.

The CPC temperature outlook for the forecast period from March 12-19 is shown in **Figure 11**. The outlook is indicating a significant increase in the chances for above-normal temperatures throughout the entire Missouri Basin, continuing with increased chances for above-normal temperatures in the plains through the end of March (**Figure 12**). With regard to precipitation, there is a slight increase in precipitation chances from March 12-19, followed by equal chances through the end of March (**Figure 12**).

During the April-May-June period (**Figure 13**), there is a slight increase in chances for below normal temperatures in the upper Basin plains, but equal chances in all other areas. With regard to precipitation there is a slight increase in precipitation chances in the Missouri Basin.

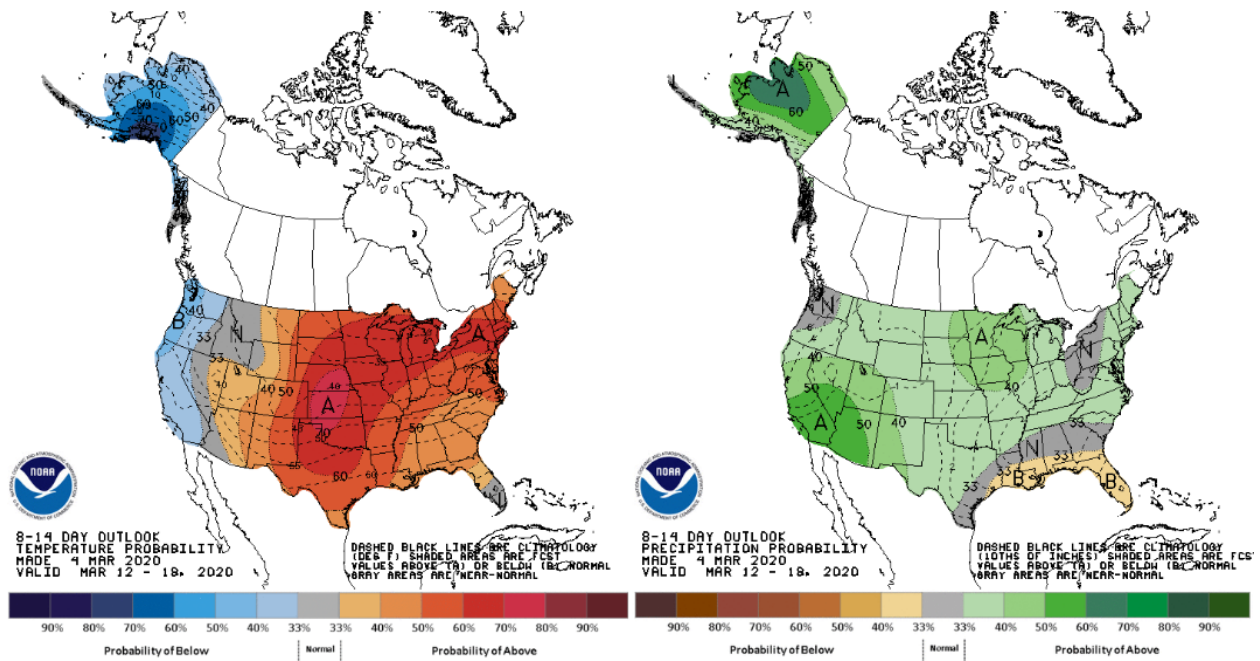


Figure 11. CPC 8-14 Day temperature and precipitation outlooks through March 19, 2020.

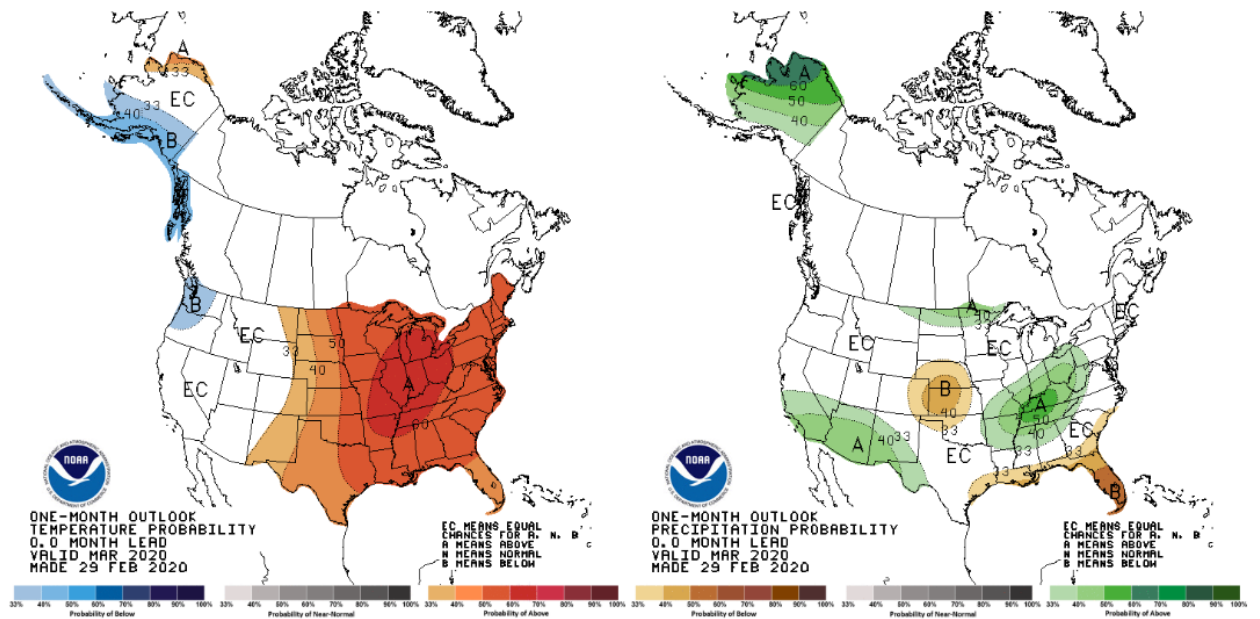


Figure 12. CPC March 2020 temperature and precipitation outlooks.

Three-month temperature and precipitation outlooks for the three-month periods from April through December 2020 are shown below in **Figures 13-15**. During the April-May-June 2020 (**Figure 13**), the CPC indicates equal chances for above-normal, normal, and below-normal temperatures throughout most of the Missouri Basin. With regard to precipitation, there are equal chances for above-normal, normal, and below-normal precipitation in most of Montana, Wyoming, and Kansas, while there are increased chances for above-normal precipitation

extending from eastern Montana and eastern Wyoming into the Dakotas, Nebraska, Iowa, Kansas, and Missouri.

During the July-August-September 2020 forecast period (**Figure 14**), there are equal chances for above-normal, normal, and below-normal temperatures throughout most of the Missouri Basin plains; however, there is an increased chance for above-normal temperatures in Montana, Wyoming, and Colorado. With regard to precipitation during the July-August-September period, there are equal chances for precipitation in the plains, while there is an increased chance for below-normal precipitation in Montana and much of Wyoming.

Finally during the October-November-December 2020 period, there is an increased chance for above-normal precipitation all of the Missouri Basin (**Figure 15**). With regard to precipitation, there is a slight increase in chances for above-normal precipitation in Montana, Wyoming, and the western Dakotas, while there are equal chances in all other areas of the Missouri Basin. As previously noted, though, there is limited confidence in climate outlooks beyond the winter and early spring seasons; therefore, the climate outlooks will likely change as the calendar progresses.

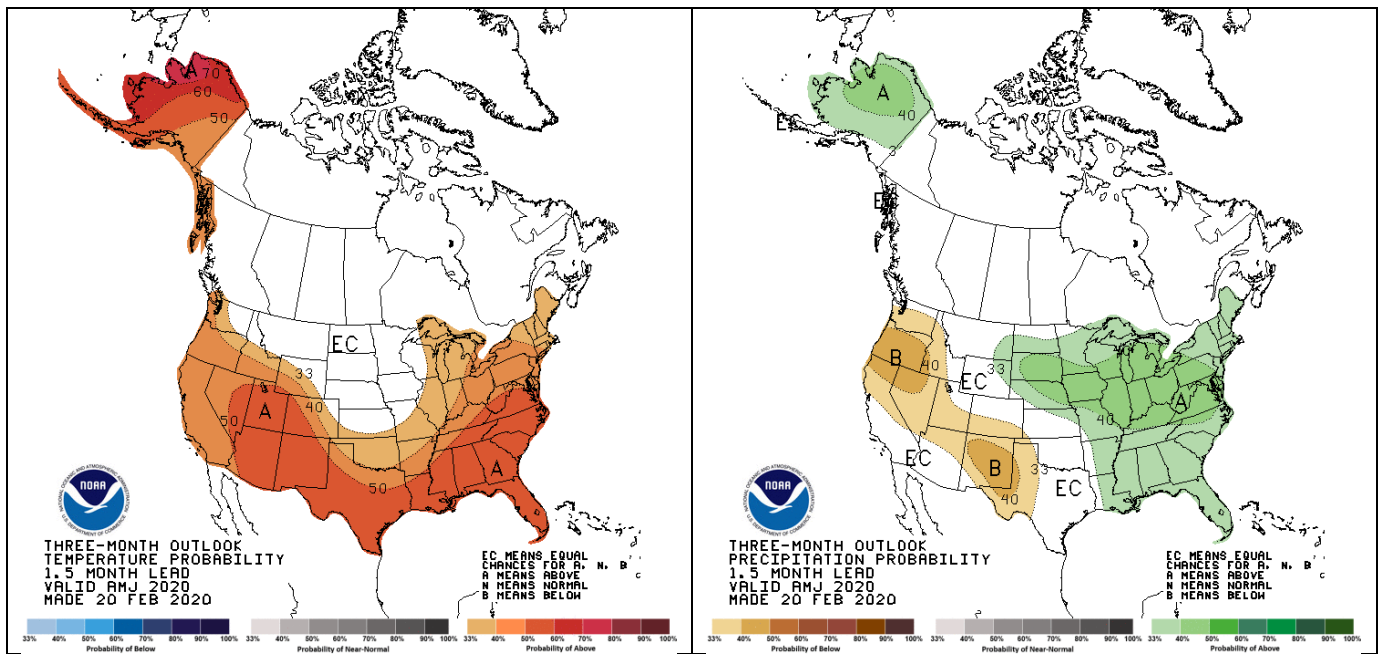


Figure 13. CPC April-May-June 2020 temperature and precipitation outlooks.

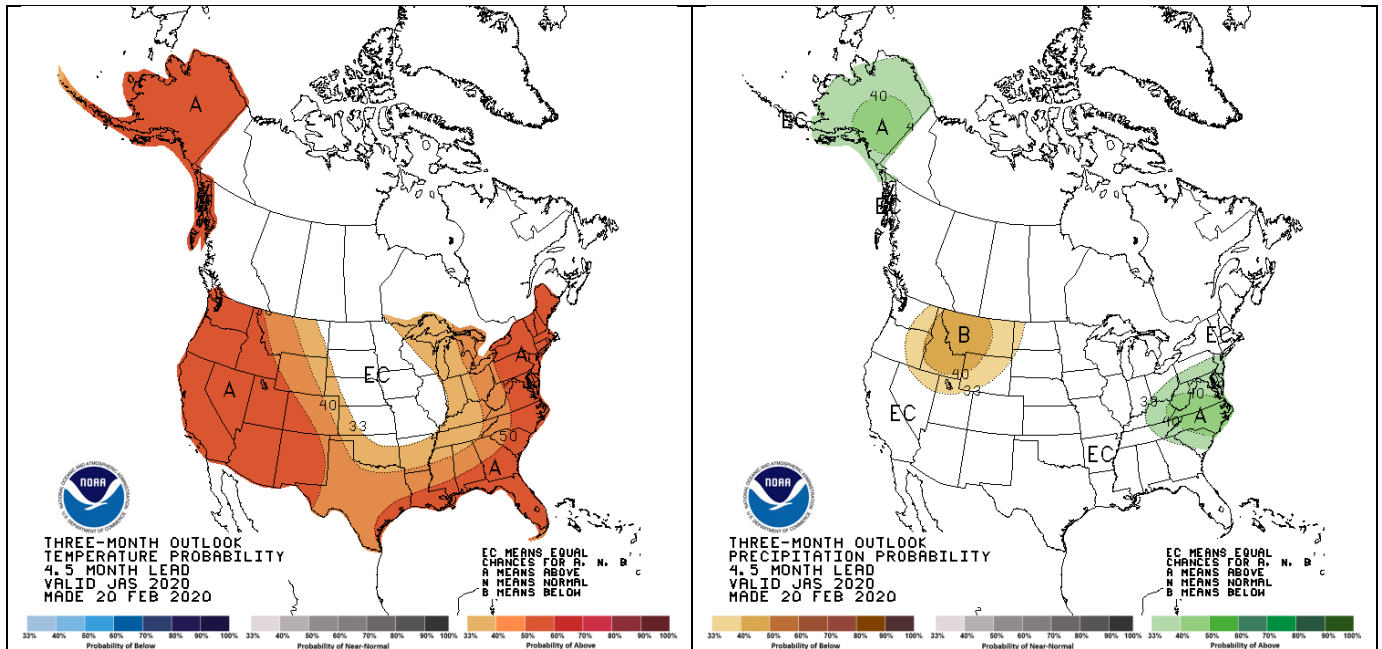


Figure 14. CPC July-August-September 2020 temperature and precipitation outlooks.

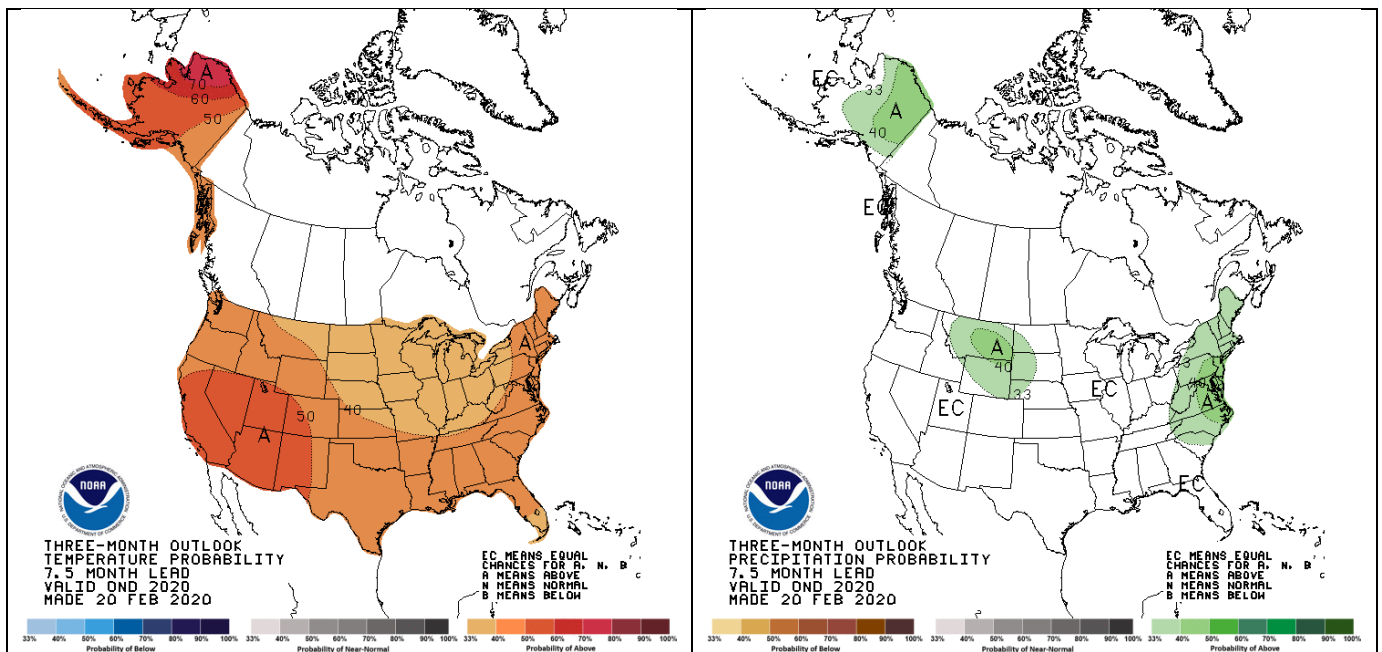


Figure 15. October-November-December 2020 temperature and precipitation outlooks.

## Summary

In summary, the 2020 calendar year runoff forecast is **36.9 MAF (143% of average)**. If realized, this runoff volume would rank as the 9th highest annual runoff volume in 122 years of record-keeping.

## Water Supply Forecasts

USDA NRCS National Water & Climate Center

\* - DATA CURRENT AS OF: March 05, 2020 11:54:36 AM

- Based on March 01, 2020 forecast values

### PRELIMINARY MISSOURI RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
Lake Sherburne Inflow (2)	APR-JUL	104	107	124	112	95	83	97
	APR-SEP	119	106	142	128	110	96	112
St. Mary R at Intl Boundary (2)	APR-JUL	470	108	585	515	425	360	435
	APR-SEP	540	107	665	590	490	420	505
Lima Reservoir Inflow (2)	APR-JUL	71	95	105	85	57	37	75
	APR-SEP	77	96	115	92	62	39	80
Clark Canyon Reservoir Inflow (2)	APR-JUL	96	95	153	119	73	39	101
	APR-SEP	112	93	179	139	85	45	120
Jefferson R nr Three Forks (2)	APR-JUL	740	100	1110	890	590	365	740
	APR-SEP	795	99	1210	965	625	375	800
Hebgen Lake Inflow (2)	APR-JUL	335	91	410	365	305	260	370
	APR-SEP	430	91	520	465	395	340	470
Ennis Lake Inflow (2)	APR-JUL	560	90	705	620	500	415	625
	APR-SEP	705	91	880	775	635	530	775
Missouri R at Toston (2)	APR-JUL	1800	101	2440	2060	1540	1160	1790
	APR-SEP	2060	100	2800	2360	1760	1320	2070
Smith R bl Eagle Ck (2)	APR-JUL	117	110	173	140	94	61	106
	APR-SEP	128	110	194	155	101	62	116
Gibson Reservoir Inflow (2)	APR-JUL	415	105	515	455	375	315	395
	APR-SEP	455	103	565	500	410	345	440
Marias R nr Shelby (2)	APR-JUL	360	100	515	420	300	205	360
	APR-SEP	370	99	530	435	305	210	375

### PRELIMINARY YELLOWSTONE RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
West Rosebud Ck nr Roscoe (2)	APR-JUL	61	103	71	65	57	51	59
	APR-SEP	77	104	89	82	72	65	74
Wind R ab Bull Lake Ck	APR-JUL	510	112	650	565	450	365	455
	APR-SEP	545	111	705	610	480	385	490
Bull Lake Ck nr Lenore (2)	APR-JUL	131	94	166	145	117	97	139
	APR-SEP	159	94	200	176	143	118	169
Boysen Reservoir Inflow (2)	APR-JUL	640	105	1000	790	490	275	610
	APR-SEP	685	103	1070	840	530	295	665
Greybull R at Meeteetse	APR-JUL	141	108	200	165	117	81	131
	APR-SEP	191	108	265	220	162	119	177
Shell Ck nr Shell	APR-JUL	60	109	76	67	54	45	55
	APR-SEP	72	109	89	79	65	55	66
Bighorn R at Kane (2)	APR-JUL	920	110	1460	1140	700	375	840
	APR-SEP	975	108	1560	1210	735	390	905
NF Shoshone R at Wapiti	APR-JUL	520	113	625	560	475	415	460
	APR-SEP	575	112	695	625	530	460	515
SF Shoshone R nr Valley	APR-JUL	230	107	285	250	210	176	215
	APR-SEP	265	108	325	290	240	200	245
Buffalo Bill Reservoir Inflow	APR-JUL	750	111	940	825	670	555	675

	APR-SEP	825	111	1030	905	740	615	745
Bighorn R nr St. Xavier (2)	APR-JUL	1520	110	2200	1790	1250	845	1380
	APR-SEP	1590	109	2340	1890	1290	845	1460
Little Bighorn R nr Hardin	APR-JUL	117	119	175	140	94	59	98
	APR-SEP	131	118	195	157	105	67	111
Tongue R nr Dayton (2)	APR-JUL	97	113	128	110	85	67	86
	APR-SEP	111	113	144	124	97	77	98
Tongue River Reservoir Inflow (2)	APR-JUL	220	114	330	265	176	111	193
	APR-SEP	245	114	360	290	198	130	215
NF Powder R nr Hazelton	APR-JUL	10.8	119	14.7	12.4	9.2	6.9	9.1
	APR-SEP	11.6	117	15.6	13.2	10.0	7.6	9.9
Powder R at Moorhead	APR-JUL	225	127	370	285	166	80	177
	APR-SEP	245	125	395	305	185	96	196
Powder R nr Locate	APR-JUL	255	128	410	315	188	93	199
	APR-SEP	275	125	445	345	205	107	220

PRELIMINARY RAPID VALLEY UNIT FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
Deerfield Reservoir Inflow (2)	MAR-JUL	7.2	116	10.8	8.6	5.7	3.5	6.2
	APR-JUL	5.9	113	9.3	7.3	4.6	2.6	5.2
Pactola Reservoir Inflow (2)	MAR-JUL	27	108	43	34	21	11.4	25
	APR-JUL	24	109	39	30	17.9	8.8	22

PRELIMINARY PLATTE RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
North Platte R nr Northgate (2)	APR-JUL	280	124	410	335	230	154	225
	APR-SEP	310	124	450	365	255	169	250
Encampment R nr Encampment (2)	APR-JUL	145	112	200	168	122	88	129
	APR-SEP	154	112	215	178	130	95	138
Rock Ck ab King Canyon Cnl nr Arlington	APR-JUL	65	133	82	72	58	47	49
	APR-SEP	68	131	86	75	61	50	52
Seminole Reservoir Inflow (2)	APR-JUL	920	129	1290	1070	775	555	715
	APR-SEP	990	129	1370	1140	835	605	770
Sweetwater R nr Alcova	APR-JUL	29	49	61	42	15.3	-4.2	59
	APR-SEP	31	48	67	46	17.1	-3.8	64
La Prele Ck nr Douglas	APR-JUL	28	141	45	35	21	10.3	19.9
	APR-SEP	28	141	46	36	21	10.6	19.9
North Platte R bl Glendo Reservoir (2)	APR-JUL	940	115	1450	1140	735	430	820
	APR-SEP	980	115	1500	1190	765	455	850
North Platte R bl Guernsey Reservoir (2)	APR-JUL	945	115	1470	1160	735	425	820
	APR-SEP	985	116	1520	1200	770	445	850
Laramie R and Pioneer Cnl nr Woods Lg (2)	APR-JUL	126	110	184	149	103	68	115
	APR-SEP	138	110	200	163	113	75	126
Little Laramie R nr Filmore	APR-JUL	79	155	101	88	70	57	51
	APR-SEP	85	155	109	95	76	62	55

Max (10%), 30%, 50%, 70% and Min (90%) chance that actual volume will exceed forecast.  
Averages are for the 1981-2010 period.  
All volumes are in thousands of acre-feet.

footnotes:

- 1) Max and Min are 5% and 95% chance that actual volume will exceed forecast
- 2) streamflow is adjusted for upstream storage
- 3) median value used in place of average

**Upper Missouri River Basin  
April 2020 Calendar Year Runoff Forecast  
April 3, 2020**

**U.S. Army Corps of Engineers, Northwestern Division  
Missouri River Basin Water Management  
Omaha, NE**

**Calendar Year Runoff Forecast**

**Explanation and Purpose of Forecast**

The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. The Calendar Year Runoff Forecast is available at <http://www.nwd-mr.usace.army.mil/rcc/reports/runoff.pdf>. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows in million acre-feet (MAF) from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri Basin above Sioux City (upper Basin). The Calendar Year Runoff Forecast is used in the Monthly Study simulation model to plan future system regulation in order to meet the authorized project purposes throughout the calendar year.

**Observed Runoff**

March 2020 runoff was 5.5 MAF, about two times the average March runoff volume, continuing the high runoff trend from 2019. The above-average runoff was a direct result of warmer-than-normal temperatures in the upper Basin, resulting in the melting of most plains snowpack on nearly saturated soils and unseasonably high river baseflow.

**2020 Calendar Year Forecast Synopsis**

The 2020 calendar year runoff forecast for the upper Missouri Basin above Sioux City, IA is **35.5 MAF, 138% of average**. The 2020 calendar year runoff forecast for the Missouri Basin above Gavins Point is **29.0 MAF, 124% of average**.

Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next 9 months, expected inflow could range from the 46.1 MAF upper basic forecast to the 26.0 MAF lower basic forecast. The upper and lower basic forecasts are used in long-term regulation planning models to “bracket” the range of expected runoff given much wetter or drier conditions, respectively. Given that nine months are being forecast for this April 1 forecast (3 months observed/9 months forecast), the range of possible wetter-than-expected (upper basic)

and drier-than-expected (lower basic) conditions is very large, and is attributed to all six reaches for the remaining 9 months of the year. The result is a range or “bracket” for each reach, and thus, for the total runoff forecast.

## Current Conditions

### Drought Analysis

The National Drought Mitigation Center’s drought monitor for March 31, 2020 is shown in **Figure 1**. The drought monitor is available at <http://droughtmonitor.unl.edu/>. The U.S. Drought Monitor shows only Abnormally Dry (D0) conditions in an area of western Montana and northwestern North Dakota. The Seasonal Drought Outlook in **Figure 2**, which extends through the end of June, indicates no drought development within the Missouri River Basin during the outlook period.

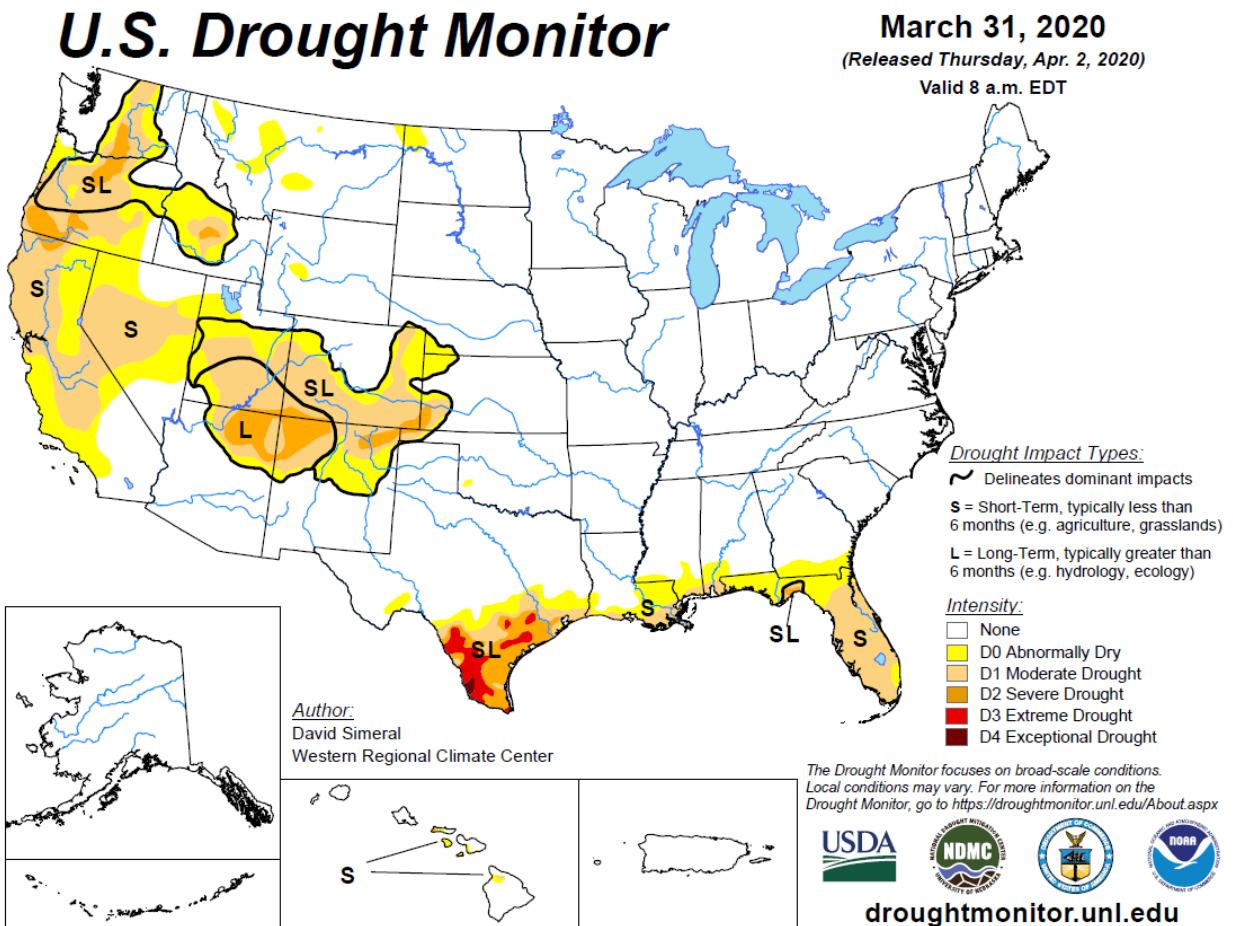


Figure 1. National Drought Mitigation Center U.S. Drought Monitor for March 31, 2020.

# U.S. Seasonal Drought Outlook Drought Tendency During the Valid Period

Valid for March 19 - June 30, 2020  
Released March 19

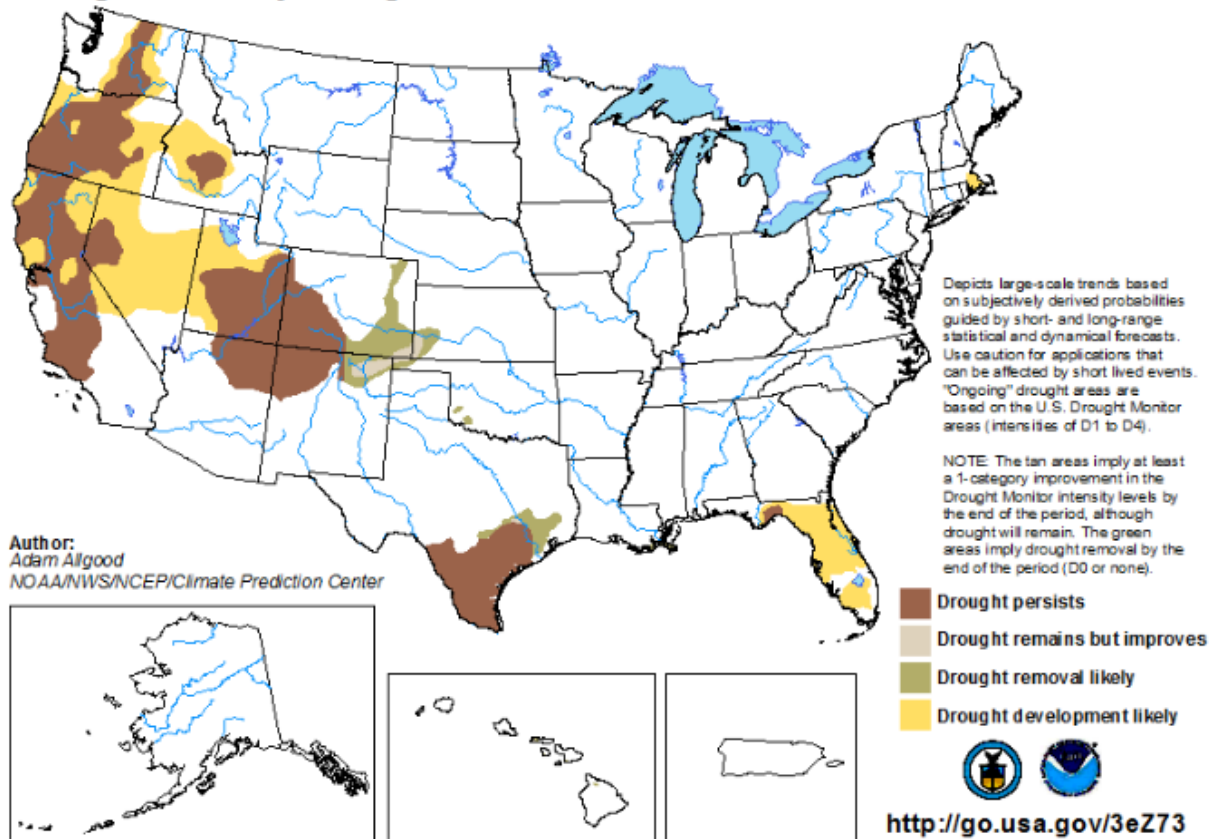


Figure 2. National Drought Mitigation Center U.S. Drought Seasonal Drought Outlook.

## Precipitation

Monthly precipitation accumulations are shown using High Plains Regional Climate Center images available at <http://www.hprcc.unl.edu/>. The March precipitation accumulations are shown in **Figure 3** as a percent of normal precipitation. March precipitation was generally above normal in the lower Basin (CO, NE, IA, KS, and MO), the upper Yellowstone, and upper Missouri basins; while it was less than 25 percent of normal in areas of the upper Basin (MT, ND, SD, and WY).

Precipitation as a percent of normal for the January-February-March period (**Figure 4**) follows the same trend, with the upper Basin receiving below-normal precipitation and the lower Basin receiving above-normal precipitation, though not as extreme. The noticeable exception is an area of Montana that had up to 200 percent of normal precipitation over the past three months.

Percent of Normal Precipitation (%)  
3/1/2020 – 3/31/2020

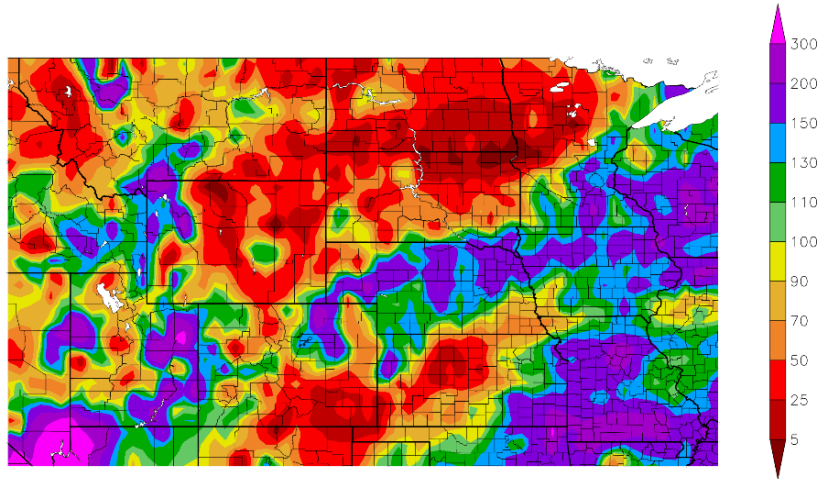


Figure 3. March 2020 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Percent of Normal Precipitation (%)  
1/1/2020 – 3/31/2020

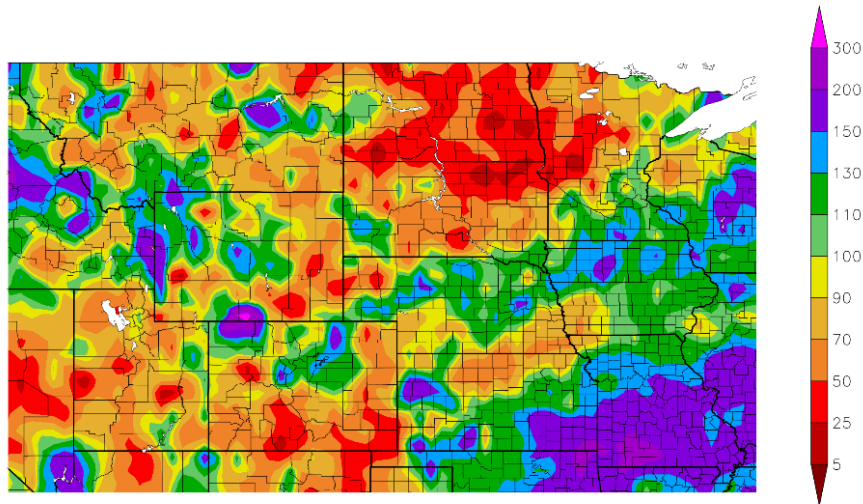
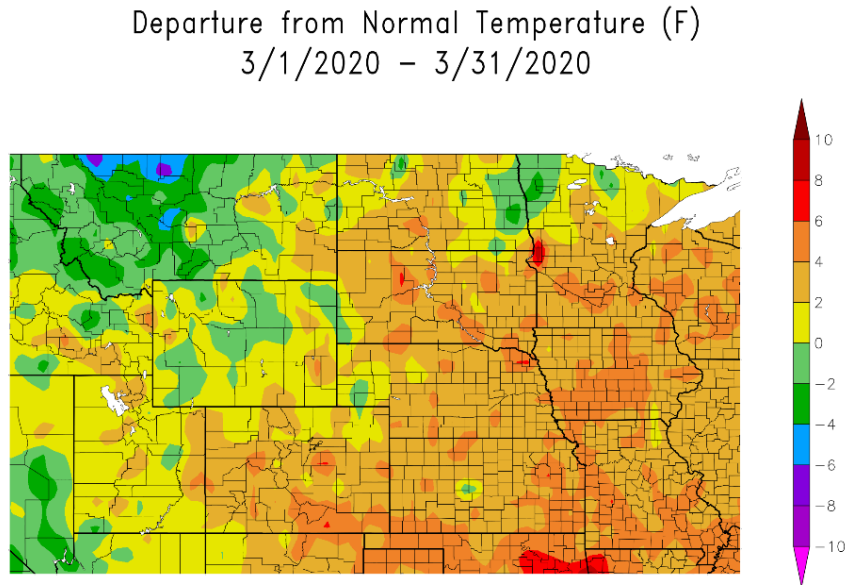


Figure 4. January-February-March 2020 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

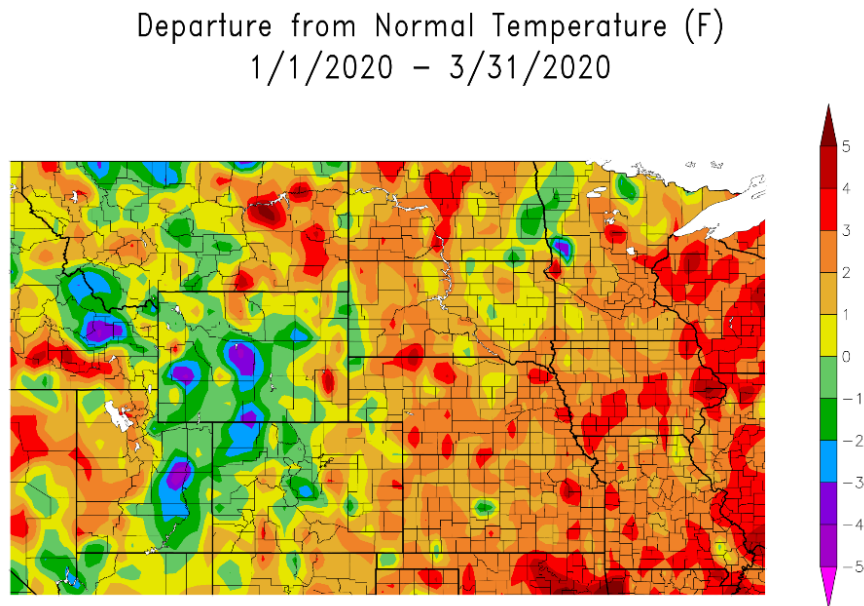
## Temperature

March temperature departures in degrees Fahrenheit (deg F) in **Figure 5** were 2 to 6 deg F above normal in plains of the upper Basin, which caused most of the plains snowpack to melt. In contrast, temperatures were 2 to 8 deg F below normal in areas of the northern Rocky Mountains, resulting in continued mountain snowpack accumulation.

January-February-March temperature departures are shown in **Figure 6**. The three-month temperature pattern shows above-normal temperatures throughout most of the Missouri Basin, in particular the plains, and an area of below-normal temperatures over the Rocky Mountains.



**Figure 5. March 2020 Departure from Normal Temperature (deg F).** Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

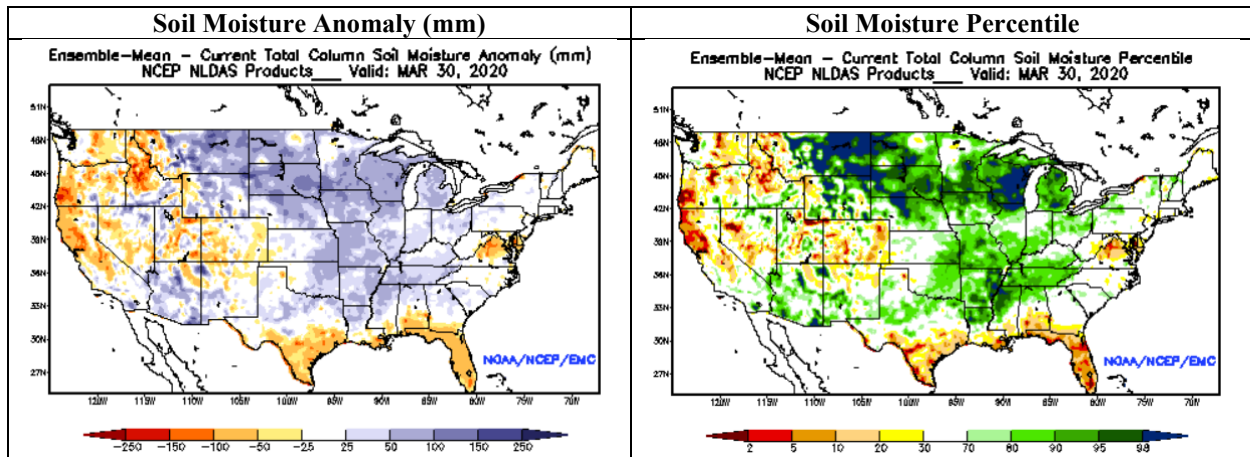


**Figure 6. January-February-March 2020 Departure from Normal Temperature (deg F).** Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

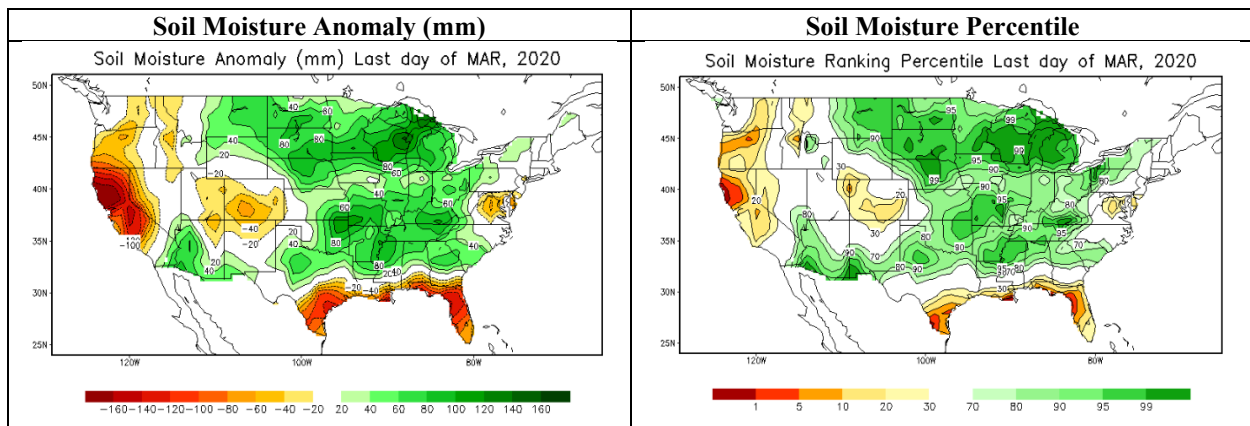
## Soil Moisture

Soil moisture is factored into the forecast as an indicator of wet or dry hydrologic basin conditions. Typically when soil moisture conditions are wet or greater than normal, rainfall and snowmelt runoff is greater than when soil moisture is dry or less than normal. Not only is soil moisture a physical parameter that influences runoff, it can be used as an indicator of future runoff.

Soil moisture at the end of March is much wetter than normal as shown in the soil moisture estimates from the NOAA National Land Data Assimilation System (NLDAS) and the Climate Prediction Center (CPC) in **Figure 7** and **Figure 8**, respectively. The soil moisture anomalies and the soil moisture percentiles are shown in these figures. Both figures indicate that end of March soil moisture anomalies in the Missouri River Basin are well-above normal. The soil moisture percentiles rank very high; above the 98<sup>th</sup> and 99<sup>th</sup> percentiles in some areas based on both the NLDAS and CPC percentile maps. The 99<sup>th</sup> percentile indicates that soil moisture is at its wettest for this time of year, compared to long-term soil moisture simulations. Generally, when soil moisture is high during the winter, the potential for high spring runoff is **much** higher.



**Figure 7.** NOAA NLDAS Soil Moisture Anomaly (mm) and Soil Moisture Percentile. Source: NOAA NLDAS Drought Monitor Soil Moisture. <http://www.emc.ncep.noaa.gov/mmb/nldas/drought/>



**Figure 8.** NOAA CPC Soil Moisture Anomaly (mm) and Soil Moisture Percentile. Source: NOAA NLDAS Drought Monitor Soil Moisture. [https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

## Plains Snowpack

Plains snowpack is an important parameter that influences the volume of runoff occurring in the basin during the months of March and April. A common misperception is that the March-April runoff is a result of plains snowmelt only. Historically, about 25% of annual runoff occurs in March and April, during the time when plains snow is melting, due to both melting snowpack and rainfall runoff. Runoff occurs in March and April whether or not there is any plains snow to melt. Determining exact rainfall amounts and locations are nearly impossible to predict more than a week in advance. Thus, the March-April runoff forecast is formulated based on existing plains snowpack and existing basin conditions and hydrologic forecasts, which for this year primarily includes long-term precipitation outlooks. At this time of year, plains snowpack provides some indication of March-April runoff; however, as the snowpack reaches its ultimate peak accumulation, better forecasts of future runoff can be made.

The National Weather Service's National Operational Hydrologic Remote Sensing Center (NOHRSC), modeled snow assessment from April 1, shown in **Figure 9**, indicates only trace amounts of SWE remaining in Montana and western North Dakota. The NWS is forecasting additional snow across the plains during the first few days of April, but any snowpack received is likely to melt off quickly. The runoff forecast for some reaches was reduced for April to reflect the current plains snowpack conditions. The estimated peak plains snowpack occurred on February 20, 2020, shown in the bottom image of **Figure 9**. SWE amounts in the James River basin were as high as 8 inches in small areas, with large areas of up to 4 inches. Trace amounts of SWE were also present over most of the plains on this date.

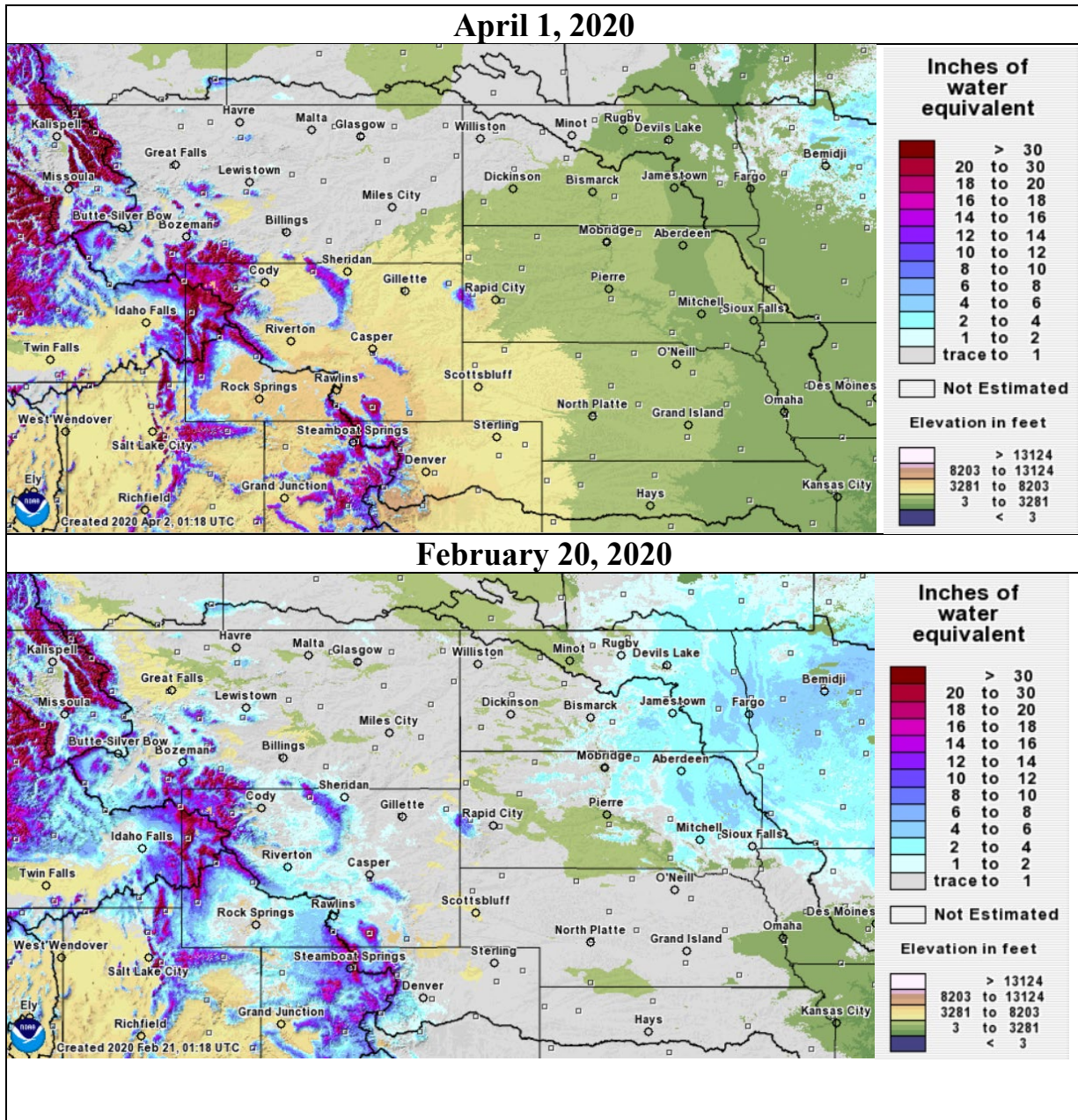


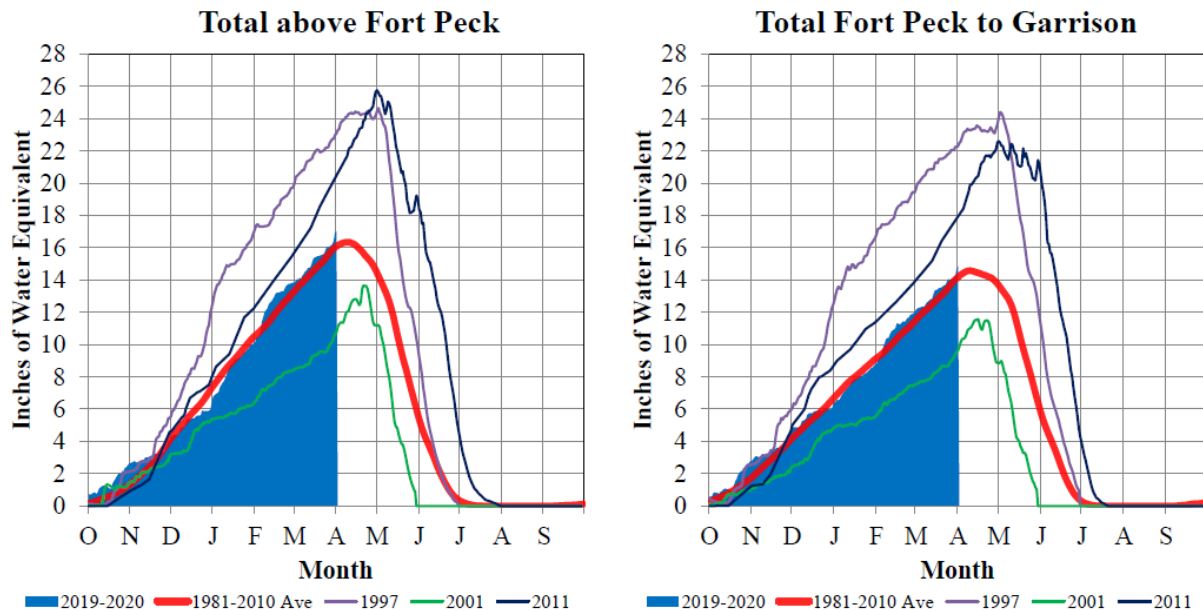
Figure 9. April 1, 2020 (top) and February 20, 2020 (bottom) NOHRSC modeled plains snow water equivalent. Source: NOAA National Operational Hydrologic Remote Sensing Center. <http://www.nohrsc.nws.gov/interactive/html/map.html>

## Mountain Snowpack

Mountain snowpack is the primary factor used to predict May, June, and July runoff volumes in the Fort Peck and Fort Peck to Garrison mainstem reservoir reaches. As the date a peak snowpack accumulation, usually around April 15, approaches, the correlation between the level of mountain snowpack and May, June and July runoff increases; therefore, mountain snowpack becomes a better predictor of Fort Peck and Garrison reach runoff.

**Figure 10** includes time series plots of the mountain SWE beginning on October 1, 2019 based on the NRCS SNOTEL data for the headwater basin above Fort Peck and the incremental basin from Fort Peck to Garrison. The current average SWE values (shaded blue area) are plotted against the 1981-2010 basin average SWE (bold red line), a recent low SWE year in 2001 (green line), and two historic high SWE years occurring in 1997 (purple) and 2011 (dark blue).

### Missouri River Basin – Mountain Snowpack Water Content 2019-2020 with comparison plots from 1997\*, 2001\*, and 2011 1-Apr-2020



The Missouri River Basin mountain snowpack normally peaks near April 15. On April 1, the mountain Snow Water Equivalent (SWE) in the “Total above Fort Peck” reach was 17.0”, 106% of the April 1 average. On April 1, the mountain SWE in the Fort Peck to Garrison reach was 14.9”, 105% of the April 1 average.

\*Generally considered the high and low year of the last 25-year period, respectively

Provisional data. Subject to revision.

**Figure 10. Mountain snowpack water content on February 2, 2020 compared to normal and historic conditions. Corps of Engineers - Missouri River Basin Water Management.**

Mountain snowpack as of April 1 was 106% above Fort Peck and 105% from Fort Peck to Garrison. Mountain snowpack as a percent of average was about the same on April 1 as it was on March 1, so the forecast for June and July runoff as a result of mountain snowpack was not

changed. However, May runoff was reduced slightly as a continuation of the lower observed March runoff and forecast April runoff in the Fort Peck and Garrison reaches.

## **Climate Outlook**

MRBWM participates in the monthly North Central U.S. Climate/Drought Outlook Webinar coordinated through NOAA, the regional climate centers, and the American Association of State Climatologists (AASC). These webinars provide updates on near-term climate outlooks and impacts including the ENSO climate pattern and its implications on winter temperature and precipitation patterns in the Missouri Basin.

### **ENSO (El Niño Southern Oscillation)**

The latest ENSO Outlook indicates that neutral conditions are present, and will likely remain neutral during the Northern Hemisphere spring 2020 and summer 2020. During ENSO-neutral conditions there are no strong climate indicators to provide much certainty on the precipitation and temperature forecasts beyond the winter and early spring seasons.

### **Temperature and Precipitation Outlooks**

The NOAA Climate Prediction Center (CPC) outlooks provide the forecasted probability (or chance) of occurrence of future weather conditions during periods ranging from 1 to 12 months into the future. The CPC outlooks are available at <http://www.cpc.ncep.noaa.gov/>.

The CPC temperature outlook for the forecast period from April 10-16 is shown in **Figure 11**. The outlook is indicating a significant increase in the chances for below-normal temperatures throughout the entire Missouri Basin, continuing with increased chances for below-normal temperatures in the upper Basin through the end of April (**Figure 12**). With regard to precipitation, there is an increase in precipitation chances from April 10-16, followed by increased chances through the end of April (**Figure 12**).

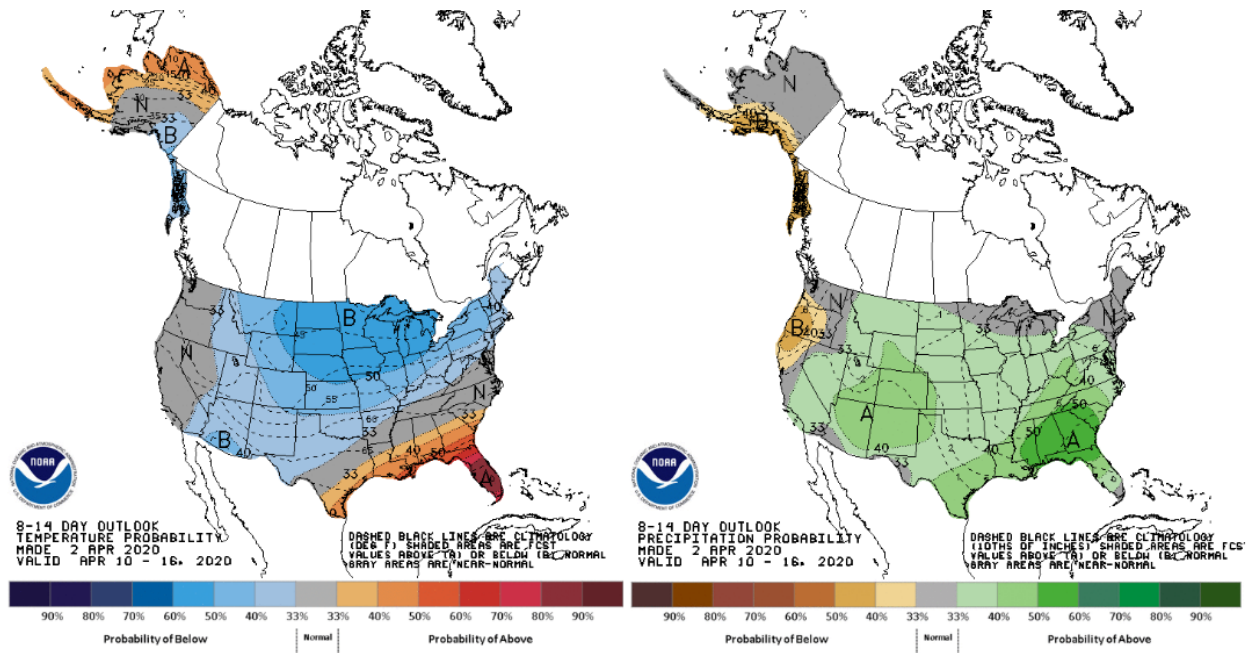


Figure 11. CPC 8-14 Day temperature and precipitation outlooks through April 18, 2020.

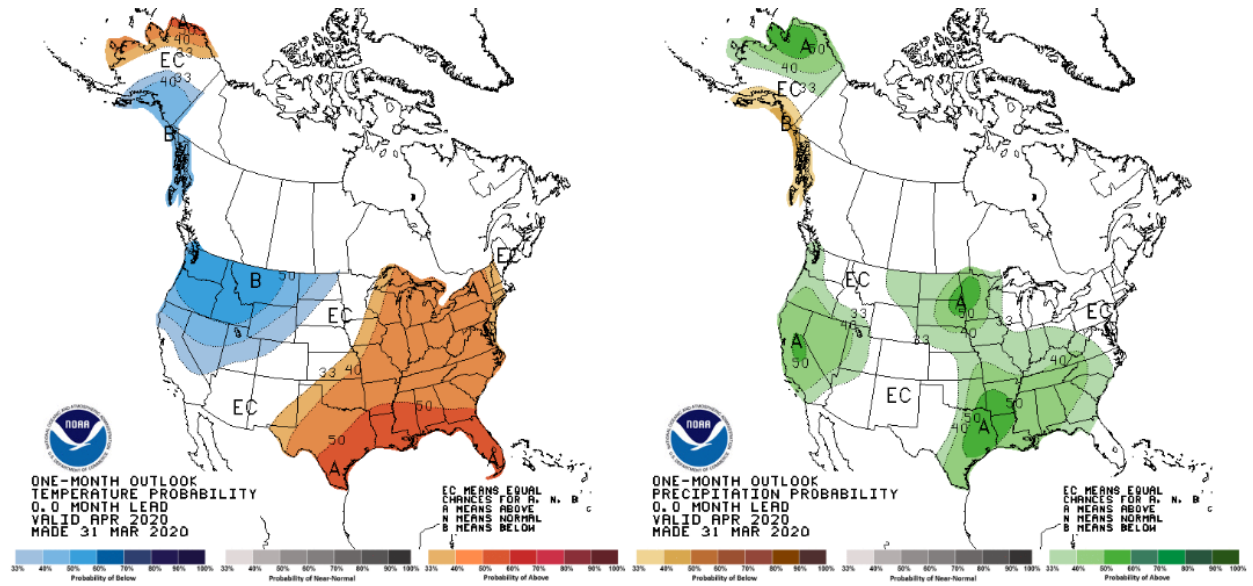


Figure 12. CPC April 2020 temperature and precipitation outlooks.

Three-month temperature and precipitation outlooks for the three-month periods from May through December 2020 are shown below in **Figures 13-15**. During the May-June-July 2020 (**Figure 13**), the CPC indicates increased chances for above-normal temperatures throughout most of the Missouri Basin, with equal chances in North Dakota and South Dakota. With regard to precipitation, there is an increased chance for precipitation in Nebraska, Iowa, and South Dakota, with equal chances elsewhere.

During the August-September-October 2020 forecast period (**Figure 14**), there are increased chances for above-normal temperatures throughout the entire Missouri Basin. With regard to precipitation during the August-September-October period, there are equal chances for precipitation across the entire Basin.

Finally during the November-December 2020-January 2021 period, there is an increased chance for above-normal temperatures throughout all of the Missouri Basin (**Figure 15**). With regard to precipitation, there is a slight increase in chances for above-normal precipitation in Montana, Wyoming, and the western Dakotas, while there are equal chances in all other areas of the Missouri Basin. As previously noted, though, there is limited confidence in climate outlooks beyond the winter and early spring seasons; therefore, the climate outlooks will likely change as the calendar progresses.

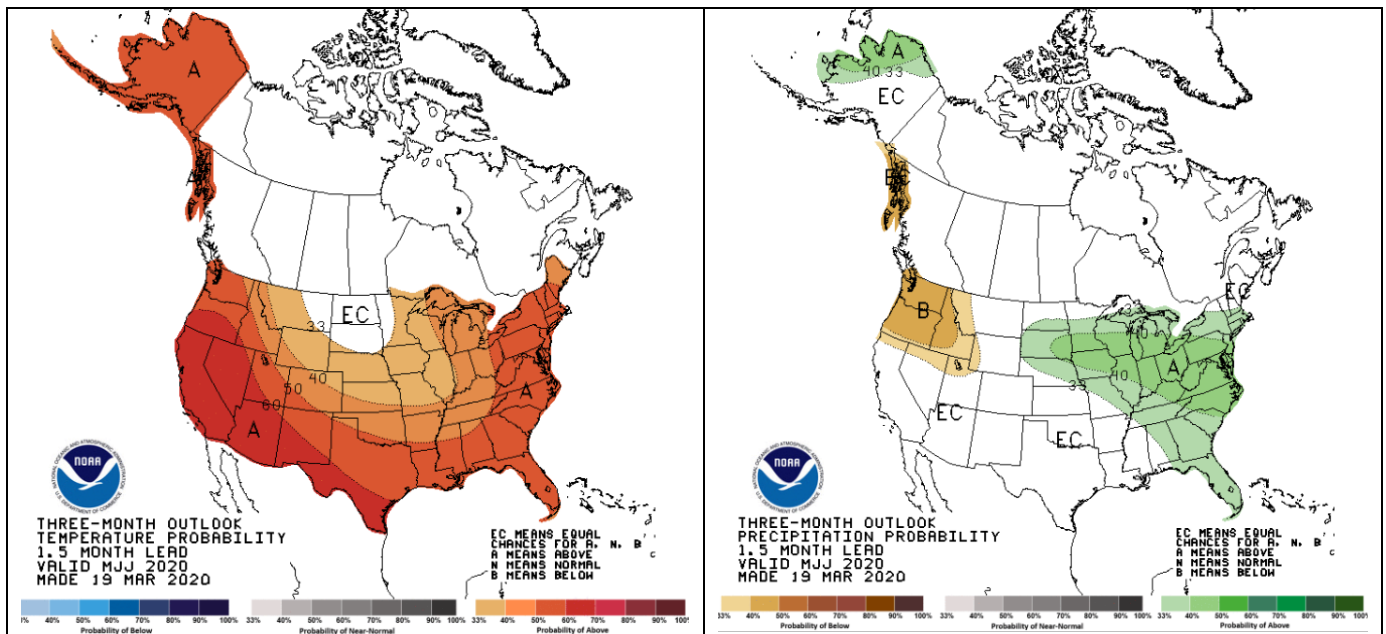


Figure 13. CPC May-June-July 2020 temperature and precipitation outlooks.

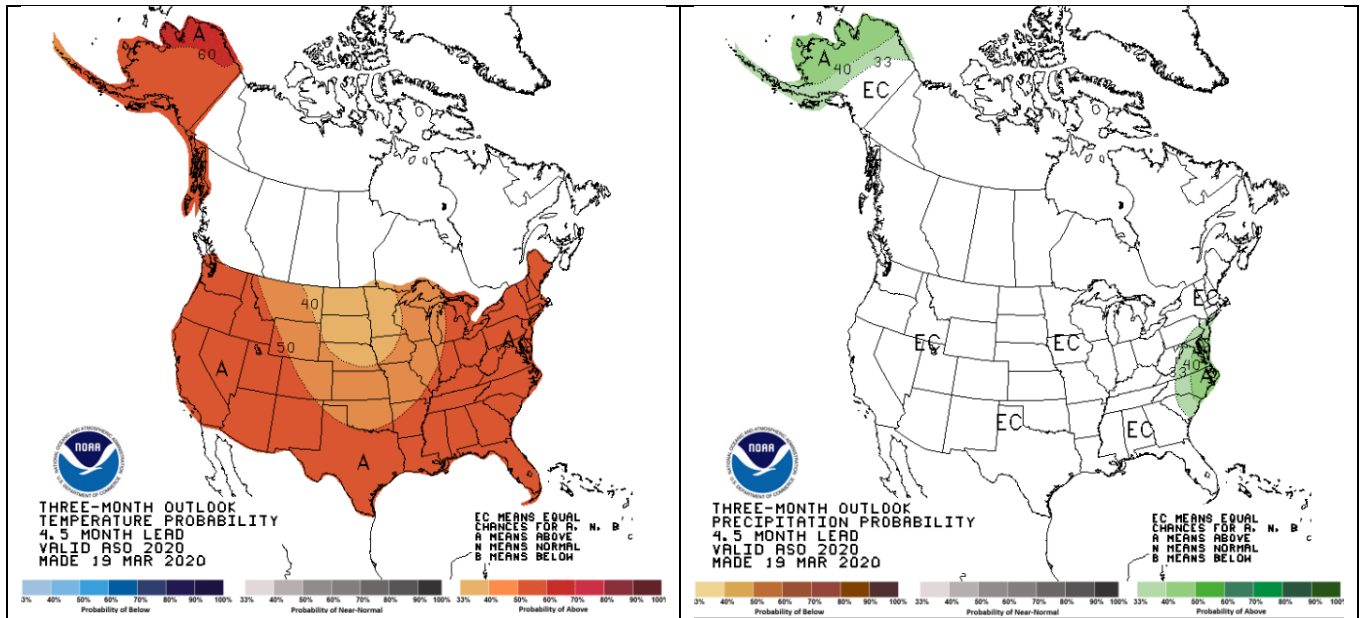


Figure 14. CPC August-September-October 2020 temperature and precipitation outlooks.

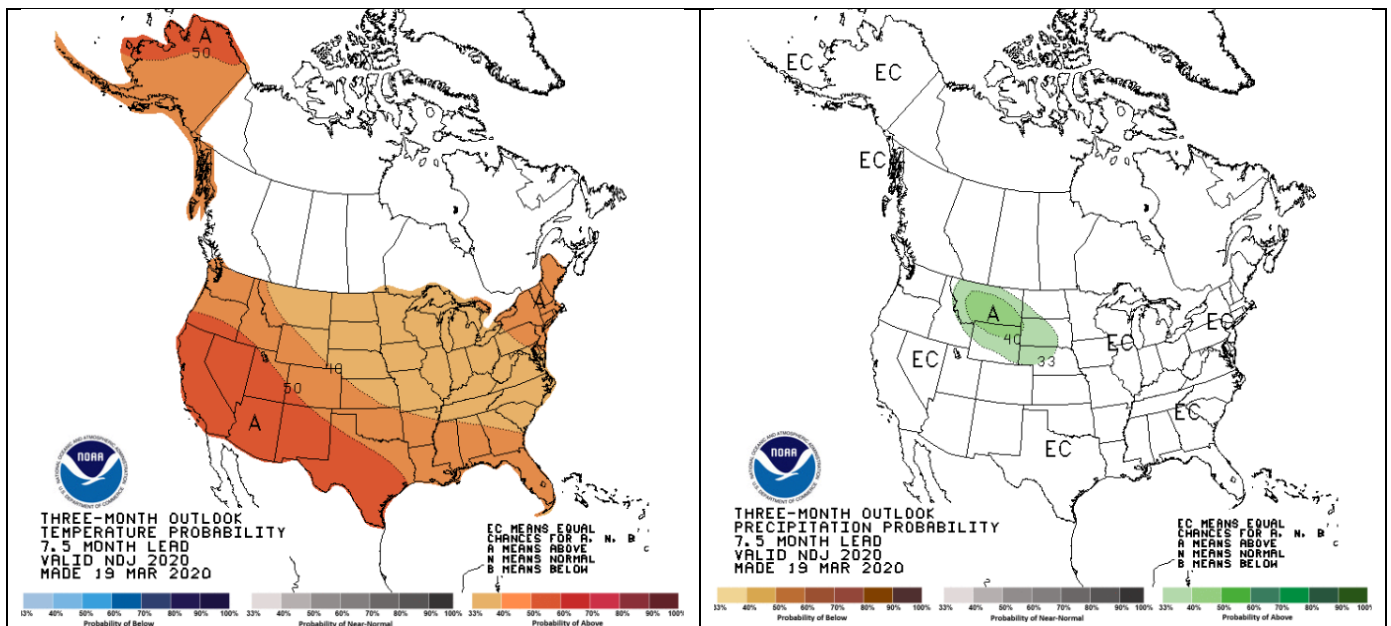


Figure 15. November-December 2020-January 2021 temperature and precipitation outlooks.

## Summary

In summary, the 2020 calendar year runoff forecast is **35.5 MAF (138% of average)**. If realized, this runoff volume would rank as the 12th highest annual runoff volume in 122 years of record-keeping.

## Water Supply Forecasts

USDA NRCS National Water & Climate Center

\* - DATA CURRENT AS OF: April 03, 2020 04:52:58 PM

- Based on April 01, 2020 forecast values

### PRELIMINARY MISSOURI RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
Lake Sherburne Inflow (2)	APR-JUL	108	111	126	115	101	90	97
	APR-SEP	124	111	144	132	115	103	112
St. Mary R at Intl Boundary (2)	APR-JUL	495	114	590	535	455	400	435
	APR-SEP	565	112	675	610	525	460	505
Lima Reservoir Inflow (2)	APR-JUL	74	99	100	85	63	48	75
	APR-SEP	80	100	108	92	68	52	80
Clark Canyon Reservoir Inflow (2)	APR-JUL	97	96	144	116	78	50	101
	APR-SEP	112	93	167	134	90	57	120
Jefferson R nr Three Forks (2)	APR-JUL	760	103	1070	885	630	445	740
	APR-SEP	805	101	1160	950	660	445	800
Hebgen Lake Inflow (2)	APR-JUL	360	97	430	390	335	295	370
	APR-SEP	450	96	535	485	415	365	470
Ennis Lake Inflow (2)	APR-JUL	620	99	750	675	565	490	625
	APR-SEP	765	99	920	830	700	610	775
Missouri R at Toston (2)	APR-JUL	1930	108	2460	2140	1710	1390	1790
	APR-SEP	2190	106	2830	2450	1930	1540	2070
Smith R bl Eagle Ck (2)	APR-JUL	109	103	161	130	88	57	106
	APR-SEP	119	103	182	145	93	56	116
Gibson Reservoir Inflow (2)	APR-JUL	410	104	490	445	375	330	395
	APR-SEP	450	102	540	485	415	360	440
Marias R nr Shelby (2)	APR-JUL	395	110	525	445	345	265	360
	APR-SEP	410	109	550	465	355	270	375

### PRELIMINARY YELLOWSTONE RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
West Rosebud Ck nr Roscoe (2)	APR-JUL	62	105	71	66	59	54	59
	APR-SEP	79	107	90	84	75	69	74
Wind R ab Bull Lake Ck	APR-JUL	515	113	655	575	460	375	455
	APR-SEP	555	113	710	620	490	400	490
Bull Lake Ck nr Lenore (2)	APR-JUL	129	93	162	142	116	96	139
	APR-SEP	157	93	196	173	141	117	169
Boysen Reservoir Inflow (2)	APR-JUL	615	101	970	760	470	260	610
	APR-SEP	665	100	1040	815	510	285	665
Greybull R at Meeteetse	APR-JUL	131	100	193	156	106	70	131
	APR-SEP	177	100	250	205	147	103	177
Shell Ck nr Shell	APR-JUL	56	102	71	62	50	41	55
	APR-SEP	68	103	84	75	61	51	66
Bighorn R at Kane (2)	APR-JUL	855	102	1390	1070	640	320	840
	APR-SEP	915	101	1480	1140	685	345	905
NF Shoshone R at Wapiti	APR-JUL	510	111	595	545	475	425	460
	APR-SEP	565	110	665	605	525	465	515
SF Shoshone R nr Valley	APR-JUL	230	107	275	245	210	181	215
	APR-SEP	260	106	315	285	240	205	245
Buffalo Bill Reservoir Inflow	APR-JUL	740	110	900	805	675	580	675

	APR-SEP	810	109	985	880	735	635	745
Bighorn R nr St. Xavier (2)	APR-JUL	1440	104	2080	1700	1190	805	1380
	APR-SEP	1520	104	2220	1800	1230	815	1460
Little Bighorn R nr Hardin	APR-JUL	98	100	148	118	77	47	98
	APR-SEP	110	99	166	133	87	54	111
Tongue R nr Dayton (2)	APR-JUL	86	100	113	97	75	58	86
	APR-SEP	98	100	128	110	86	68	98
Tongue River Reservoir Inflow (2)	APR-JUL	187	97	285	225	146	87	193
	APR-SEP	210	98	315	250	166	103	215
NF Powder R nr Hazelton	APR-JUL	10.2	112	13.7	11.6	8.8	6.7	9.1
	APR-SEP	10.9	110	14.6	12.4	9.4	7.2	9.9
Powder R at Moorhead	APR-JUL	210	119	350	265	153	68	177
	APR-SEP	230	117	375	290	172	87	196
Powder R nr Locate	APR-JUL	230	116	385	295	167	75	199
	APR-SEP	250	114	415	315	184	87	220

#### PRELIMINARY RAPID VALLEY UNIT FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
Deerfield Reservoir Inflow (2)	APR-JUL	5.8	112	8.8	7.0	4.6	2.8	5.2
Pactola Reservoir Inflow (2)	APR-JUL	26	118	39	31	21	13.3	22

#### PRELIMINARY PLATTE RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
North Platte R nr Northgate (2)	APR-JUL	265	118	380	315	220	148	225
	APR-SEP	290	116	425	345	240	162	250
Encampment R nr Encampment (2)	APR-JUL	143	111	195	164	122	91	129
	APR-SEP	152	110	205	174	130	97	138
Rock Ck ab King Canyon Cnl nr Arlington	APR-JUL	62	127	76	68	57	48	49
	APR-SEP	65	125	80	71	60	51	52
Seminole Reservoir Inflow (2)	APR-JUL	875	122	1200	1010	745	550	715
	APR-SEP	940	122	1280	1080	800	595	770
Sweetwater R nr Alcova	APR-JUL	24	41	56	37	11.2	0.59	59
	APR-SEP	26	41	60	40	12.8	0.64	64
La Prele Ck nr Douglas	APR-JUL	24	121	37	29	18.9	11.3	19.9
	APR-SEP	23	116	36	28	17.8	10.0	19.9
North Platte R bl Glendo Reservoir (2)	APR-JUL	875	107	1330	1060	695	420	820
	APR-SEP	910	107	1380	1100	720	440	850
North Platte R bl Guernsey Reservoir (2)	APR-JUL	880	107	1350	1070	690	410	820
	APR-SEP	915	108	1400	1110	715	430	850
Laramie R and Pioneer Cnl nr Woods Lg (2)	APR-JUL	122	106	171	142	102	72	115
	APR-SEP	133	106	187	155	111	79	126
Little Laramie R nr Filmore	APR-JUL	74	145	92	81	67	56	51
	APR-SEP	80	145	99	88	72	61	55

Max (10%), 30%, 50%, 70% and Min (90%) chance that actual volume will exceed forecast.

Averages are for the 1981-2010 period.

All volumes are in thousands of acre-feet.

footnotes:

- 1) Max and Min are 5% and 95% chance that actual volume will exceed forecast
- 2) streamflow is adjusted for upstream storage
- 3) median value used in place of average

**Upper Missouri River Basin  
May 2020 Calendar Year Runoff Forecast  
May 6, 2020**

**U.S. Army Corps of Engineers, Northwestern Division  
Missouri River Basin Water Management  
Omaha, NE**

**Calendar Year Runoff Forecast**

**Explanation and Purpose of Forecast**

The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. The Calendar Year Runoff Forecast is available at <http://www.nwd-mr.usace.army.mil/rcc/reports/runoff.pdf>. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows in million acre-feet (MAF) from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri Basin above Sioux City (upper Basin). The Calendar Year Runoff Forecast is used in the Monthly Study simulation model to plan future system regulation in order to meet the authorized project purposes throughout the calendar year.

**Observed Runoff**

April runoff was 3.2 MAF (108% of average), about 1.3 MAF less than what was forecast on April 1. Runoff in the Gavins Point Dam to Sioux City reach was over two and one half times the normal amount, mostly due to the extremely wet soil conditions in eastern South Dakota. Runoff in the Fort Peck, Garrison, Oahe, and Fort Randall reaches was lower than average due to below-normal April precipitation.

**2020 Calendar Year Forecast Synopsis**

The 2020 calendar year runoff forecast for the upper Missouri Basin above Sioux City, IA is **32.2 MAF, 125% of average**. The 2020 calendar year runoff forecast for the Missouri Basin above Gavins Point is **25.9 MAF, 111% of average**. In addition to adjustments made for lower-than-forecast April runoff and drier basin conditions, the forecast volume also accounts for a reduction in basin depletions. Basin depletions are calculated by the U.S. Bureau of Reclamation (Bureau) and provided to the Corps on an annual basis. Depletions are the Bureau's estimates of how much water is pulled from and then returned to the reservoirs and Missouri River during the year to serve consumptive uses, primarily irrigation and water supply. This latest update reflects

a fairly significant change from previous year's depletions. This indicates that there have been some land use changes (for example, switching farmland to rangeland and/or switching to a different type of crop) over the last 5-8 years, particularly in the areas above Fort Peck and Garrison.

Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next 8 months, expected inflow could range from the 39.8 MAF upper basic forecast to the 25.4 MAF lower basic forecast. The upper and lower basic forecasts are used in long-term regulation planning models to "bracket" the range of expected runoff given much wetter or drier conditions, respectively. Given that 8 months are being forecast for this May 1 forecast (4 months observed/8 months forecast), the range of possible wetter-than-expected (upper basic) and drier-than-expected (lower basic) conditions is very large, and is attributed to all six reaches for the remaining 8 months of the year. The result is a range or "bracket" for each reach, and thus, for the total runoff forecast.

## **Current Conditions**

### **Drought Analysis**

The National Drought Mitigation Center's drought monitor for April 28, 2020 is shown in **Figure 1**. The drought monitor is available at <http://droughtmonitor.unl.edu/>. The U.S. Drought Monitor shows Abnormally Dry (D0) conditions in pockets of western Montana, and a much larger area extending from eastern Montana into western North Dakota, and northwestern and central South Dakota. This is a reflection of much drier conditions that have occurred in 2020. The National Weather Service (NWS) Climate Prediction Center's (CPC) Seasonal Drought Outlook in **Figure 2**, which extends through the end of July, indicates no drought development within the Missouri Basin during the outlook period.

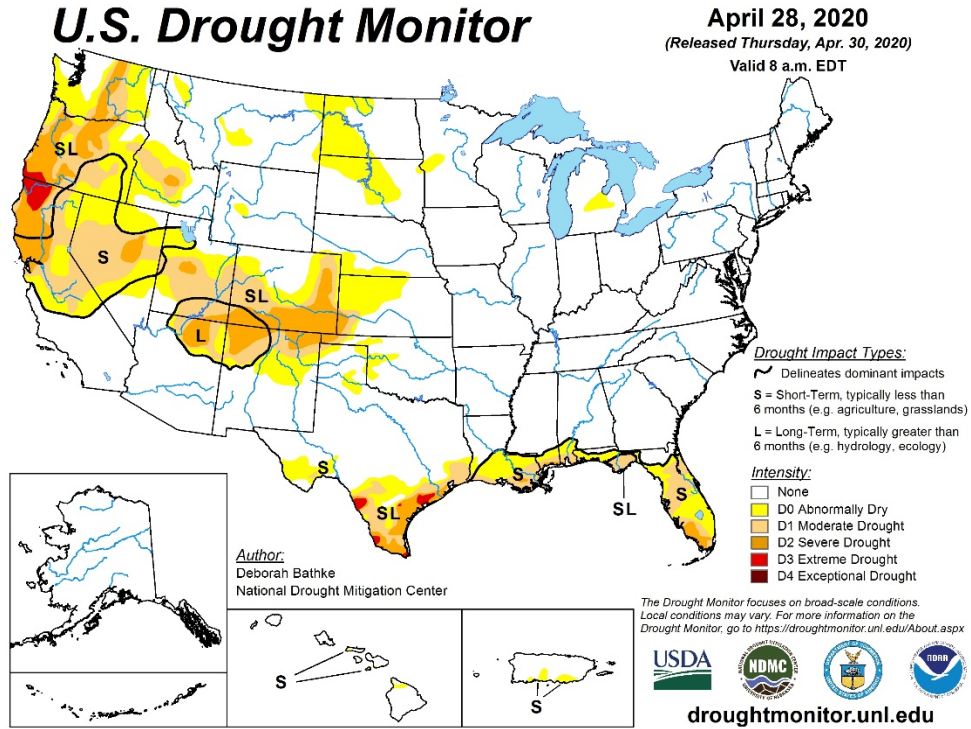


Figure 1. National Drought Mitigation Center U.S. Drought Monitor for April 28, 2020.

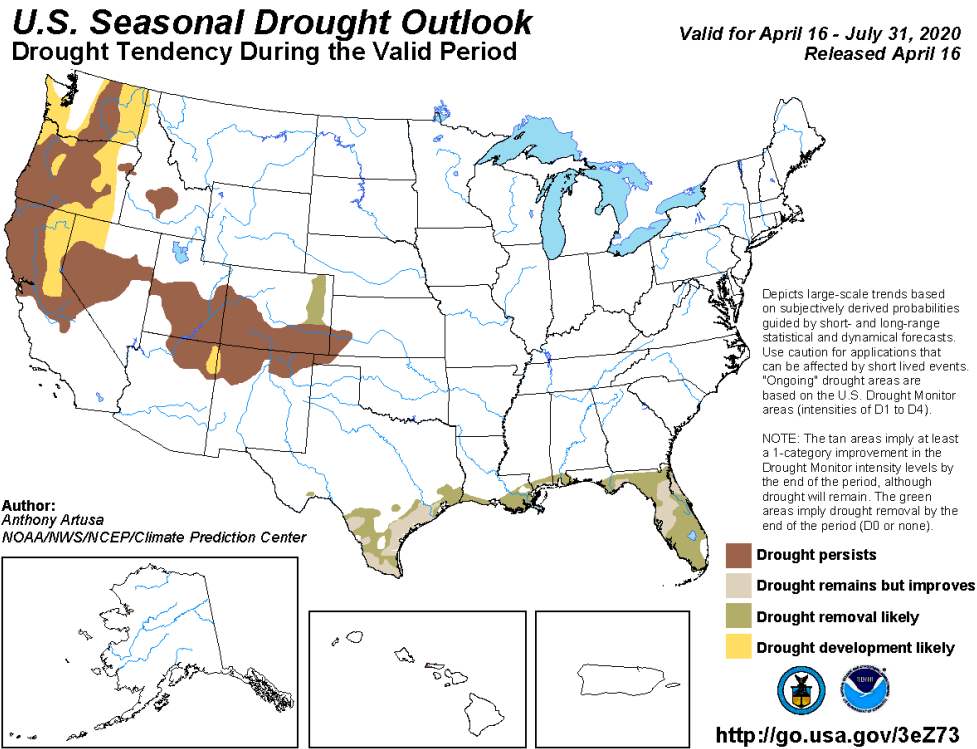
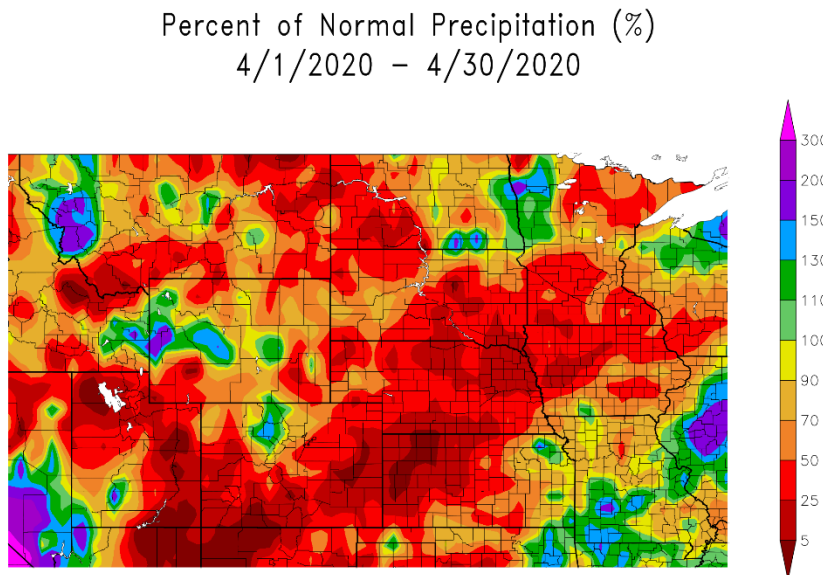


Figure 2. NWS CPC Seasonal Drought Outlook.

## Precipitation

Monthly precipitation accumulations are shown using High Plains Regional Climate Center images available at <http://www.hprcc.unl.edu/>. The April precipitation accumulation map is shown in **Figure 3** as a percent of normal precipitation. April precipitation was less than 50% of normal over much of the Missouri Basin. Some areas received less than 25% of normal precipitation including northwestern Montana, southwestern North Dakota, southeastern South Dakota, and areas in central and eastern Nebraska. Few areas of the upper Missouri Basin received above-normal precipitation, however, precipitation accumulations in central and southern Missouri were near normal to slightly above normal.



**Figure 3. April 2020 Percent of Normal Precipitation.** Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Since January 1, the upper Basin has received less than 70% of normal precipitation (see **Figure 4**) except for areas of above-normal precipitation in the mountainous areas of the upper Yellowstone River Basin. Eastern Montana, North Dakota, and South Dakota received as low as 50% of normal precipitation since January 1. In contrast, total precipitation since January 1 in Missouri has been above normal, especially in central and southern Missouri, which has received between 130% and 200% of normal precipitation.

Percent of Normal Precipitation (%)  
1/1/2020 – 4/30/2020

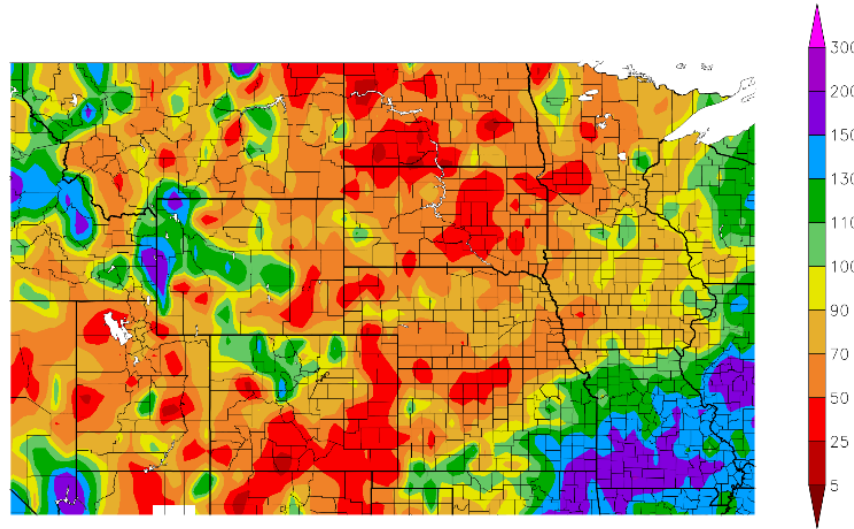


Figure 4. January 1 – April 30 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

## Temperature

April temperature departures in degrees Fahrenheit (deg F) in **Figure 5** were 2 to 6 deg F below normal in much of the upper Basin. In the Rocky Mountains, where the snowpack peaked in the Fort Peck and Garrison reaches, April temperatures were normal to about 4 deg F below normal. Temperatures in the lower Basin ranged from 0 to 4 deg F below normal.

February-March-April temperature departures are shown in **Figure 6**. The average three-month temperatures ranged from normal to about 4 deg F below normal in Montana and Wyoming, while temperatures were within 2 deg F above and below normal in North Dakota and South Dakota. Temperatures were slightly above normal in the lower Basin.

Departure from Normal Temperature (F)  
4/1/2020 – 4/30/2020

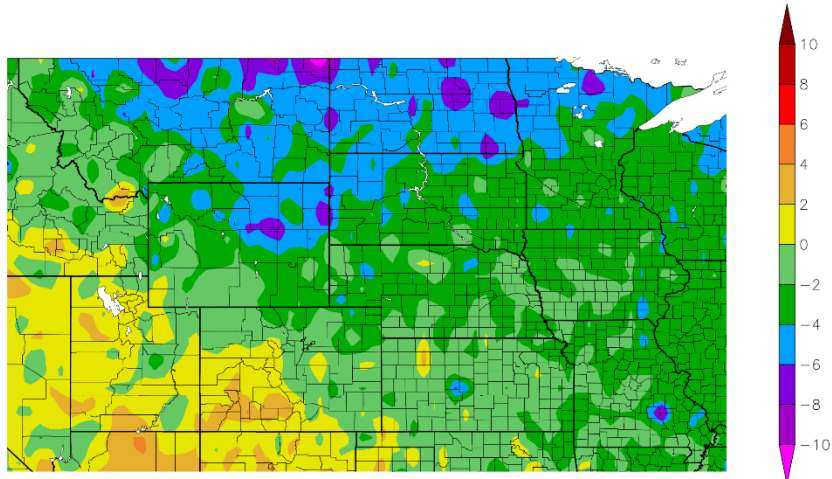


Figure 5. April 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Departure from Normal Temperature (F)  
2/1/2020 – 4/30/2020

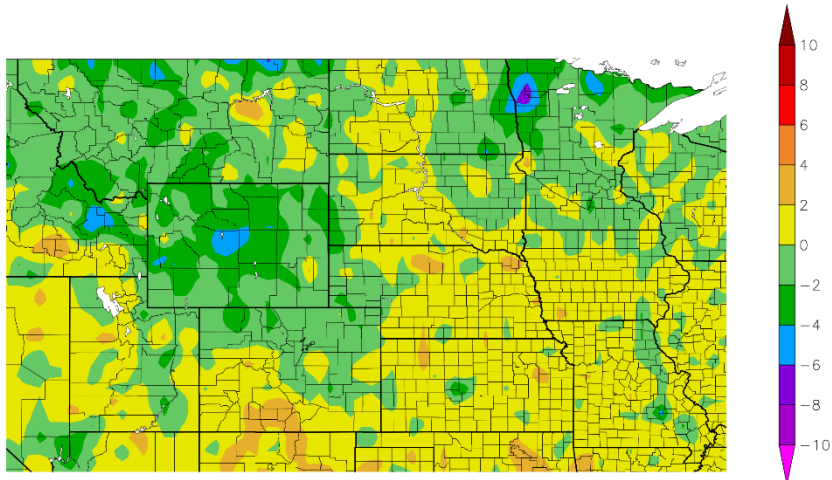
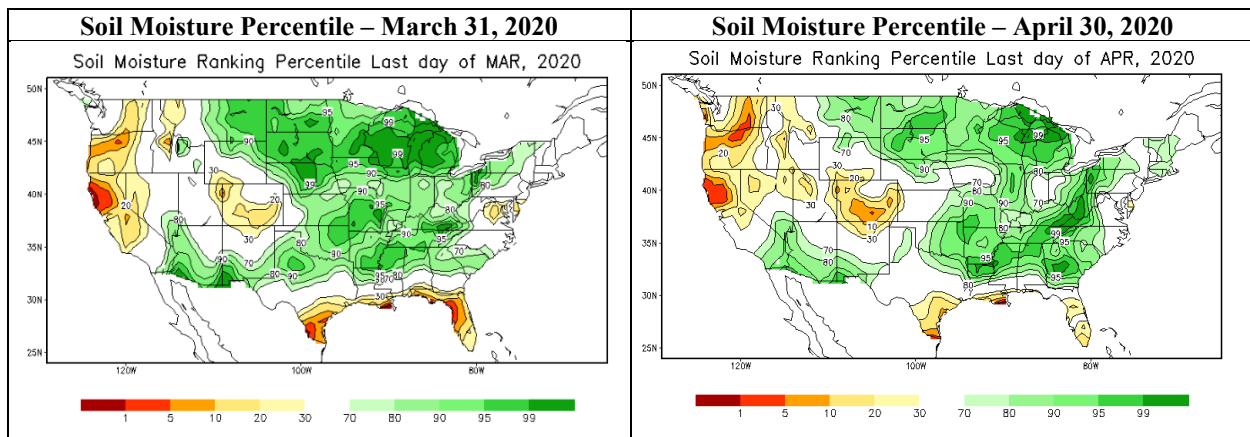


Figure 6. February-March-April 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

## Soil Moisture

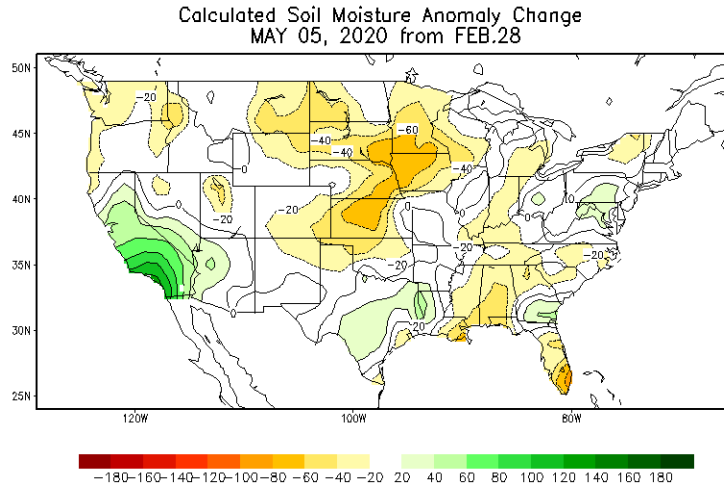
Soil moisture is factored into the forecast as an indicator of wet or dry hydrologic basin conditions. Typically when soil moisture conditions are wet or greater than normal, rainfall and snowmelt runoff is greater than when soil moisture is dry or less than normal. Not only is soil moisture a physical parameter that influences runoff, it can be used as an indicator of future runoff.

Soil moisture percentiles on March 31 based on the CPC's soil moisture model (see **Figure 7**) ranged from the 70<sup>th</sup> to 99<sup>th</sup> percentile ranking. Much of eastern Montana, North Dakota, South Dakota and Nebraska soils ranked above the 95<sup>th</sup> percentile, indicating soil conditions were very wet. In comparison, soil moisture at the end of April ranks in the 70<sup>th</sup> to 95<sup>th</sup> percentile. Widespread soil conditions are within the 90<sup>th</sup> percentile on April 30, compared to the 95<sup>th</sup> percentile on March 31. This indicates that soils have dried over the last couple months. The wettest soils on April 30 are above the 95<sup>th</sup> percentile in northern South Dakota and southern North Dakota.



**Figure 7. NOAA CPC Soil Moisture Anomaly (mm) and Soil Moisture Percentile. Source:**  
[https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

Soil moisture relative to normal soil moisture conditions has decreased since February 28, which is the climatological end of winter. The decrease in soil moisture is represented in the soil moisture anomaly change shown in **Figure 8**. Relative to normal soil moisture conditions, the soil moisture anomaly has decreased 20 mm (0.8 inches) to 60 mm (2.4 inches), indicating soils are drier relative to normal conditions on May 5. While soils have dried as a result of below-normal precipitation, runoff potential due to precipitation is still above normal because soil moisture percentiles continue to be above normal on April 30 (see **Figure 7**).



**Figure 8. Calculated soil moisture anomaly change since February 28, 2020. Source: [https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)**

## Plains Snowpack

Plains snowpack is an important parameter that influences the volume of runoff occurring in the basin during the months of March and April. A common misperception is that the March-April runoff is a result of plains snowmelt only. Historically, about 25% of annual runoff occurs in March and April, during the time when plains snow is melting, due to both melting snowpack and rainfall runoff. Runoff occurs in March and April whether or not there is any plains snow to melt. Determining exact rainfall amounts and locations are nearly impossible to predict more than a week in advance. Thus, the March-April runoff forecast is formulated based on existing plains snowpack and existing basin conditions and hydrologic forecasts, which for this year primarily includes long-term precipitation outlooks.

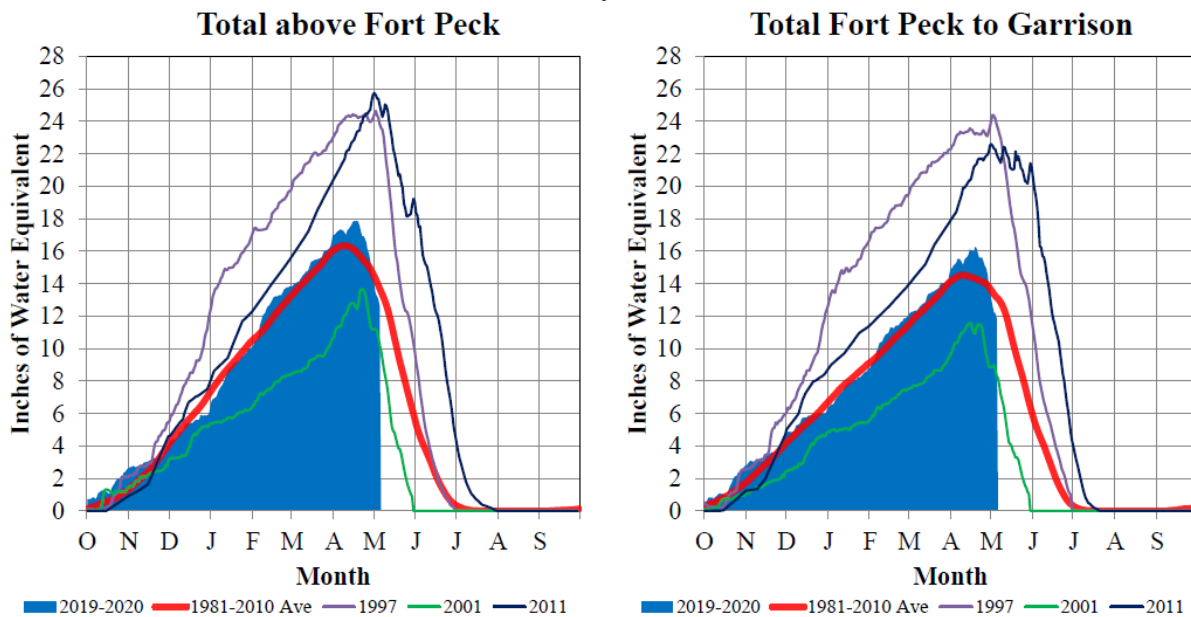
During April 2020, several winter storms deposited light-to-moderate snow in the upper Missouri Basin, and portions of the lower Basin in Nebraska and Iowa; however, this snowfall melted within several days of occurring. With the drier first months of the year and the soil conditions starting to return to more normal conditions, April streamflow and runoff did NOT rise due to the additional snowmelt. This resulted in well-below average runoff in the Fort Peck, Garrison, Oahe and Fort Randall reaches.

## Mountain Snowpack

Mountain snowpack is the primary factor used to predict May, June and July runoff volumes in the Fort Peck and Fort Peck to Garrison reaches. As the date of peak snowpack accumulation, usually around April 15, approaches, the correlation between the level of mountain snowpack and May, June and July runoff increases. Mountain snowpack becomes a better predictor of Fort Peck and Garrison reach runoff once it reaches its peak.

**Figure 9** includes time-series plots of the mountain SWE beginning on October 1, 2019 based on the NRCS SNOTEL data for the basin above Fort Peck and the incremental basin from Fort Peck to Garrison. The current average SWE values (shaded blue area) are plotted against the 1981-2010 basin average SWE (bold red line), a recent low SWE year in 2001 (green line), and two historic high SWE years occurring in 1997 (purple) and 2011 (dark blue).

### Missouri River Basin – Mountain Snowpack Water Content 2019-2020 with comparison plots from 1997\*, 2001\*, and 2011 5-May-2020



On May 5, 2020 the mountain Snow Water Equivalent (SWE) in the “Total above Fort Peck” reach was 12.7” 92% of average. The mountain SWE in the “Total Fort Peck to Garrison” reach was 11.9”, 90% of average. The “Total above Fort Peck” reach snowpack peaked on April 16 at 17.9”, 109% of the normal April 15 peak. The “Total Fort Peck to Garrison” reach snowpack peaked on April 19 at 16.3”, 112% of the normal April 15 peak.

\*Generally considered the high and low year of the last 25-year period, respectively

Provisional data. Subject to revision.

**Figure 9. Mountain snowpack water content on May 5, 2020 compared to normal and historic conditions. Corps of Engineers - Missouri River Basin Water Management.**

Mountain snowpack peaked in mid-April and has begun to melt. Mountain snowpack peaked in the Fort Peck reach at 17.9 inches (109% of average) on April 16. Mountain snowpack peaked in the Garrison reach at 16.3 inches (112% of average) on April 19. Mountain snowpack normally peaks on April 15. Mountain snowpack as of May 5 was 92% above Fort Peck and 90% from Fort Peck to Garrison. Tributary streams in the Fort Peck and Garrison reaches have risen as a result of mountain snowmelt runoff, and flows into Fort Peck and Garrison are expected to increase over the next week or so as the mountain snowmelt arrives at each reservoir.

## **Climate Outlook**

MRBWM participates in the monthly North Central U.S. Climate/Drought Outlook Webinar coordinated through NOAA, the regional climate centers, and the American Association of State Climatologists (AASC). These webinars provide updates on near-term climate outlooks and impacts including the ENSO climate pattern and its implications on winter temperature and precipitation patterns in the Missouri Basin.

### **ENSO (El Niño Southern Oscillation)**

The latest ENSO Outlook indicates that ENSO-neutral conditions are present, and will likely remain neutral during the Northern Hemisphere summer 2020 with a 60% probability. During ENSO-neutral conditions there are no strong climate indicators to provide much certainty on the precipitation and temperature outlooks beyond the winter and early spring seasons.

### **Temperature and Precipitation Outlooks**

The CPC outlooks provide the forecasted probability (or chance) of occurrence of future weather conditions during periods ranging from 1 to 12 months into the future. The CPC outlooks are available at <http://www.cpc.ncep.noaa.gov/>.

The CPC temperature outlook for the forecast period from May 14-20 is shown in **Figure 10**. The outlook is indicating a slight increase in the chances for below-normal temperatures in the north central U.S., with equal chances for above-normal, normal, and below-normal temperatures in Montana and Wyoming. With regard to precipitation, there is a slight increase in the chances for above-normal precipitation throughout the Missouri Basin. During the month of May (**Figure 11**), the temperature outlook is indicating mostly equal chances for above-normal, normal, and below normal temperatures in the Missouri Basin. In the continental U.S., there is a significant increase in chances for above-normal temperatures in the western and southwestern U.S., and an increase in chances for below-normal temperatures centered over the Great Lakes region. With regard to precipitation, the May outlook is indicating mostly equal chances for above-normal, normal, and below-normal precipitation in the Missouri Basin. There is a slight increase in chances for below-normal precipitation in southwestern Wyoming and eastern South Dakota.

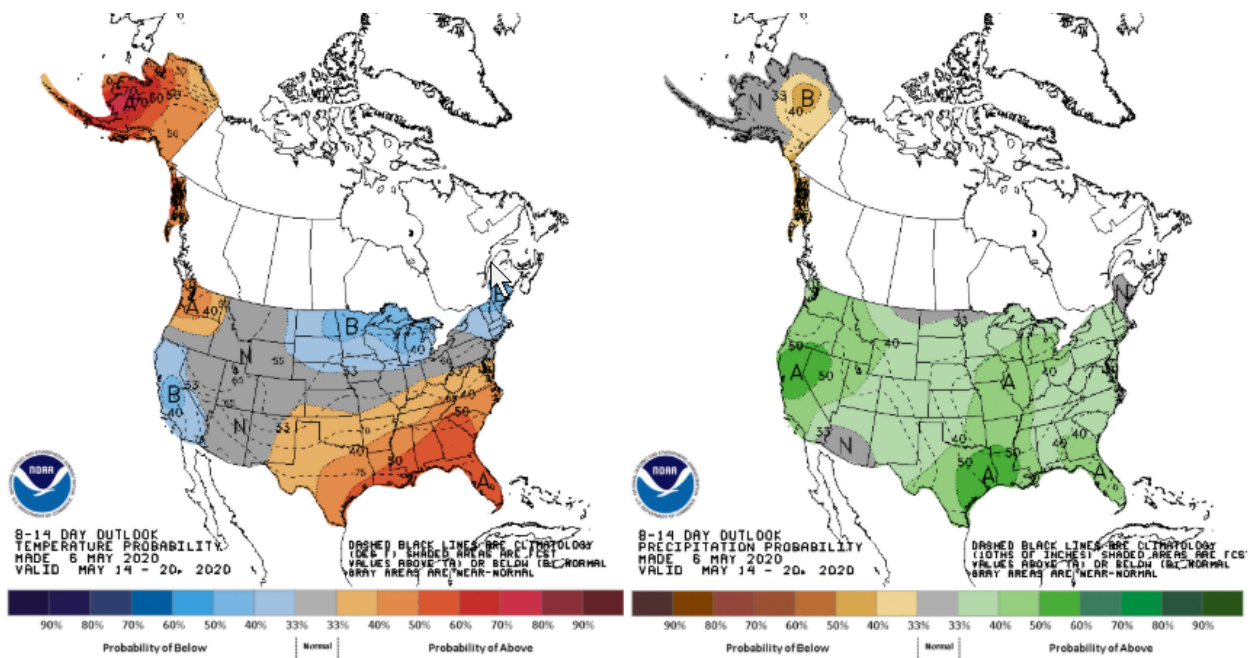


Figure 10. CPC 8-14 Day temperature and precipitation outlooks through May 20, 2020.

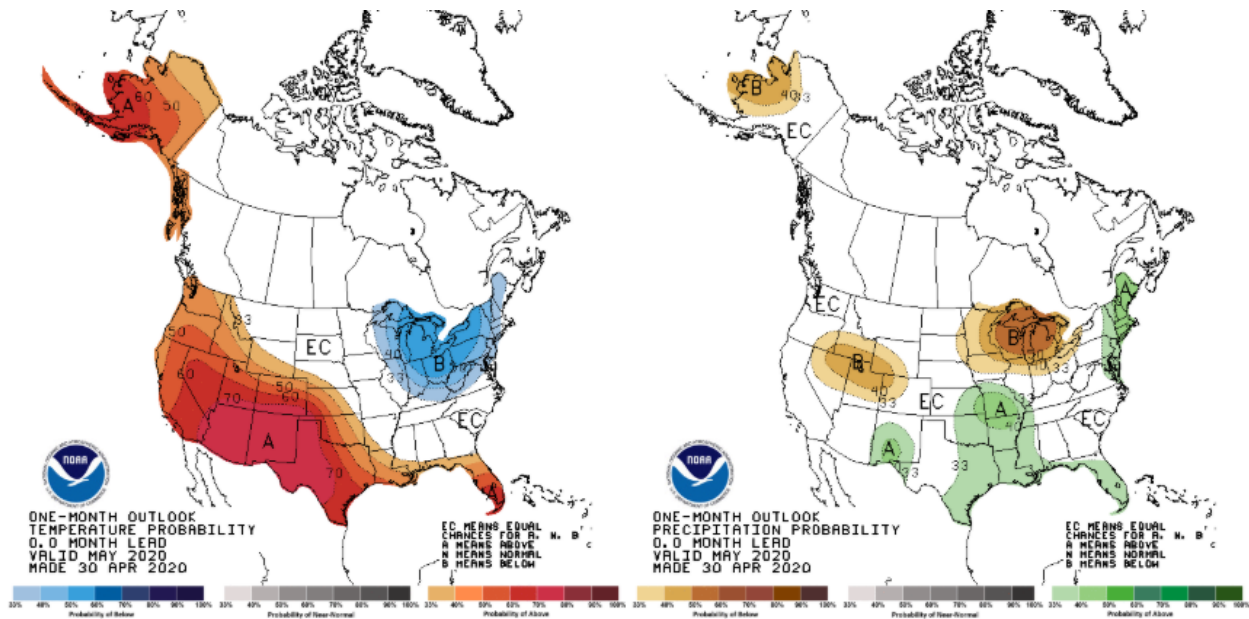


Figure 11. CPC May 2020 temperature and precipitation outlooks.

Three-month temperature and precipitation outlooks for the three-month periods from June through February 2021 are shown below in **Figures 12-14**. During the June-July-August 2020 (**Figure 12**), the CPC indicates increased chances for above-normal temperatures in the western two-thirds of the Missouri Basin, with equal chances in eastern regions of North Dakota, South Dakota, Nebraska and Kansas, and all of Iowa and Missouri. With regard to precipitation, there

are increased chances for below-normal precipitation in Montana and northwestern Wyoming, and a slight increase in chances for above-normal precipitation in eastern South Dakota and the lower Basin.

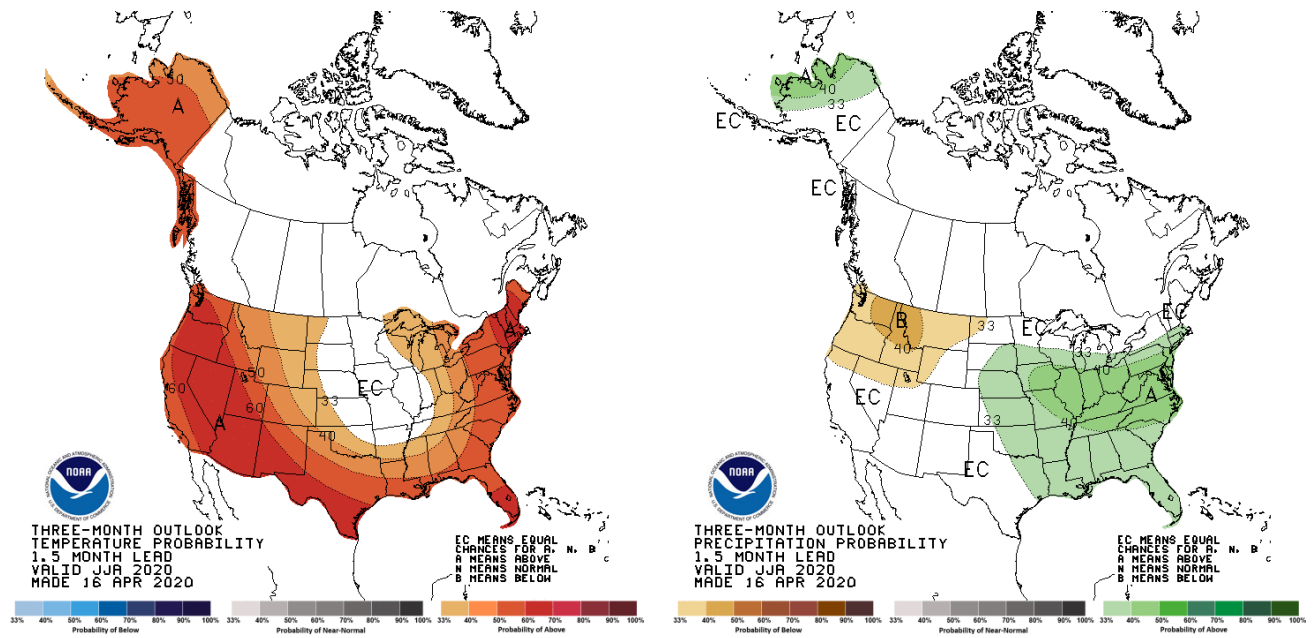


Figure 12. CPC June-July-August 2020 temperature and precipitation outlooks.

During the September-October-November 2020 forecast period (**Figure 13**), there are increased chances for above-normal temperatures throughout the entire Missouri Basin. With regard to precipitation during the September-October-November period, CPC is indicating there could be increased chances for above-normal precipitation in most of the upper Basin, and a slight tilt toward below-normal precipitation in southern areas of the lower Basin.

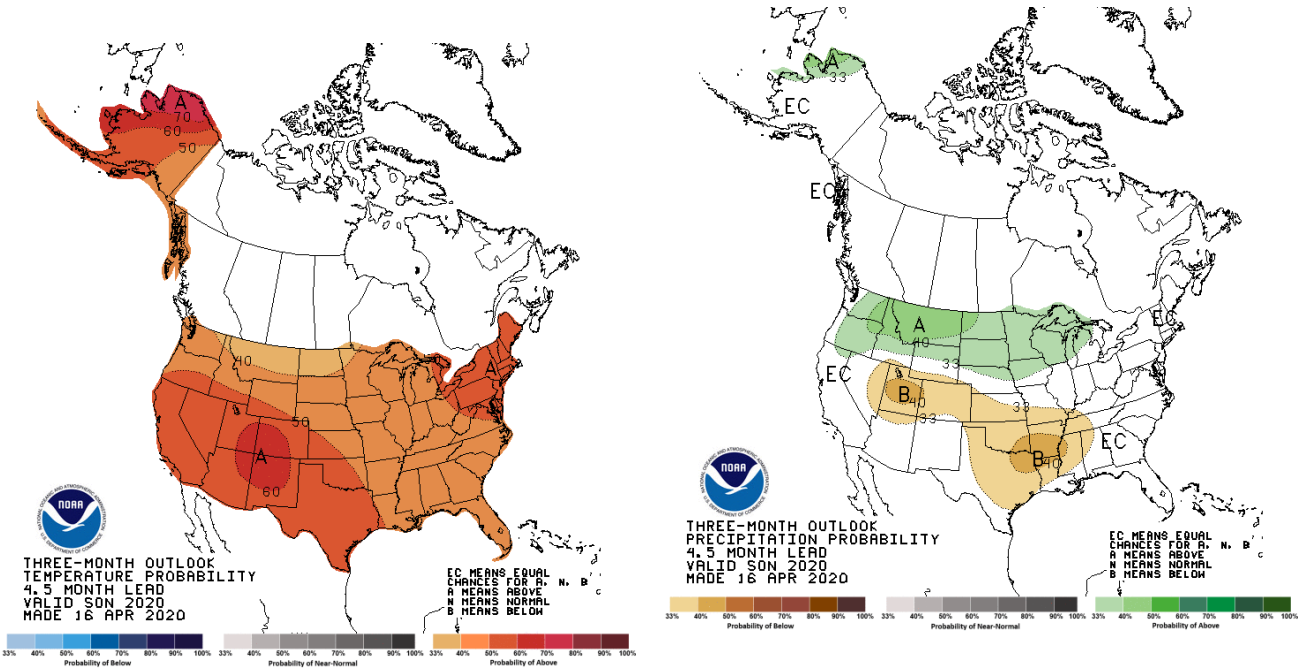


Figure 13. CPC September-October-November 2020 temperature and precipitation outlooks.

Finally, during the December 2020-January-February 2021 period, there is an increased chance for above-normal temperatures in Montana, Wyoming, Colorado, portions of Kansas and southern Missouri, while there are equal chances in the remainder of the Missouri Basin (Figure 14). With regard to precipitation, there are increased chances for above-normal precipitation throughout much of the Missouri Basin, and equal chances in Kansas and much of Missouri. As previously noted, though, there is limited confidence in climate outlooks beyond several months from the date of forecast. The climate outlooks are expected to change as the calendar year progresses.

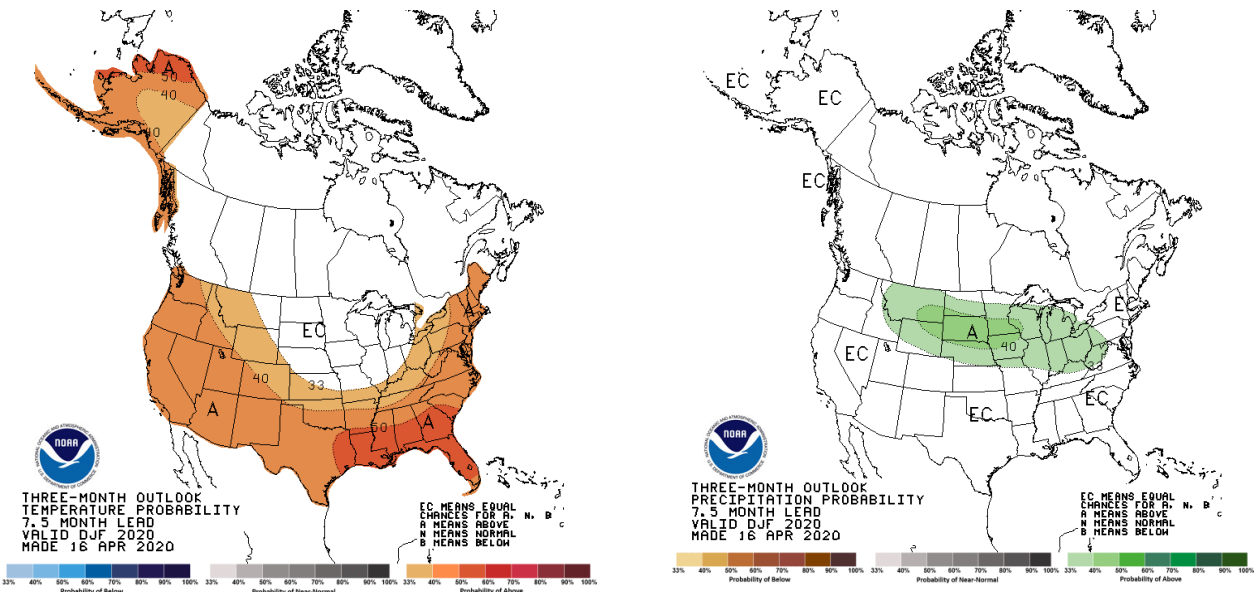


Figure 14. CPC December 2020-January-February 2021 temperature and precipitation outlooks.

## **Summary**

In summary, the 2020 calendar year runoff forecast is **32.2 MAF (125% of average)**. The May 1 calendar year runoff forecast is about midway between an upper quartile and upper decile runoff volume.

## Water Supply Forecasts

USDA NRCS National Water & Climate Center

\* - DATA CURRENT AS OF: May 06, 2020 12:57:42 PM

- Based on May 01, 2020 forecast values

### PRELIMINARY MISSOURI RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
Lake Sherburne Inflow (2)	MAY-JUL	95	110	112	102	88	78	86
	MAY-SEP	110	109	129	118	103	91	101
St. Mary R at Intl Boundary (2)	MAY-JUL	445	111	535	480	405	350	400
	MAY-SEP	515	110	620	555	470	410	470
Lima Reservoir Inflow (2)	MAY-JUL	36	72	59	45	27	12.6	50
	MAY-SEP	40	71	66	50	30	14.2	56
Clark Canyon Reservoir Inflow (2)	MAY-JUL	40	63	85	58	22	1.00	64
	MAY-SEP	56	67	111	78	34	1.06	83
Jefferson R nr Three Forks (2)	MAY-JUL	465	81	740	575	355	194	575
	MAY-SEP	510	80	830	640	385	195	635
Hebgen Lake Inflow (2)	MAY-JUL	280	92	345	305	255	215	305
	MAY-SEP	375	93	460	410	340	290	405
Ennis Lake Inflow (2)	MAY-JUL	465	88	575	510	420	355	530
	MAY-SEP	605	89	745	660	550	465	680
Missouri R at Toston (2)	MAY-JUL	1370	93	1810	1550	1190	930	1480
	MAY-SEP	1620	92	2180	1840	1390	1060	1760
Smith R bl Eagle Ck (2)	MAY-JUL	85	96	131	104	66	39	89
	MAY-SEP	95	96	151	118	72	39	99
Gibson Reservoir Inflow (2)	MAY-JUL	375	106	440	400	350	310	355
	MAY-SEP	415	105	490	445	385	340	395
Marias R nr Shelby (2)	MAY-JUL	330	110	445	375	285	215	300
	MAY-SEP	345	110	470	395	295	220	315

### PRELIMINARY YELLOWSTONE RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
West Rosebud Ck nr Roscoe (2)	MAY-JUL	60	105	67	63	57	52	57
	MAY-SEP	77	107	86	80	73	67	72
Wind R ab Bull Lake Ck	MAY-JUL	455	106	560	500	415	350	430
	MAY-SEP	490	105	605	535	445	375	465
Bull Lake Ck nr Lenore (2)	MAY-JUL	122	90	144	131	112	99	135
	MAY-SEP	148	89	174	159	137	122	166
Boysen Reservoir Inflow (2)	MAY-JUL	530	95	755	620	440	305	560
	MAY-SEP	575	93	810	670	480	340	615
Greybull R at Meeteetse	MAY-JUL	108	87	155	127	89	61	124
	MAY-SEP	148	87	205	171	126	93	170
Shell Ck nr Shell	MAY-JUL	52	100	66	57	46	37	52
	MAY-SEP	63	100	78	69	56	47	63
Bighorn R at Kane (2)	MAY-JUL	705	92	1070	855	560	340	770
	MAY-SEP	750	90	1130	905	595	370	830
NF Shoshone R at Wapiti	MAY-JUL	465	108	545	500	430	385	430
	MAY-SEP	520	107	615	560	480	425	485
SF Shoshone R nr Valley	MAY-JUL	220	110	260	235	205	181	200
	MAY-SEP	255	109	300	270	235	210	235
Buffalo Bill Reservoir Inflow	MAY-JUL	705	112	840	760	650	570	630

	MAY-SEP	780	111	925	840	725	635	700
Bighorn R nr St. Xavier (2)	MAY-JUL	1250	99	1710	1440	1070	795	1260
	MAY-SEP	1310	98	1810	1510	1110	820	1340
Little Bighorn R nr Hardin	MAY-JUL	76	89	119	93	58	33	85
	MAY-SEP	87	90	136	107	68	39	97
Tongue R nr Dayton (2)	MAY-JUL	72	90	97	83	62	48	80
	MAY-SEP	84	91	112	95	73	57	92
Tongue River Reservoir Inflow (2)	MAY-JUL	147	84	235	182	111	59	175
	MAY-SEP	169	85	265	205	132	76	198
NF Powder R nr Hazelton	MAY-JUL	8.7	105	11.9	10.0	7.5	5.6	8.3
	MAY-SEP	9.4	104	12.7	10.8	8.1	6.2	9.0
Powder R at Moorhead	MAY-JUL	149	99	270	199	99	26	151
	MAY-SEP	167	98	290	215	117	43	170
Powder R nr Locate	MAY-JUL	164	100	305	220	107	25	164
	MAY-SEP	183	99	330	240	124	38	185

#### PRELIMINARY RAPID VALLEY UNIT FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
Deerfield Reservoir Inflow (2)	MAY-JUL	4.2	108	6.6	5.2	3.2	1.72	3.9
Pactola Reservoir Inflow (2)	MAY-JUL	18.2	104	30	23	13.6	6.8	17.5

#### PRELIMINARY PLATTE RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
North Platte R nr Northgate (2)	MAY-JUL	199	106	290	235	161	105	187
	MAY-SEP	225	107	330	265	181	118	210
Encampment R nr Encampment (2)	MAY-JUL	112	95	153	128	95	70	118
	MAY-SEP	120	94	163	137	102	76	127
Rock Ck ab King Canyon Cnl nr Arlington	MAY-JUL	56	117	68	61	52	45	48
	MAY-SEP	59	118	72	64	54	47	50
Seminole Reservoir Inflow (2)	MAY-JUL	665	108	905	760	570	430	615
	MAY-SEP	730	109	980	830	625	475	670
Sweetwater R nr Alcova	MAY-JUL	19.3	42	43	29	9.8	1.00	46
	MAY-SEP	22	44	47	32	11.8	0.50	50
La Prele Ck nr Douglas	MAY-JUL	15.3	103	23	18.5	12.1	7.4	14.9
	MAY-SEP	15.4	104	23	18.6	12.2	7.5	14.8
North Platte R bl Glendo Reservoir (2)	MAY-JUL	635	95	965	770	505	310	670
	MAY-SEP	675	96	1010	810	535	335	700
North Platte R bl Guernsey Reservoir (2)	MAY-JUL	635	95	975	770	495	290	670
	MAY-SEP	675	96	1020	815	530	325	700
Laramie R and Pioneer Cnl nr Woods Lg (2)	MAY-JUL	101	94	140	117	86	63	108
	MAY-SEP	112	94	154	129	95	70	119
Little Laramie R nr Filmore	MAY-JUL	64	133	80	71	58	49	48
	MAY-SEP	70	135	87	77	63	53	52

Max (10%), 30%, 50%, 70% and Min (90%) chance that actual volume will exceed forecast.

Averages are for the 1981-2010 period.

All volumes are in thousands of acre-feet.

footnotes:

- 1) Max and Min are 5% and 95% chance that actual volume will exceed forecast
- 2) streamflow is adjusted for upstream storage

**Upper Missouri River Basin  
June 2020 Calendar Year Runoff Forecast  
June 3, 2020**

**U.S. Army Corps of Engineers, Northwestern Division  
Missouri River Basin Water Management  
Omaha, NE**

**Calendar Year Runoff Forecast**

**Explanation and Purpose of Forecast**

The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. The Calendar Year Runoff Forecast is available at <http://www.nwd-mr.usace.army.mil/rcc/reports/runoff.pdf>. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows in million acre-feet (MAF) from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri Basin above Sioux City (upper Basin). The Calendar Year Runoff Forecast is used in the Monthly Study simulation model to plan future system regulation in order to meet the authorized project purposes throughout the calendar year.

**Observed Runoff**

May runoff was 4.5 MAF (131% of average) in the upper Basin above Sioux City, about 0.5 MAF more than what was forecast on May 1. Above-normal precipitation in parts of Montana and South Dakota on top of wet soils resulted in above-average runoff in every reach.

**2020 Calendar Year Forecast Synopsis**

The 2020 calendar year runoff forecast for the upper Missouri Basin above Sioux City, IA is **32.3 MAF, 125% of average**. The 2020 calendar year runoff forecast for the Missouri Basin above Gavins Point is **26.2 MAF, 112% of average**. Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next 7 months, expected inflow could range from the 38.1 MAF upper basic forecast to the 27.2 MAF lower basic forecast. The upper and lower basic forecasts are used in long-term regulation planning models to “bracket” the range of expected runoff given much wetter or drier conditions, respectively. Given that 7 months are being forecast for this June 1 forecast (5 months observed/7 months forecast), the range of possible wetter-than-expected (upper basic) and drier-than-expected (lower basic) conditions is

very large, and is attributed to all six reaches for the remaining 7 months of the year. The result is a range or “bracket” for each reach, and thus, for the total runoff forecast.

## Current Conditions

### Drought Analysis

The National Drought Mitigation Center’s drought monitor for May 26, 2020 is shown in **Figure 1**. The drought monitor is available at <http://droughtmonitor.unl.edu/>. The U.S. Drought Monitor shows Moderate Drought (D1) is now present in southwestern North Dakota. Abnormally Dry (D0) conditions are present in southern and eastern Montana, western North Dakota, northern Wyoming, isolated areas of Iowa, and along the Nebraska-Kansas border. This is a reflection of much drier conditions that have occurred in 2020. The National Weather Service (NWS) Climate Prediction Center’s (CPC) Seasonal Drought Outlook in **Figure 2**, which extends through the end of August, shows the drought in North Dakota persisting and indicates no new drought development within the Missouri Basin during the outlook period.

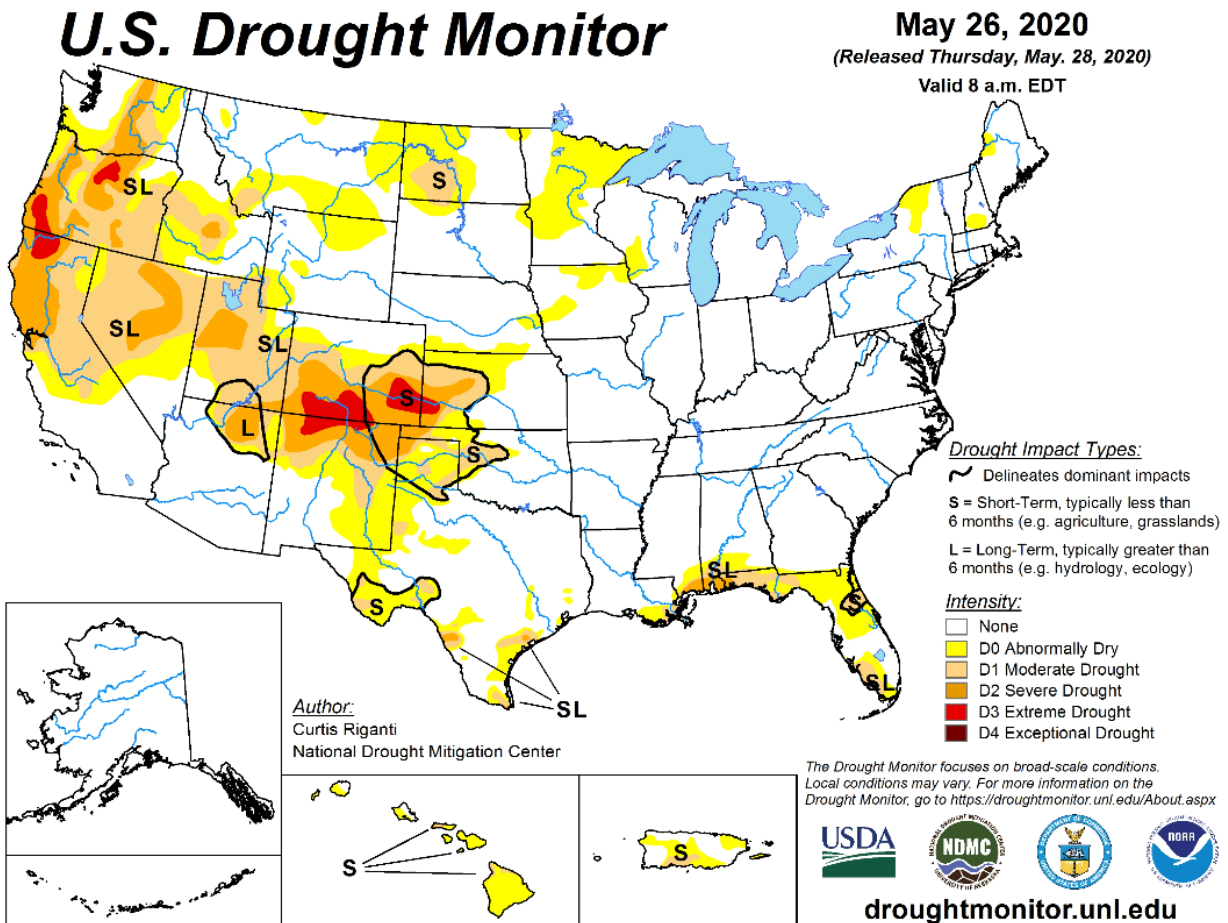


Figure 1. National Drought Mitigation Center U.S. Drought Monitor for May 26, 2020.

# U.S. Seasonal Drought Outlook

## Drought Tendency During the Valid Period

Valid for May 21 - August 31, 2020  
Released May 21

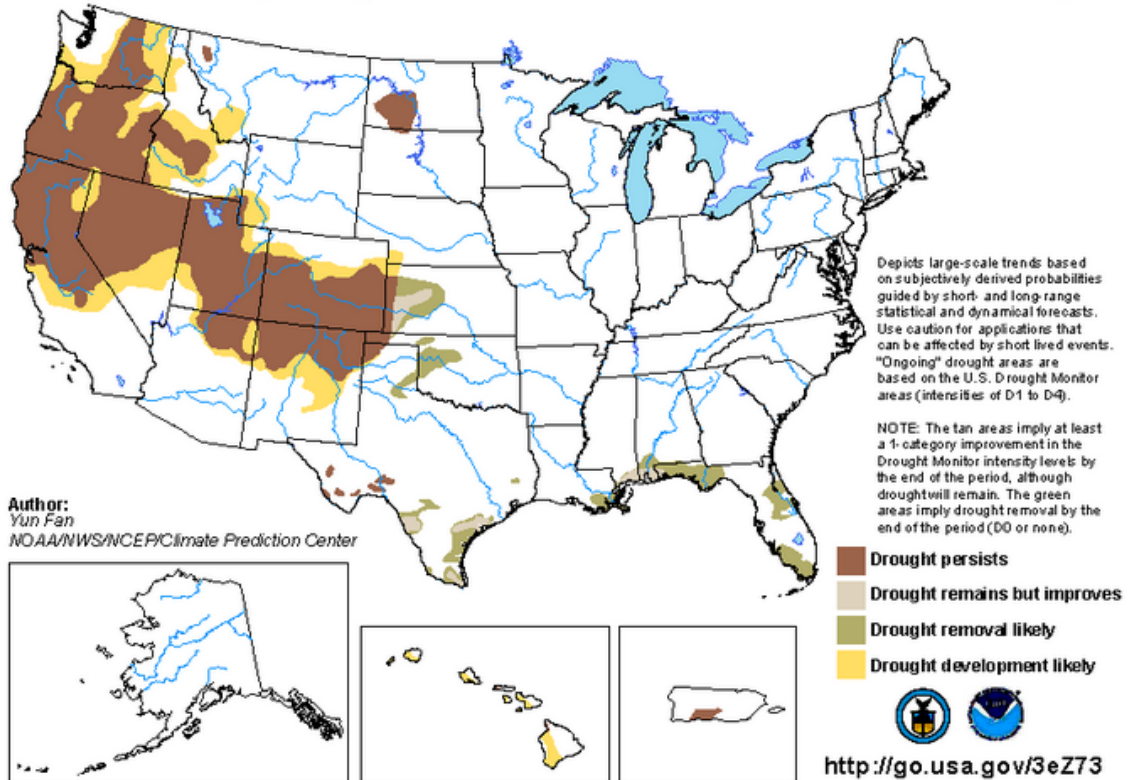


Figure 2. NWS CPC Seasonal Drought Outlook.

## Precipitation

Monthly precipitation accumulations are shown using High Plains Regional Climate Center images available at <http://www.hprcc.unl.edu/>. The May precipitation accumulation map is shown in **Figure 3** as a percent of normal precipitation. May precipitation was below normal over most of the upper Basin, with the exception of central Nebraska, central South Dakota, and areas of Montana, which received from 130 to 200% of normal precipitation. May precipitation for Wyoming and North Dakota was as low as 25% of normal.

Percent of Normal Precipitation (%)  
5/1/2020 – 5/31/2020

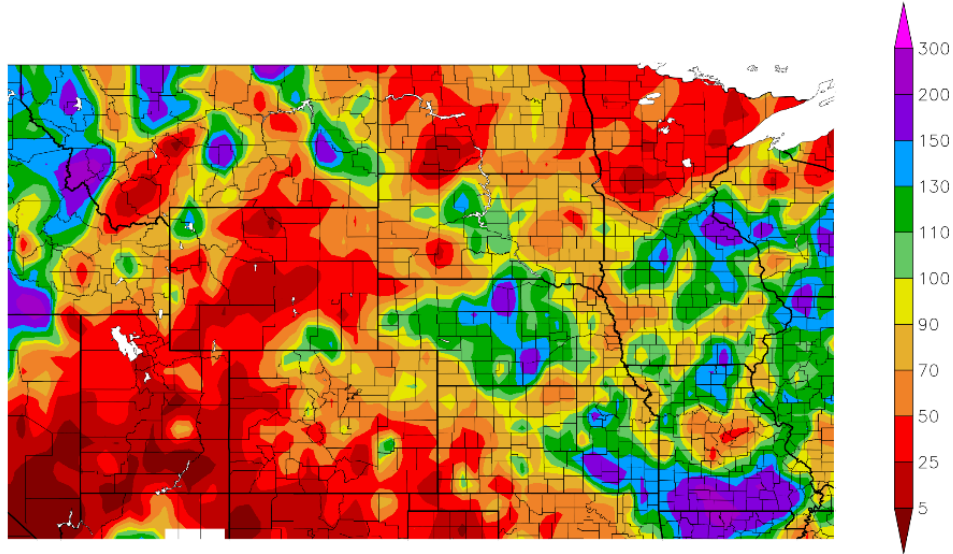


Figure 3. May 2020 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Since February 2, the upper Basin has received less than 70% of normal precipitation (see **Figure 4**) in most areas except for areas of Montana, central South Dakota, and central Nebraska. Western North Dakota received as low as 50% of normal precipitation over the past 120 days.

Percent of Normal Precipitation (%)  
2/2/2020 – 5/31/2020

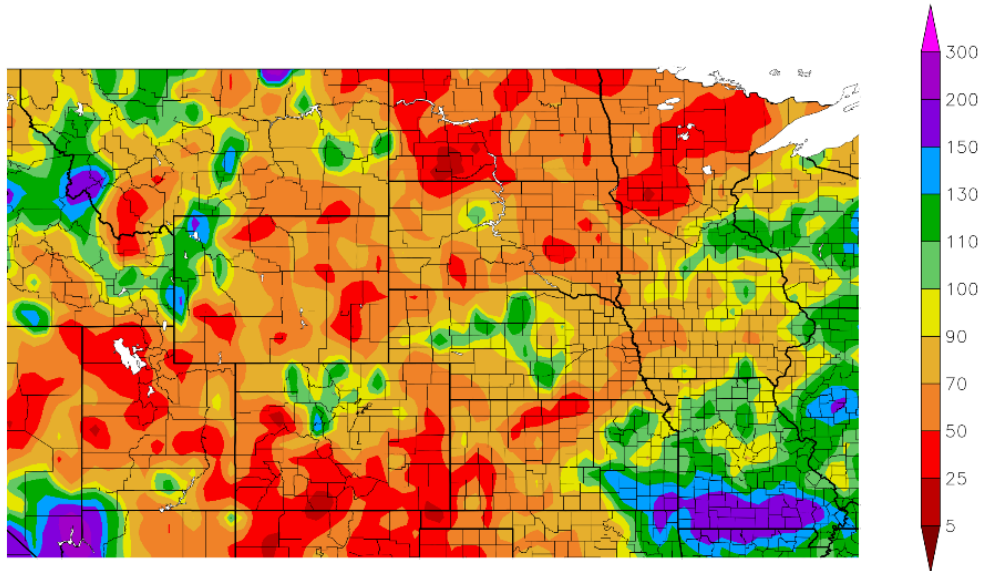


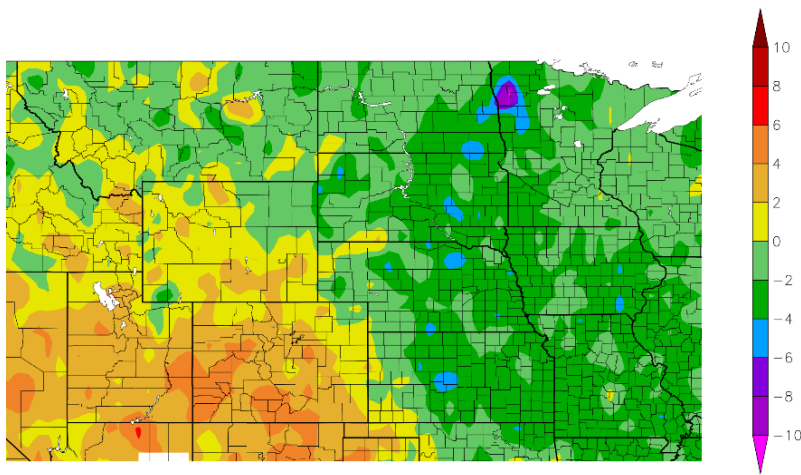
Figure 4. February 2 – May 31 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

## Temperature

May temperature departures in degrees Fahrenheit (deg F) in **Figure 5** were 2 to 6 deg F below normal in most of the Basin. In the Rocky Mountains, May temperatures were normal to about 4 deg F above normal.

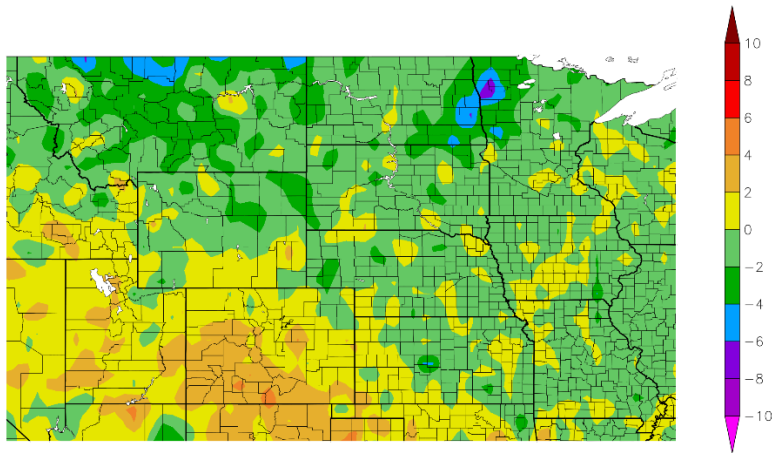
March-April-May temperature departures are shown in **Figure 6**. The average three-month temperatures were generally near-normal, with areas of slightly warmer temperatures in Colorado and southern Wyoming, and areas of slightly cooler temperatures in Montana and North Dakota.

Departure from Normal Temperature (F)  
5/1/2020 – 5/31/2020



**Figure 5. May 2020 Departure from Normal Temperature (deg F).** Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Departure from Normal Temperature (F)  
3/1/2020 – 5/31/2020

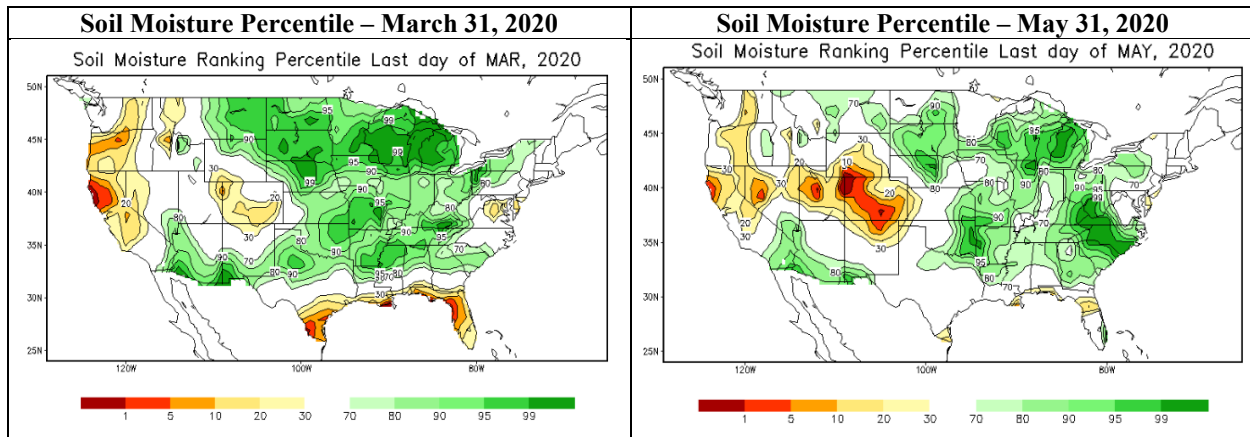


**Figure 6. March-April-May 2020 Departure from Normal Temperature (deg F).** Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

## Soil Moisture

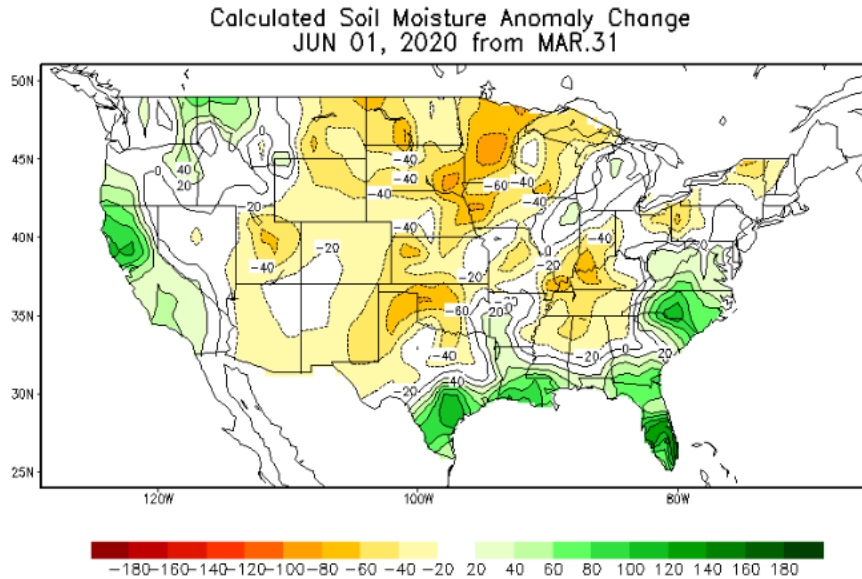
Soil moisture is factored into the forecast as an indicator of wet or dry hydrologic basin conditions. Typically when soil moisture conditions are wet or greater than normal, rainfall and snowmelt runoff is greater than when soil moisture is dry or less than normal. Not only is soil moisture a physical parameter that influences runoff, it can be used as an indicator of future runoff.

Soil moisture percentiles on March 31 based on the CPC's soil moisture model (see **Figure 7**) ranged from the 70<sup>th</sup> to 99<sup>th</sup> percentile ranking. Much of eastern Montana, North Dakota, South Dakota and Nebraska soils ranked above the 95<sup>th</sup> percentile, indicating soil conditions were very wet. In comparison, soil moisture at the end of May ranks in the 30<sup>th</sup> to 70<sup>th</sup> percentile over much of the Basin. This indicates that soils have dried over the last couple months over much of the Basin. Soil moisture is still in the 90<sup>th</sup> to 99<sup>th</sup> percentile in north-central Nebraska, central South Dakota, and eastern North Dakota.



**Figure 7. NOAA CPC Soil Moisture Anomaly (mm) and Soil Moisture Percentile. Source:**  
[https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

Soil moisture relative to normal soil moisture conditions has decreased since March 31. The decrease in soil moisture is represented in the soil moisture anomaly change shown in **Figure 8**. Relative to normal soil moisture conditions, the soil moisture anomaly has decreased 20 mm (0.8 inches) to 80 mm (3.15 inches), indicating soils are drier relative to normal conditions on June 1. While soils have dried as a result of below-normal precipitation, runoff potential due to precipitation is still normal to above normal because soil moisture percentiles continue to be above normal in many areas on May 31 (see **Figure 7**).



**Figure 8. Calculated soil moisture anomaly change since March 31, 2020. Source:**  
[https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

## Plains Snowpack

Plains snowpack is an important parameter that influences the volume of runoff occurring in the basin during the months of March and April. A common misperception is that the March-April runoff is a result of plains snowmelt only. Historically, about 25% of annual runoff occurs in March and April, during the time when plains snow is melting, due to both melting snowpack and rainfall runoff. Runoff occurs in March and April whether or not there is any plains snow to melt. Determining exact rainfall amounts and locations are nearly impossible to predict more than a week in advance. Thus, the March-April runoff forecast is formulated based on existing plains snowpack and existing basin conditions and hydrologic forecasts, which for this year primarily includes long-term precipitation outlooks.

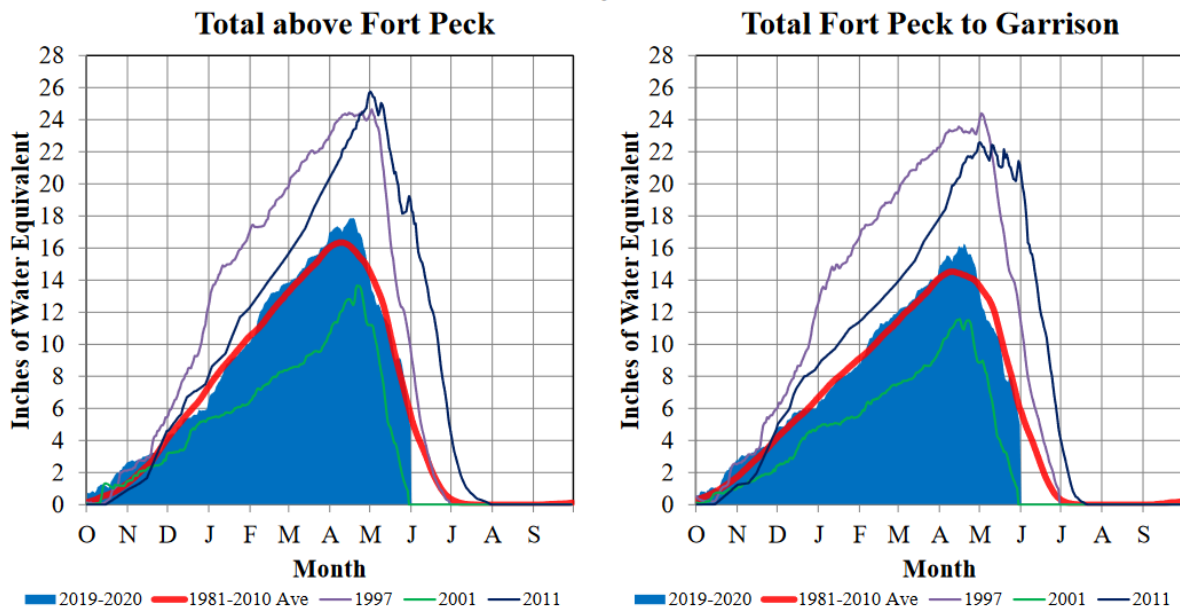
While snow may have occurred in some areas of the plains during May, this did not contribute to increasing flows. Plains snowpack was not a factor in this June 1 forecast.

## Mountain Snowpack

Mountain snowpack is the primary factor used to predict May, June and July runoff volumes in the Fort Peck and Fort Peck to Garrison reaches. As the date of peak snowpack accumulation, usually around April 15, approaches, the correlation between the level of mountain snowpack and May, June and July runoff increases. Mountain snowpack becomes a better predictor of Fort Peck and Garrison reach runoff once it reaches its peak.

**Figure 9** includes time-series plots of the mountain SWE beginning on October 1, 2019 based on the NRCS SNOTEL data for the basin above Fort Peck and the incremental basin from Fort Peck to Garrison. The current average SWE values (shaded blue area) are plotted against the 1981-2010 basin average SWE (bold red line), a recent low SWE year in 2001 (green line), and two historic high SWE years occurring in 1997 (purple) and 2011 (dark blue).

### Missouri River Basin – Mountain Snowpack Water Content 2019-2020 with comparison plots from 1997\*, 2001\*, and 2011 31-May-2020



On May 31, 2020 the mountain Snow Water Equivalent (SWE) in the “Total above Fort Peck” reach was 4.8” 84% of the May 31 average. The mountain SWE in the “Total Fort Peck to Garrison” reach was 4.9” 83% of the May 31 average. The “Total above Fort Peck” reach snowpack peaked on April 16 at 17.9”, 109% of the normal April 15 peak. The “Total Fort Peck to Garrison” reach snowpack peaked on April 19 at 16.3”, 112% of the normal April 15 peak.

\*Generally considered the high and low year of the last 25-year period, respectively

Provisional data. Subject to revision.

**Figure 9. Mountain snowpack water content on May 31, 2020 compared to normal and historic conditions. Corps of Engineers - Missouri River Basin Water Management.**

Mountain snowpack peaked in mid-April and has begun to melt. Mountain snowpack peaked in the Fort Peck reach at 17.9 inches (109% of average) on April 16. Mountain snowpack peaked in the Garrison reach at 16.3 inches (112% of average) on April 19. Mountain snowpack normally peaks on April 15. Mountain snowpack as of May 31 was 84% of the May 31 average above Fort Peck and 83% of the May 31 average from Fort Peck to Garrison. Inflows into Fort Peck and Garrison have begun increasing as the mountain snowmelt arrives at each reservoir. Inflows into Fort Peck and Garrison are expected to be fairly high during the first two weeks of June.

## **Climate Outlook**

MRBWM participates in the monthly North Central U.S. Climate/Drought Outlook Webinar coordinated through NOAA, the regional climate centers, and the American Association of State Climatologists (AASC). These webinars provide updates on near-term climate outlooks and impacts including the ENSO climate pattern and its implications on winter temperature and precipitation patterns in the Missouri Basin.

### **ENSO (El Niño Southern Oscillation)**

The latest ENSO Outlook indicates that ENSO-neutral conditions are present, and will likely remain neutral during the Northern Hemisphere summer 2020 with a 65% probability. During ENSO-neutral conditions there are no strong climate indicators to provide much certainty on the precipitation and temperature outlooks beyond the winter and early spring seasons.

### **Temperature and Precipitation Outlooks**

The CPC outlooks provide the forecasted probability (or chance) of occurrence of future weather conditions during periods ranging from 1 to 12 months into the future. The CPC outlooks are available at <http://www.cpc.ncep.noaa.gov/>.

The CPC temperature outlook for the forecast period from June 7-11 is shown in **Figure 10**. The outlook is indicating an increase in the chances for below-normal temperatures in Montana and Wyoming, with an increase in the chances for above-normal temperatures across the rest of the Basin. With regard to precipitation, there is a slight increase in the chances for above-normal precipitation throughout the upper Missouri Basin. During the month of June (**Figure 11**), the temperature outlook is indicating increased chances for above-normal temperatures throughout the Basin. With regard to precipitation for the remainder of June, there are equal chances for above-normal, below-normal, and normal precipitation over the upper Basin. There are increased chances for below-normal precipitation in the lower Basin.

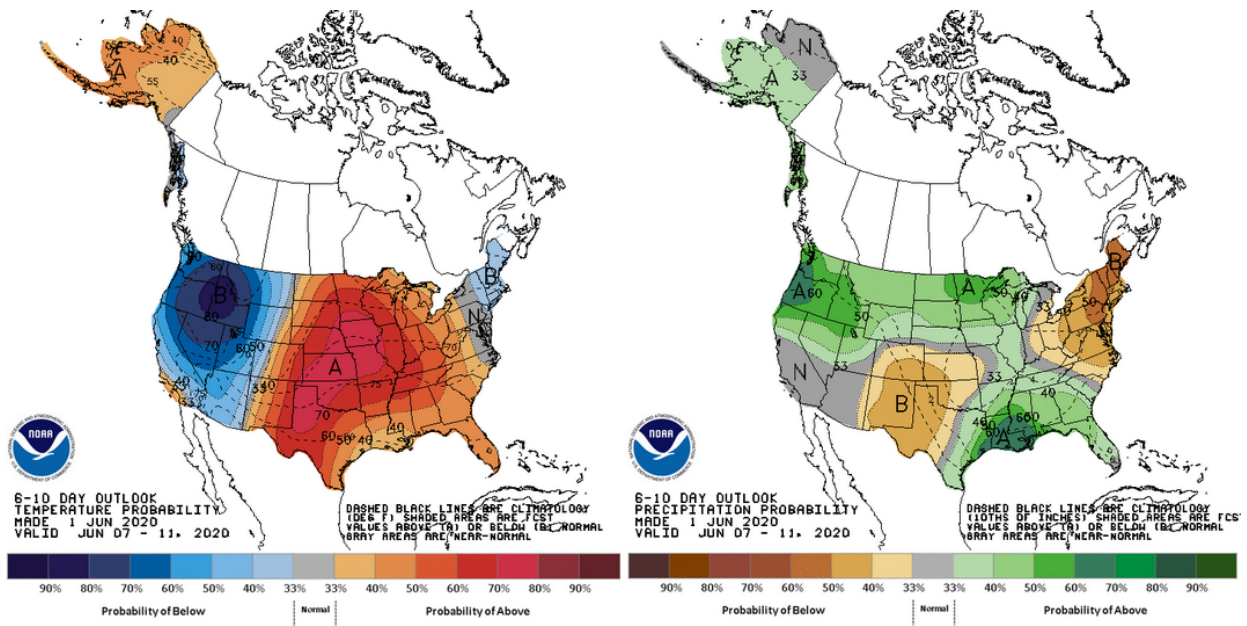


Figure 10. CPC 6-10 Day temperature and precipitation outlooks through June 11, 2020.

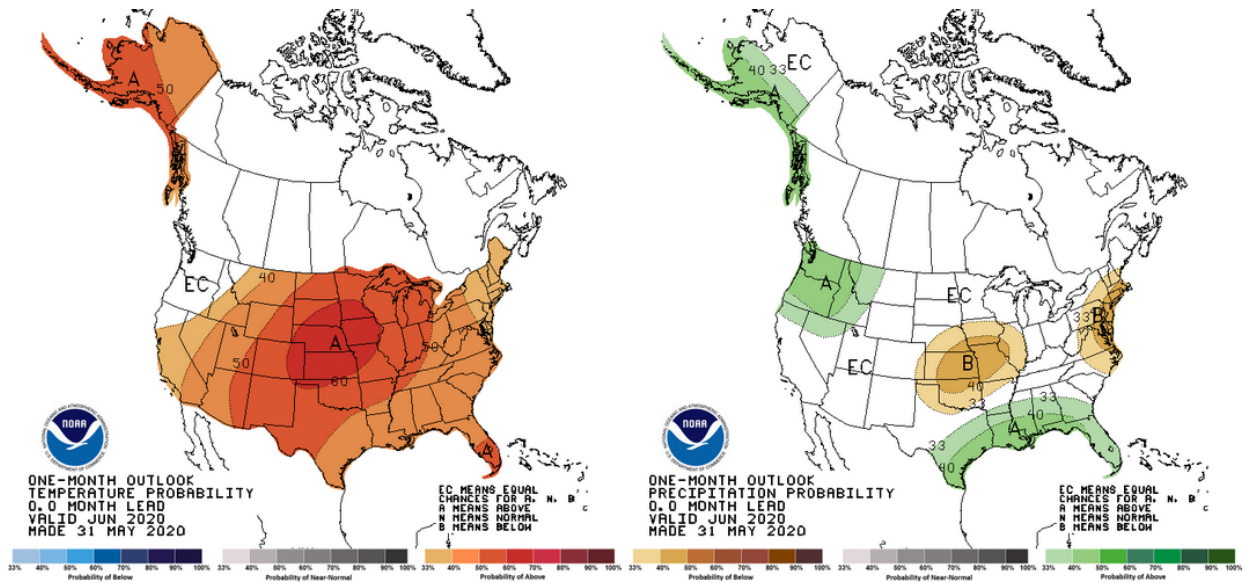


Figure 11. CPC June 2020 temperature and precipitation outlooks.

Three-month temperature and precipitation outlooks for the three-month periods from August through December 2020 are shown below in **Figure 12** and **Figure 13**. During July-August-September 2020 (**Figure 12**), the CPC indicates increased chances for above-normal temperatures across the entire Basin, with the exception of Missouri, which has equal chances. With regard to precipitation, there are increased chances for below-normal precipitation in Montana and western Wyoming, and a slight increase in chances for above-normal precipitation in the lower Basin.

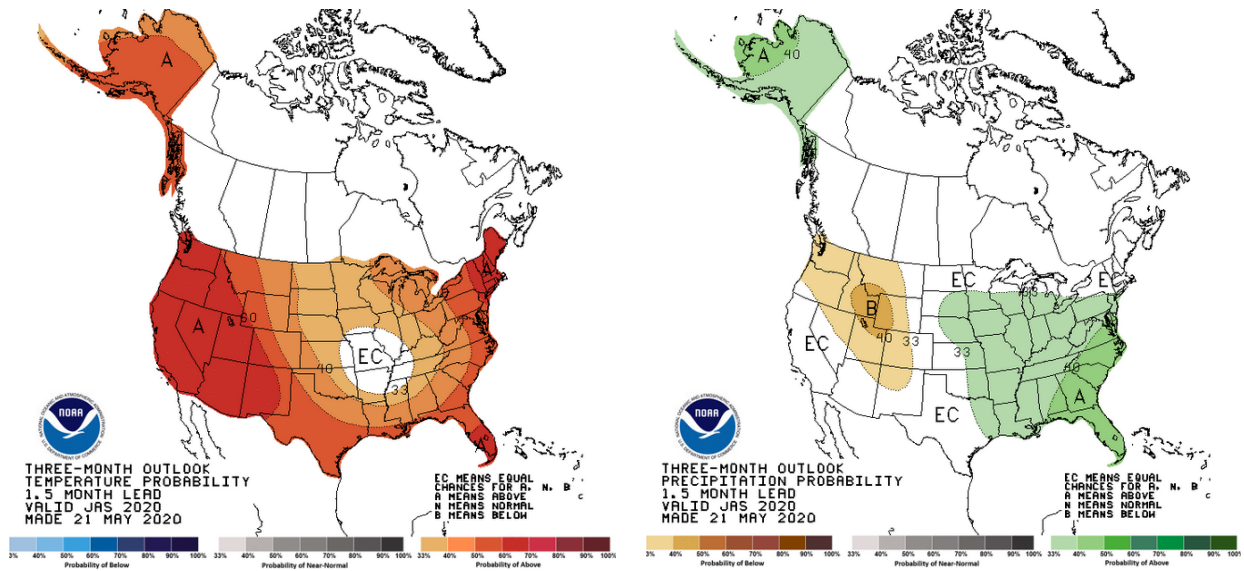


Figure 12. CPC July-August-September 2020 temperature and precipitation outlooks.

During the October-November-December 2020 forecast period (**Figure 13**), there are increased chances for above-normal temperatures throughout the entire Missouri Basin. With regard to precipitation during the October-November-December period, CPC is indicating there could be increased chances for above-normal precipitation in most of the upper Basin, and a slight tilt toward below-normal precipitation in southern areas of the lower Basin.

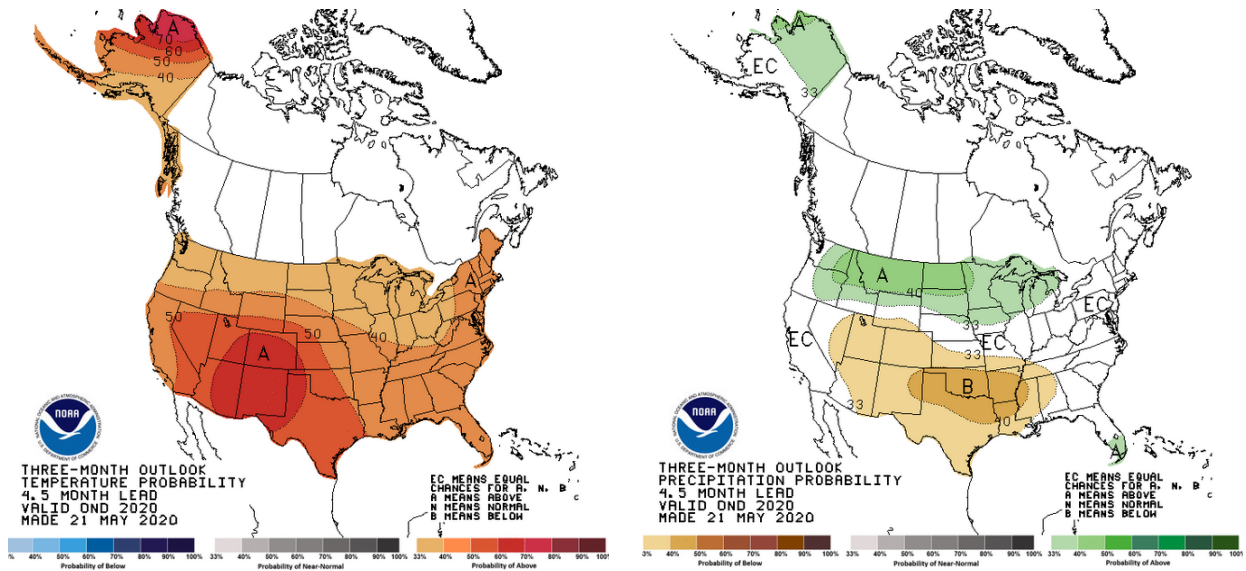


Figure 13. CPC October-November-December 2020 temperature and precipitation outlooks.

## **Summary**

In summary, the 2020 calendar year runoff forecast is **32.3 MAF (125%** of average). The June 1 calendar year runoff forecast is about midway between an upper quartile and upper decile runoff volume.

## Water Supply Forecasts

USDA NRCS National Water & Climate Center

\* - DATA CURRENT AS OF: June 05, 2020 09:58:49 AM

- Based on June 01, 2020 forecast values

### PRELIMINARY MISSOURI RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
Lake Sherburne Inflow (2)	JUN-JUL	61	109	76	67	54	45	56
	JUN-SEP	76	107	94	83	69	58	71
St. Mary R at Intl Boundary (2)	JUN-JUL	300	109	390	335	260	205	275
	JUN-SEP	370	107	475	410	325	265	345
Lima Reservoir Inflow (2)	JUN-JUL	18.1	67	30	23	13.3	6.3	27
	JUN-SEP	23	70	38	29	17.1	8.4	33
Clark Canyon Reservoir Inflow (2)	JUN-JUL	10.2	29	41	23	-2.4	-21	35
	JUN-SEP	25	45	67	42	7.9	-17.2	55
Jefferson R nr Three Forks (2)	JUN-JUL	189	53	400	275	103	3.6	355
	JUN-SEP	225	54	490	330	118	4.2	415
Hebgen Lake Inflow (2)	JUN-JUL	149	84	189	165	132	108	178
	JUN-SEP	240	86	300	265	215	181	280
Ennis Lake Inflow (2)	JUN-JUL	250	76	325	280	220	177	330
	JUN-SEP	385	79	490	430	345	285	485
Missouri R at Toston (2)	JUN-JUL	715	76	1070	860	570	355	940
	JUN-SEP	940	77	1480	1190	800	515	1220
Smith R bl Eagle Ck (2)	JUN-JUL	62	115	96	76	48	28	54
	JUN-SEP	72	111	118	90	54	26	65
Gibson Reservoir Inflow (2)	JUN-JUL	200	95	245	220	182	156	210
	JUN-SEP	240	96	290	260	220	189	250
Marias R nr Shelby (2)	JUN-JUL	111	71	196	145	77	26	156
	JUN-SEP	122	71	225	163	81	21	172

### PRELIMINARY YELLOWSTONE RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
West Rosebud Ck nr Roscoe (2)	JUN-JUL	47	100	54	50	44	40	47
	JUN-SEP	63	100	73	67	59	53	63
Wind R ab Bull Lake Ck	JUN-JUL	225	68	310	260	191	141	330
	JUN-SEP	240	66	345	285	197	133	365
Bull Lake Ck nr Lenore (2)	JUN-JUL	73	68	90	80	66	56	108
	JUN-SEP	96	69	118	105	87	74	139
Boysen Reservoir Inflow (2)	JUN-JUL	184	43	325	240	128	44	425
	JUN-SEP	200	41	375	275	130	26	485
Greybull R at Meeteetse	JUN-JUL	68	71	103	82	53	32	96
	JUN-SEP	104	73	148	122	86	60	142
Shell Ck nr Shell	JUN-JUL	25	71	35	29	21	15.3	35
	JUN-SEP	36	78	47	40	31	24	46
Bighorn R at Kane (2)	JUN-JUL	230	40	480	335	132	0.000	570
	JUN-SEP	235	37	535	355	114	0.000	630
NF Shoshone R at Wapiti	JUN-JUL	320	105	385	345	295	255	305
	JUN-SEP	375	104	450	405	345	300	360
SF Shoshone R nr Valley	JUN-JUL	152	97	183	165	139	121	157
	JUN-SEP	183	97	220	198	168	145	189
Buffalo Bill Reservoir Inflow	JUN-JUL	455	98	565	500	415	350	465

	JUN-SEP	530	99	650	580	480	405	535
Bighorn R nr St. Xavier (2)	JUN-JUL	550	60	915	710	435	230	920
	JUN-SEP	555	55	990	745	410	167	1010
Little Bighorn R nr Hardin	JUN-JUL	32	60	60	43	20	3.7	53
	JUN-SEP	42	64	75	55	28	8.1	66
Tongue R nr Dayton (2)	JUN-JUL	32	65	47	38	25	15.8	49
	JUN-SEP	42	68	61	50	35	24	62
Tongue River Reservoir Inflow (2)	JUN-JUL	59	54	107	79	40	11.9	110
	JUN-SEP	78	58	135	101	55	21	134
NF Powder R nr Hazelton	JUN-JUL	3.6	80	5.6	4.4	2.7	1.51	4.5
	JUN-SEP	4.3	83	6.5	5.2	3.3	1.99	5.2
Powder R at Moorhead	JUN-JUL	73	79	130	96	49	15.1	92
	JUN-SEP	91	83	157	117	64	24	110
Powder R nr Locate	JUN-JUL	82	81	157	113	52	7.3	101
	JUN-SEP	101	83	189	137	66	13.5	122

PRELIMINARY RAPID VALLEY UNIT FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
Deerfield Reservoir Inflow (2)	JUN-JUL	2.4	104	4.1	3.1	1.70	0.67	2.3
Pactola Reservoir Inflow (2)	JUN-JUL	10.1	96	19.4	13.9	6.3	0.76	10.5

PRELIMINARY PLATTE RIVER BASIN FORECASTS

Forecast Point	period	50% (KAF)	% of avg	max (KAF)	30% (KAF)	70% (KAF)	min (KAF)	30-yr avg
North Platte R nr Northgate (2)	JUN-JUL	100	81	144	118	82	56	123
	JUN-SEP	120	82	171	140	100	69	146
Encampment R nr Encampment (2)	JUN-JUL	57	76	82	67	47	32	75
	JUN-SEP	64	76	90	74	54	38	84
Rock Ck ab King Canyon Cnl nr Arlington	JUN-JUL	36	113	46	40	32	27	32
	JUN-SEP	39	111	49	43	35	29	35
Seminole Reservoir Inflow (2)	JUN-JUL	345	88	475	400	290	215	390
	JUN-SEP	395	89	535	455	340	260	445
Sweetwater R nr Alcova	JUN-JUL	2.6	10	12.7	6.7	-1.49	-7.5	26
	JUN-SEP	5.3	17	17.5	10.2	0.36	-6.9	31
La Prele Ck nr Douglas	JUN-JUL	1.89	42	5.8	3.5	0.33	0.040	4.5
	JUN-SEP	2.2	46	6.2	3.9	0.60	0.050	4.8
North Platte R bl Glendo Reservoir (2)	JUN-JUL	250	67	380	300	195	115	375
	JUN-SEP	275	68	420	330	215	128	405
North Platte R bl Guernsey Reservoir (2)	JUN-JUL	240	65	375	295	184	103	370
	JUN-SEP	265	66	415	325	205	117	400
Laramie R and Pioneer Cnl nr Woods Lg (2)	JUN-JUL	44	62	67	53	34	20	71
	JUN-SEP	52	63	78	62	42	26	82
Little Laramie R nr Filmore	JUN-JUL	41	117	51	45	37	31	35
	JUN-SEP	46	118	57	50	42	35	39

Max (10%), 30%, 50%, 70% and Min (90%) chance that actual volume will exceed forecast.

Averages are for the 1981-2010 period.

All volumes are in thousands of acre-feet.

footnotes:

- 1) Max and Min are 5% and 95% chance that actual volume will exceed forecast
- 2) streamflow is adjusted for upstream storage
- 3) median value used in place of average

**Upper Missouri River Basin  
July 2020 Calendar Year Runoff Forecast  
July 6, 2020**

**U.S. Army Corps of Engineers, Northwestern Division  
Missouri River Basin Water Management  
Omaha, NE**

**Calendar Year Runoff Forecast**

**Explanation and Purpose of Forecast**

The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. The Calendar Year Runoff Forecast is available at <http://www.nwd-mr.usace.army.mil/rcc/reports/runoff.pdf>. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows in million acre-feet (MAF) from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri Basin above Sioux City (upper Basin). The Calendar Year Runoff Forecast is used in the Monthly Study simulation model to plan future system regulation in order to meet the authorized project purposes throughout the calendar year.

**Observed Runoff**

June runoff was 5.2 MAF (94% of average) in the upper Basin above Sioux City, about 0.5 MAF less than what was forecast on June 1. Below-normal precipitation over most of the upper Basin resulted in below-average runoff in the Fort Peck, Garrison and Oahe reaches. Above-normal precipitation over central South Dakota kept tributary flows high in the Fort Randall, Gavins Point and Sioux City reaches. Runoff in these three reaches was above average.

**2020 Calendar Year Forecast Synopsis**

The 2020 calendar year runoff forecast for the upper Missouri Basin above Sioux City, IA is **31.2 MAF, 121% of average**. The 2020 calendar year runoff forecast for the Missouri Basin above Gavins Point is **25.3 MAF, 108% of average**. Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next 6 months, expected inflow could range from the 34.2 MAF upper basic forecast to the 28.5 MAF lower basic forecast. The upper and lower basic forecasts are used in long-term regulation planning models to “bracket” the range of expected runoff given much wetter or drier conditions, respectively. Given that 6 months are being forecast for this July 1 forecast (6 months observed/6 months forecast), the range of

possible wetter-than-expected (upper basic) and drier-than-expected (lower basic) conditions is very large, and is attributed to all six reaches for the remaining 6 months of the year. The result is a range or “bracket” for each reach, and thus, for the total runoff forecast.

## Current Conditions

### Drought Analysis

The National Drought Mitigation Center’s drought monitor for June 23, 2020 is shown in **Figure 1**. The drought monitor is available at <http://droughtmonitor.unl.edu/>. The U.S. Drought Monitor shows Moderate Drought (D1) is present in much of Wyoming, western North Dakota, and western South Dakota. Abnormally Dry (D0) conditions are present in southern and eastern Montana, central North Dakota, parts of Wyoming, isolated areas of Iowa and South Dakota, and along the Nebraska-Kansas border. This is a reflection of much drier conditions that have occurred in 2020. The National Weather Service (NWS) Climate Prediction Center’s (CPC) Seasonal Drought Outlook in **Figure 2**, which extends through the end of September, shows the drought in North Dakota, Wyoming, Montana and South Dakota expanding.

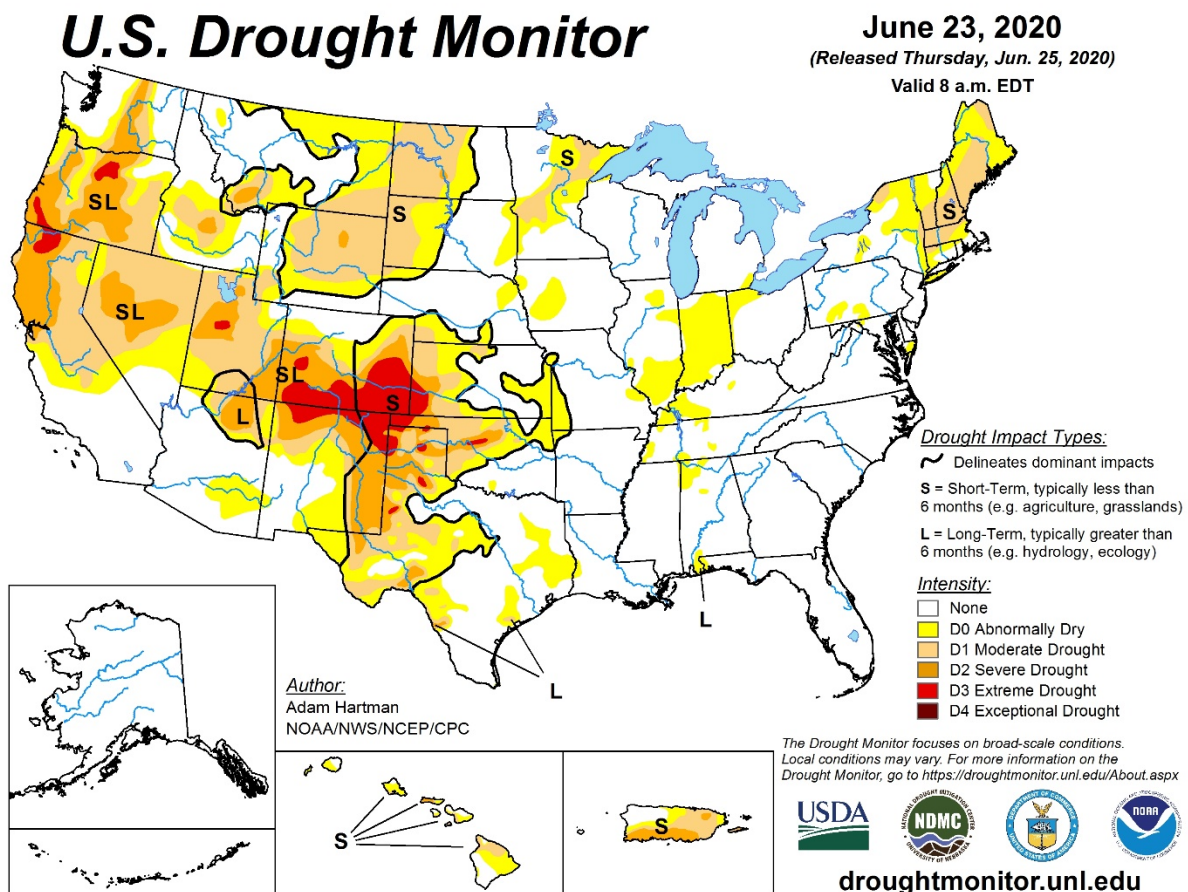


Figure 1. National Drought Mitigation Center U.S. Drought Monitor for June 23, 2020.

# U.S. Seasonal Drought Outlook

## Drought Tendency During the Valid Period

Valid for June 18 - September 30, 2020  
Released June 18

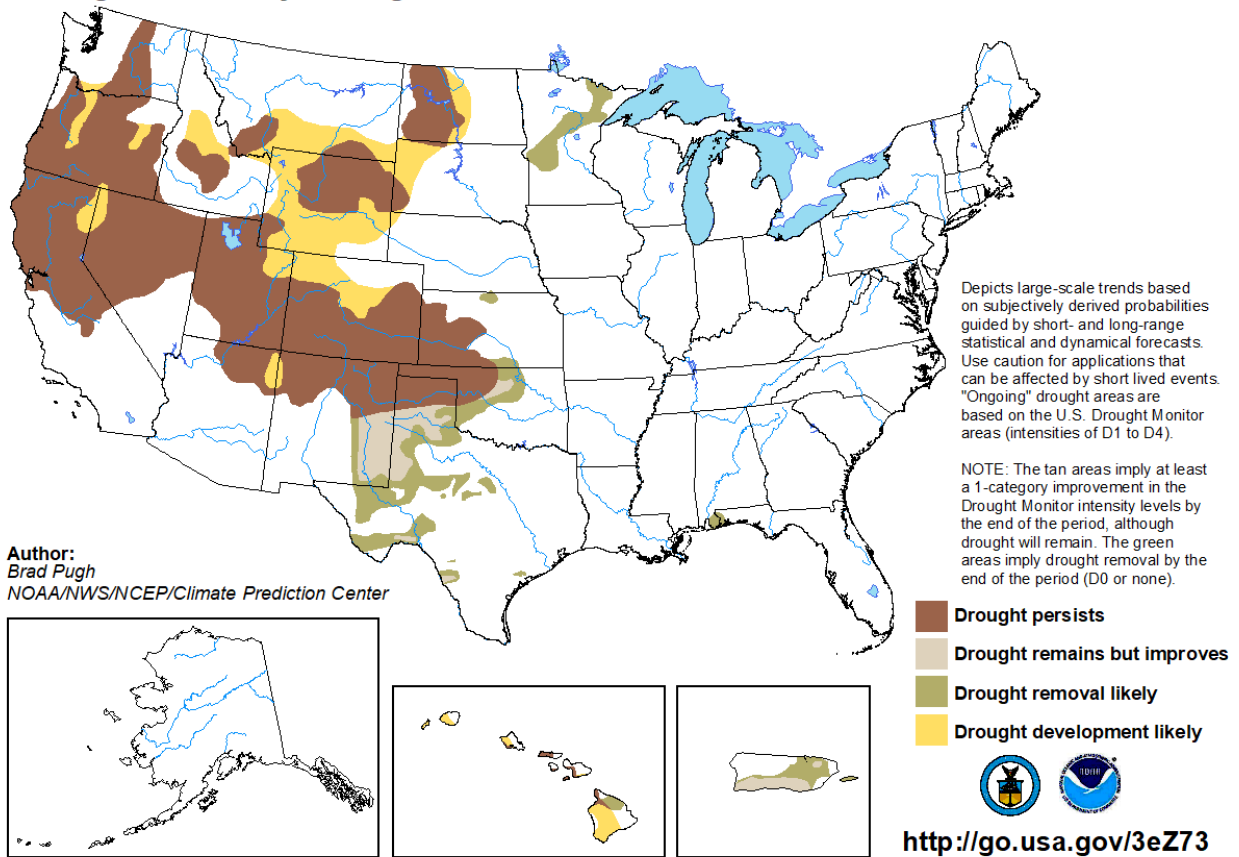


Figure 2. NWS CPC Seasonal Drought Outlook.

### Precipitation

Monthly precipitation accumulations are shown using High Plains Regional Climate Center images available at <http://www.hprcc.unl.edu/>. The June precipitation accumulation map is shown in **Figure 3** as a percent of normal precipitation. June precipitation was below normal over most of the upper Basin, with the exception of central South Dakota and areas of Montana, which received from 130% to 200% of normal precipitation. June precipitation for Wyoming, North Dakota and Nebraska was as low as 5% of normal.

Percent of Normal Precipitation (%)  
6/1/2020 – 6/30/2020

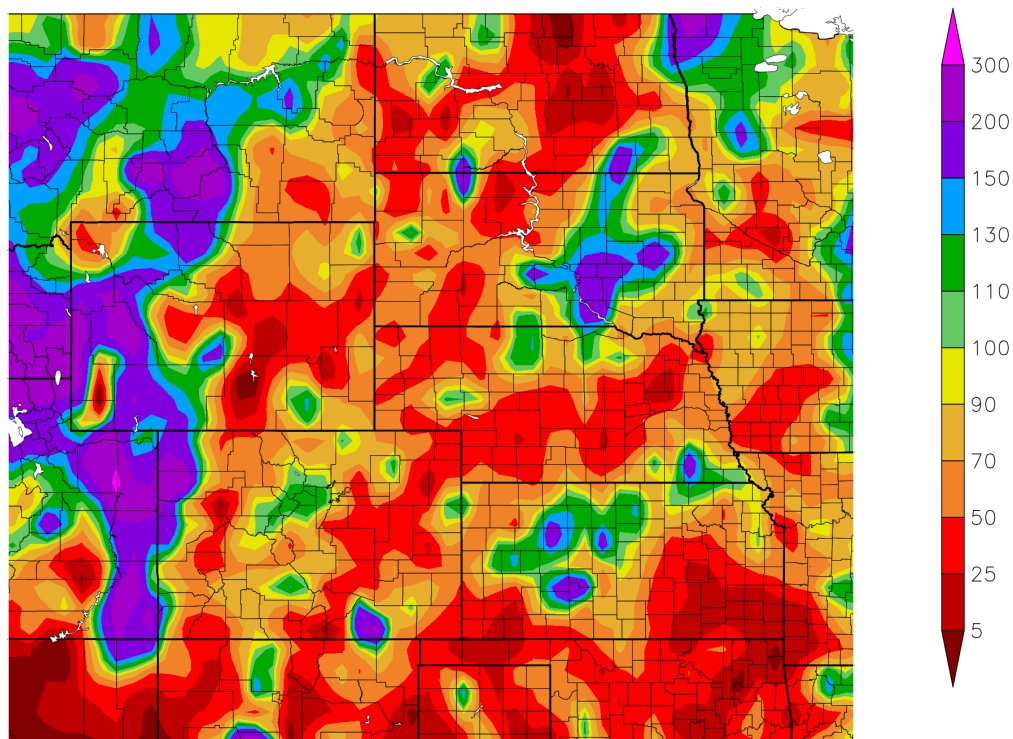


Figure 3. June 2020 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Since January 1, the upper Basin has received less than 70% of normal precipitation (see **Figure 4**) in most areas except for areas of Montana, central South Dakota, and northern Nebraska. Western and central North Dakota received as low as 25% of normal precipitation since January 1.

Percent of Normal Precipitation (%)  
1/1/2020 – 6/30/2020

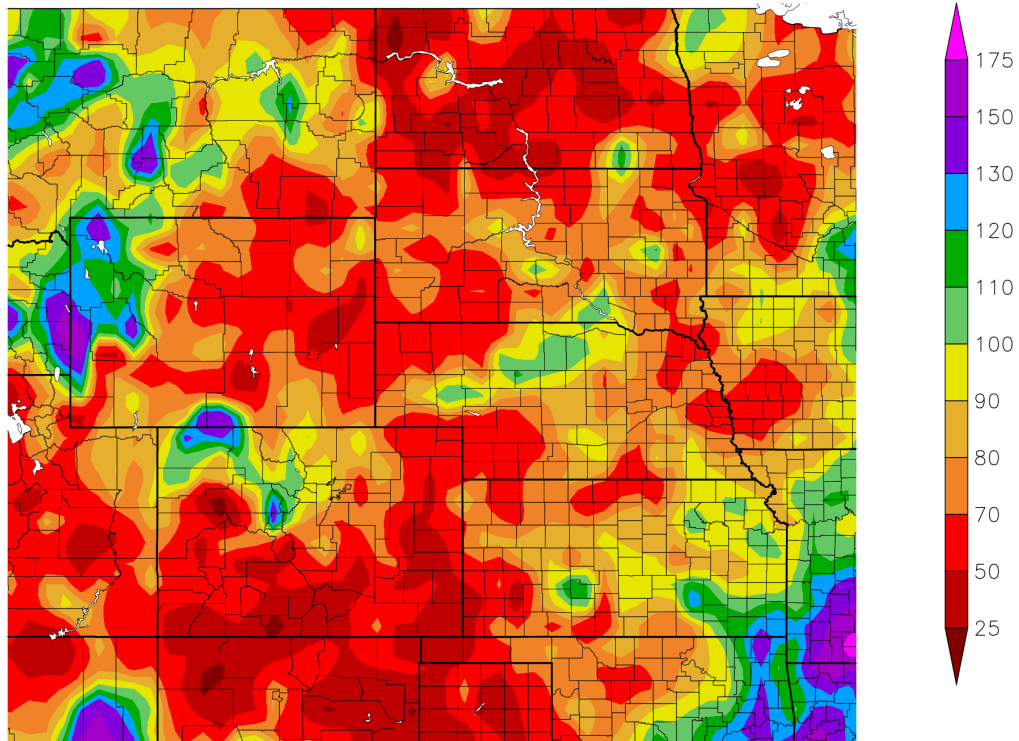


Figure 4. January 1 – June 30 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

### Temperature

June temperature departures in degrees Fahrenheit (deg F) in **Figure 5** were 2 to 8 deg F above normal in most of the Basin. In the Rocky Mountains, June temperatures were normal to about 2 deg F below normal.

April-May-June temperature departures are shown in **Figure 6**. The average three-month temperatures were generally near-normal, with areas of slightly warmer temperatures in Colorado and southern Wyoming, and areas of slightly cooler temperatures in northern Montana and North Dakota.

Departure from Normal Temperature (F)  
6/1/2020 – 6/30/2020

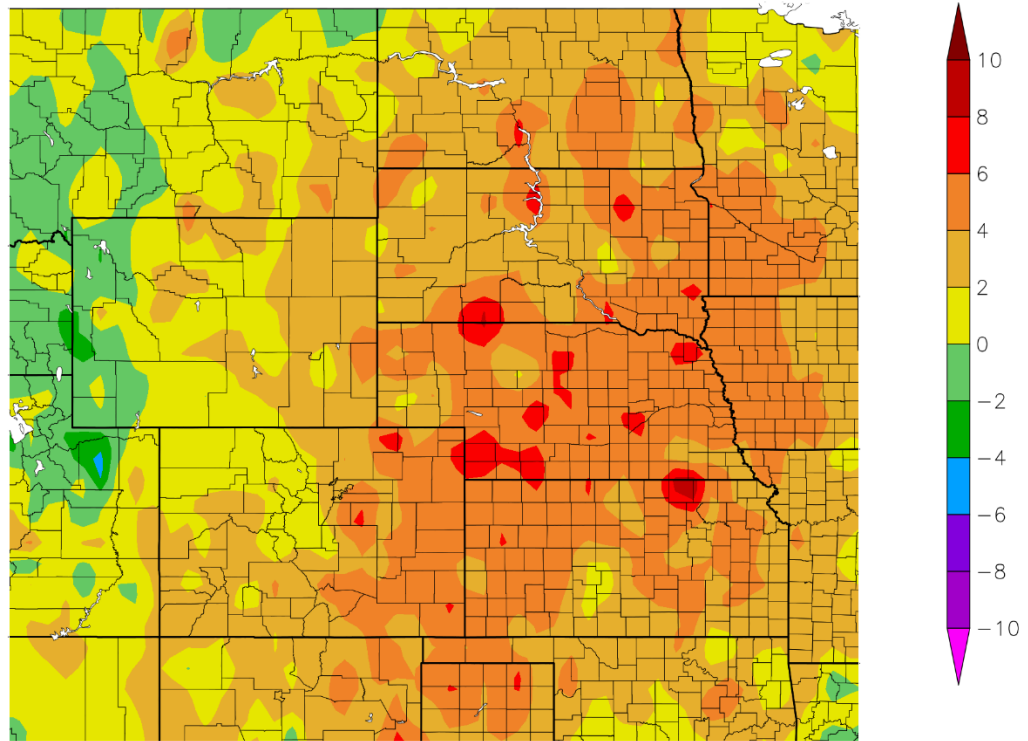


Figure 5. June 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Departure from Normal Temperature (F)  
4/1/2020 – 6/30/2020

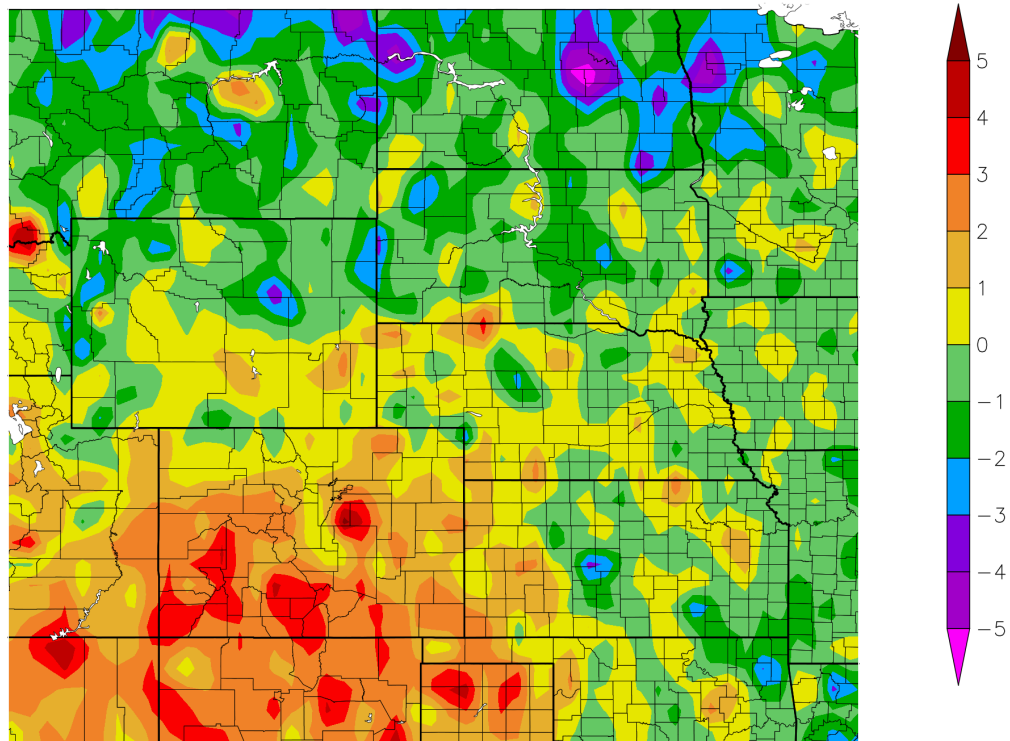
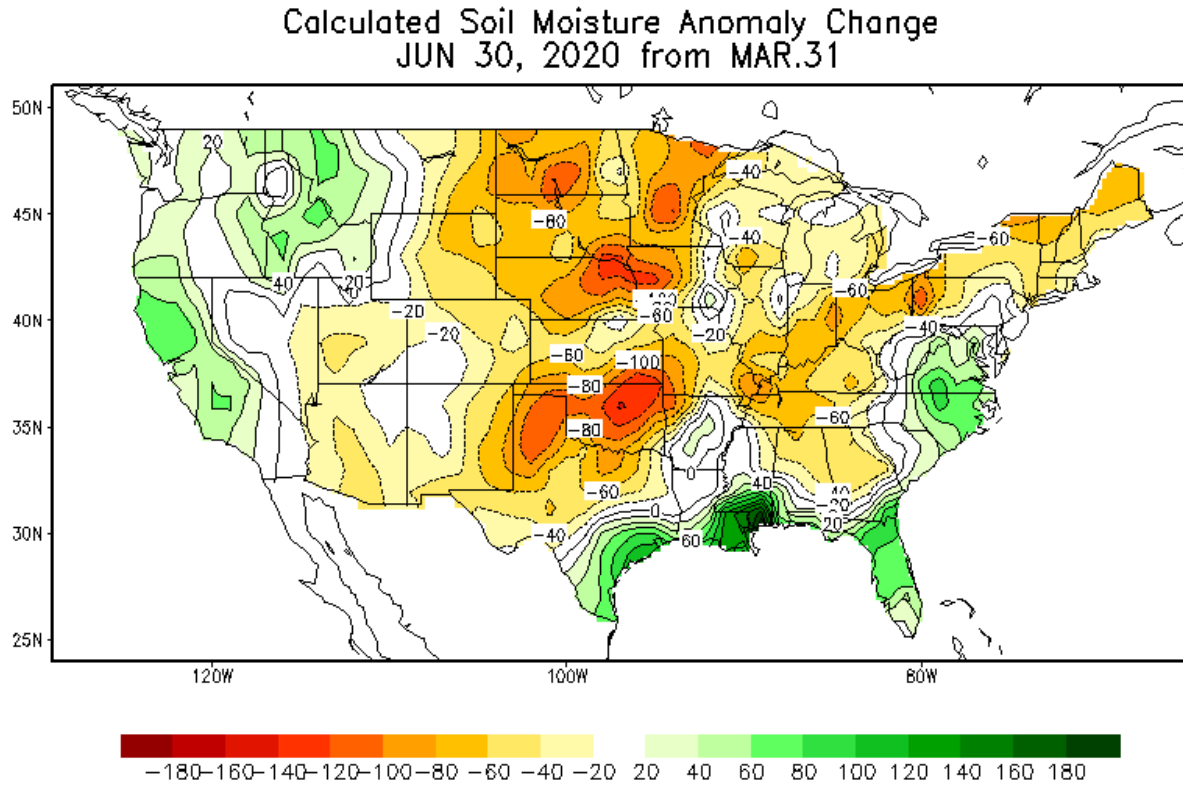


Figure 6. April-May-June 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

## Soil Moisture

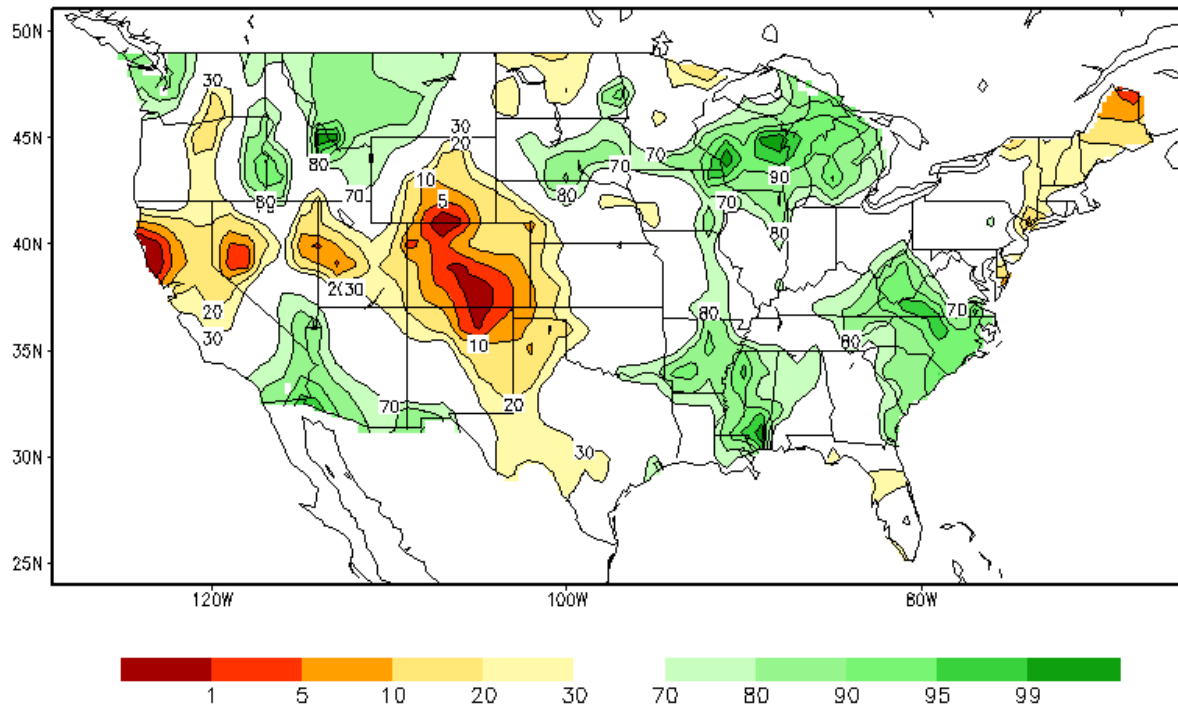
Soil moisture is factored into the forecast as an indicator of wet or dry hydrologic basin conditions. Typically, when soil moisture conditions are wet or greater than normal, rainfall and snowmelt runoff is greater than when soil moisture is dry or less than normal. Not only is soil moisture a physical parameter that influences runoff, it can be used as an indicator of future runoff.

Soil moisture percentiles on March 31 based on the CPC's soil moisture model ranged from the 70<sup>th</sup> to 99<sup>th</sup> percentile ranking. Much of eastern Montana, North Dakota, South Dakota and Nebraska soils ranked above the 95<sup>th</sup> percentile, indicating soil conditions were very wet. Since March 31, soils have dried out considerably (see **Figure 7**). Based on the CPC's soil moisture model, the soil moisture anomaly has decreased by 60 to 140 mm over most of the Basin. Soil moisture is still in the 70<sup>th</sup> to 80<sup>th</sup> percentile in north-central Nebraska, central South Dakota, and eastern North Dakota (see **Figure 8**).



**Figure 7. NOAA CPC Soil Moisture Anomaly Change (mm) March 31 to June 30. Source: [https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)**

## Calculated Soil Moisture Ranking Percentile JUN 30, 2020



**Figure 8. Calculated soil moisture anomaly change since March 31, 2020. Source:**  
[https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

### Plains Snowpack

Plains snowpack is an important parameter that influences the volume of runoff occurring in the basin during the months of March and April. A common misperception is that the March-April runoff is a result of plains snowmelt only. Historically, about 25% of annual runoff occurs in March and April, during the time when plains snow is melting, due to both melting snowpack and rainfall runoff. Runoff occurs in March and April whether or not there is any plains snow to melt. Determining exact rainfall amounts and locations are nearly impossible to predict more than a week in advance. Thus, the March-April runoff forecast is formulated based on existing plains snowpack and existing basin conditions and hydrologic forecasts, which for this year primarily includes long-term precipitation outlooks.

While snow may have occurred in some areas of the plains during May, this did not contribute to increasing flows. Plains snowpack was not a factor in this July 1 forecast.

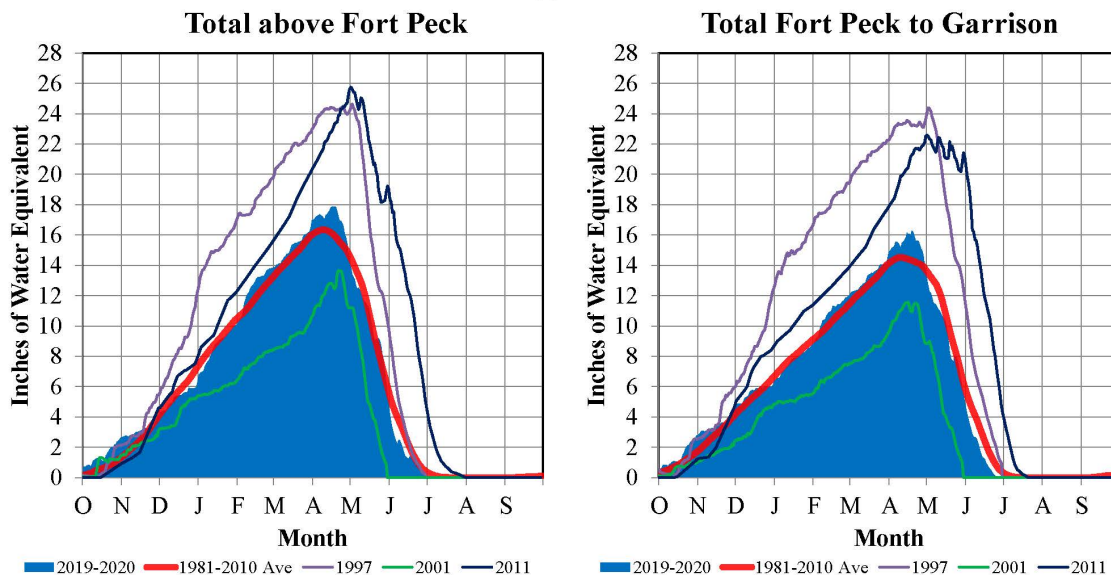
## Mountain Snowpack

Mountain snowpack is the primary factor used to predict May, June and July runoff volumes in the Fort Peck and Fort Peck to Garrison reaches. As the date of peak snowpack accumulation, usually around April 15, approaches, the correlation between the level of mountain snowpack and May, June and July runoff increases. Mountain snowpack becomes a better predictor of Fort Peck and Garrison reach runoff once it reaches its peak.

**Figure 9** includes time-series plots of the mountain SWE beginning on October 1, 2019 based on the NRCS SNOTEL data for the basin above Fort Peck and the incremental basin from Fort Peck to Garrison. The current average SWE values (shaded blue area) are plotted against the 1981-2010 basin average SWE (bold red line), a recent low SWE year in 2001 (green line), and two historic high SWE years occurring in 1997 (purple) and 2011 (dark blue).

### Missouri River Basin – Mountain Snowpack Water Content 2019-2020 with comparison plots from 1997\*, 2001\*, and 2011

28-Jun-2020



On June 28, 2020 the mountain Snow Water Equivalent (SWE) in the “Total above Fort Peck” reach was less than an 1.0”, 82% of the June 28 average. The mountain SWE in the “Total Fort Peck to Garrison” reach has melted. The “Total above Fort Peck” reach snowpack peaked on April 16 at 17.9”, 109% of the normal April 15 peak. The “Total Fort Peck to Garrison” reach snowpack peaked on April 19 at 16.3”, 112% of the normal April 15 peak.

\*Generally considered the high and low year of the last 25-year period, respectively

Provisional data. Subject to revision.

**Figure 9. Mountain snowpack water content on June 28, 2020 compared to normal and historic conditions. Corps of Engineers - Missouri River Basin Water Management.**

Mountain snowpack peaked in the Fort Peck reach at 17.9 inches (109% of average) on April 16. Mountain snowpack peaked in the Garrison reach at 16.3 inches (112% of average) on April 19. Mountain snowpack normally peaks on April 15. Mountain snowpack as of June 28 had essentially melted in both reaches. Inflows into Fort Peck and Garrison have peaked and receded in both the Fort Peck and Garrison reaches.

## **Climate Outlook**

MRBWM participates in the monthly North Central U.S. Climate/Drought Outlook Webinar coordinated through NOAA, the regional climate centers, and the American Association of State Climatologists (AASC). These webinars provide updates on near-term climate outlooks and impacts including the ENSO climate pattern and its implications on winter temperature and precipitation patterns in the Missouri Basin.

### **ENSO (El Niño Southern Oscillation)**

The latest ENSO Outlook indicates that ENSO-neutral conditions are present, and will likely remain neutral during the Northern Hemisphere summer 2020 with a 60 percent probability. During ENSO-neutral conditions there are no strong climate indicators to provide much certainty on the precipitation and temperature outlooks beyond the winter and early spring seasons. There are equal chances of La Niña or ENSO-neutral during the autumn and winter months. During La Niña winters, the probability for a colder-than-normal and slightly wetter-than-normal weather pattern in the Northern Rockies and Northern Plains is higher.

### **Temperature and Precipitation Outlooks**

The CPC outlooks provide the forecasted probability (or chance) of occurrence of future weather conditions during periods ranging from 1 to 12 months into the future. The CPC outlooks are available at <http://www.cpc.ncep.noaa.gov/>.

The CPC temperature outlook for the forecast period from July 7-11 is shown in **Figure 10**. The outlook is indicating an increase in the chances for below-normal temperatures in western Montana, with an increase in the chances for above-normal temperatures across the rest of the Basin. With regard to precipitation, there is an increase in the chances for above-normal precipitation in the northern portion of the Missouri Basin. During the month of July (**Figure 11**), the temperature outlook is indicating increased chances for above-normal temperatures throughout the Basin. With regard to precipitation for July, there are increased chances of above-normal precipitation in the northern portion of the Basin and a slight increase in chances of below-normal precipitation in the southern portion of the Basin.

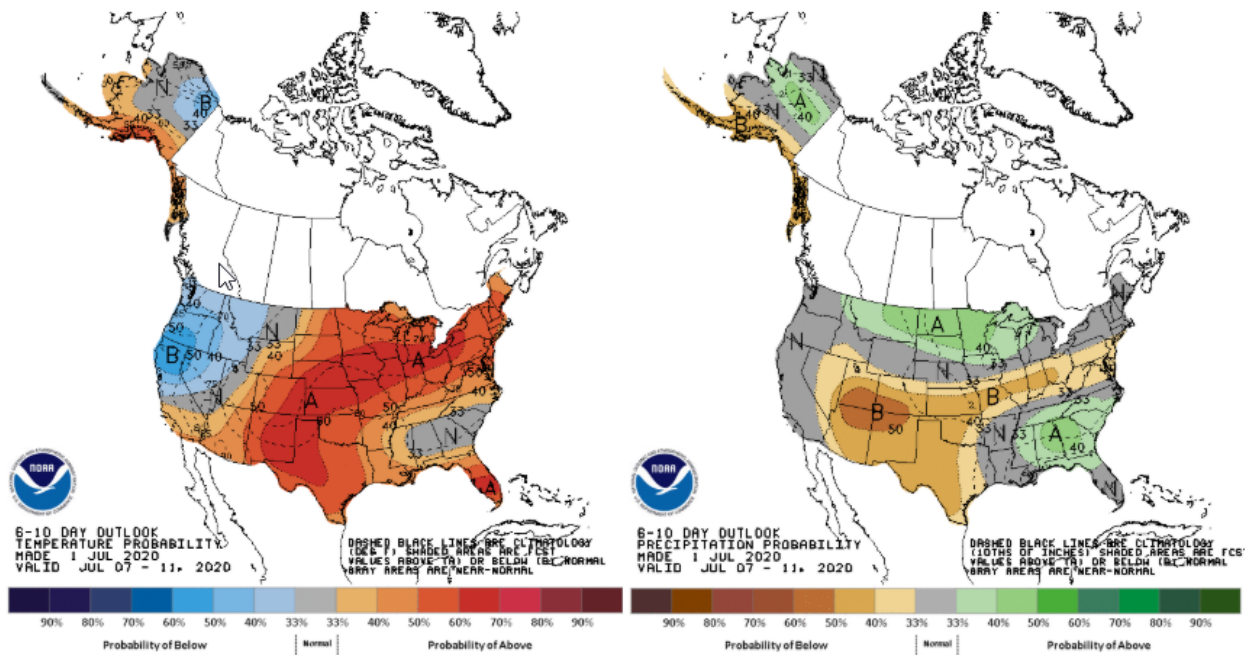


Figure 10. CPC 6-10 Day temperature and precipitation outlooks through July 11, 2020.

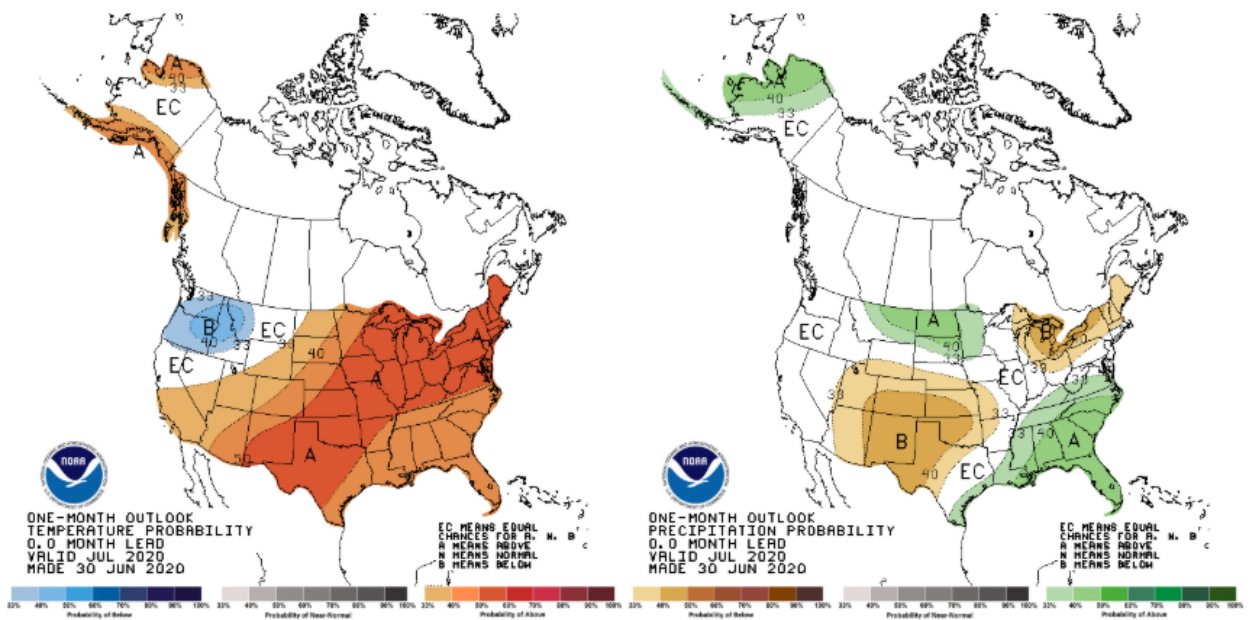


Figure 11. CPC July 2020 temperature and precipitation outlooks.

Three-month temperature and precipitation outlooks for the three-month periods from August through December 2020 are shown below in **Figure 12** and **Figure 13**. During August-September-October 2020 (**Figure 12**), the CPC indicates increased chances for above-normal temperatures across the entire Basin. With regard to precipitation, there are increased chances for above-normal precipitation in the eastern portion of the Basin, a slight increase in chances for

below-normal precipitation in the far western portions of the Basin, and equal chances over the remainder of the Basin.

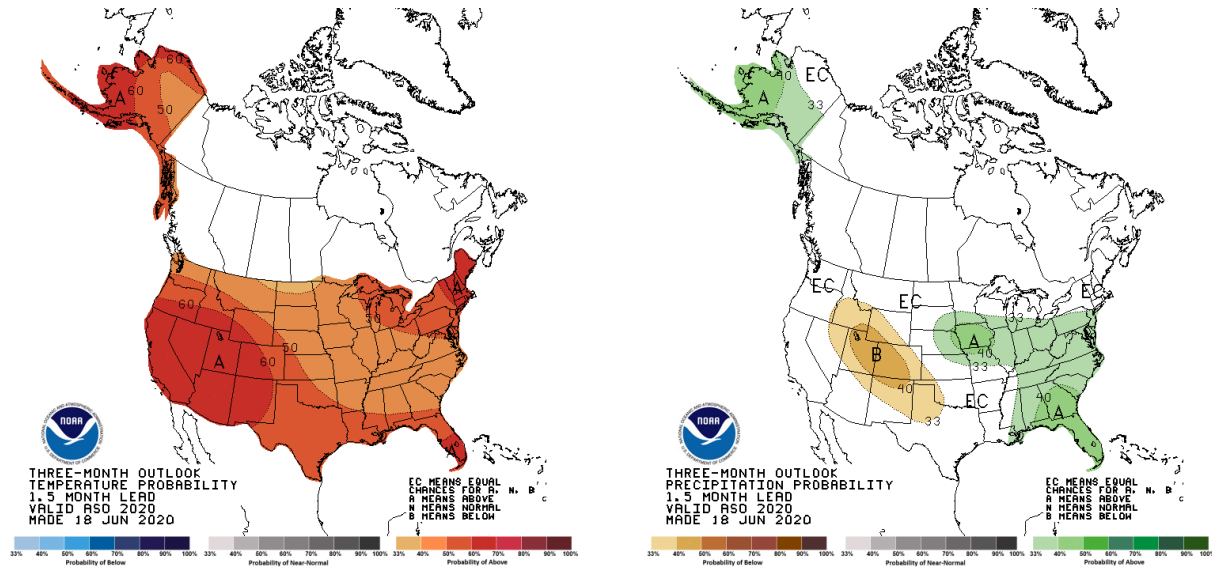


Figure 12. CPC August-September-October 2020 temperature and precipitation outlooks.

During the October-November-December 2020 forecast period (**Figure 13**), there are increased chances for above-normal temperatures throughout the entire Missouri Basin. With regard to precipitation during the October-November-December period, CPC is indicating increased chances for above-normal precipitation in most of the upper Basin, and a slight tilt toward below-normal precipitation in southern areas of the lower Basin.

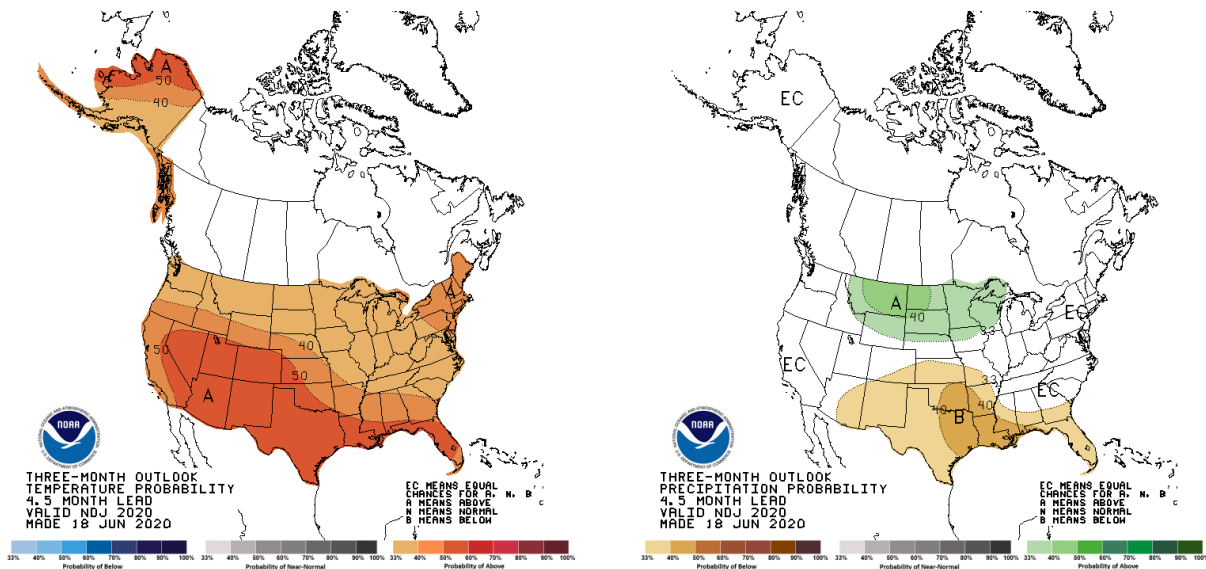


Figure 13. CPC November-December-January 2020 temperature and precipitation outlooks.

## **Summary**

In summary, the 2020 calendar year runoff forecast is **31.2 MAF (121% of average)**. The July 1 calendar year runoff forecast is about midway between an upper quartile and upper decile runoff volume.

## **Water Supply Forecasts**

No water supply forecast sent by NRCS

**Upper Missouri River Basin  
August 2020 Calendar Year Runoff Forecast  
August 5, 2020**

**U.S. Army Corps of Engineers, Northwestern Division  
Missouri River Basin Water Management  
Omaha, NE**

**Calendar Year Runoff Forecast**

**Explanation and Purpose of Forecast**

The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. The Calendar Year Runoff Forecast is available at <http://www.nwd-mr.usace.army.mil/rcc/reports/runoff.pdf>. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows in million acre-feet (MAF) from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri Basin above Sioux City (upper Basin). The Calendar Year Runoff Forecast is used in the Monthly Study simulation model to plan future system regulation in order to meet the authorized project purposes throughout the calendar year.

**Observed Runoff**

July precipitation varied across the Basin. Most of Montana, Wyoming, Iowa, and northern Colorado had as low as 25% of normal precipitation. Conversely, most of Kansas, Missouri, eastern North Dakota, central South Dakota, and central Nebraska had as high as 200% of normal precipitation. This resulted in July runoff of 3.1 MAF (93% of average) in the upper Basin above Sioux City, and 2.5 MAF (82% of average) for the upper Basin above Gavins Point Dam. July runoff was above average in the lower three reaches (Fort Randall, Gavins Point, and Sioux City), average in the Oahe reach, and below average in the upper two reaches (Fort Peck and Garrison).

**2020 Calendar Year Forecast Synopsis**

The 2020 calendar year runoff forecast for the upper Missouri Basin above Sioux City, IA is **30.9 MAF, 120% of average**. The 2020 calendar year runoff forecast for the Missouri Basin above Gavins Point is **24.8 MAF, 106% of average**. Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next 5 months, expected inflow could range from the 32.4 MAF upper basic forecast to the 29.5 MAF lower basic forecast. The upper and

lower basic forecasts are used in long-term regulation planning models to “bracket” the range of expected runoff given much wetter or drier conditions, respectively. Given that 5 months are being forecast for this August 1 forecast (7 months observed/5 months forecast), the range of possible wetter-than-expected (upper basic) and drier-than-expected (lower basic) conditions is fairly large, and is attributed to all six reaches for the remaining 5 months of the year. The result is a range or “bracket” for each reach, and thus, for the total runoff forecast.

## Current Conditions

### Drought Analysis

The National Drought Mitigation Center’s drought monitor for July 28, 2020 is shown in **Figure 1**. The drought monitor is available at <http://droughtmonitor.unl.edu/>. The U.S. Drought Monitor shows D3 “extreme drought” conditions are present in areas of Wyoming and Colorado. D2 “severe drought” is also present in those states, and also in western Iowa. There are small areas of D1 “moderate drought” and D0 “abnormally dry” conditions present in every state in the Basin. The National Weather Service (NWS) Climate Prediction Center’s (CPC) Seasonal Drought Outlook in **Figure 2**, which extends through the end of October, shows the drought in southern Montana, Wyoming, Colorado, Kansas and Nebraska persisting, with improvement and removal likely elsewhere.

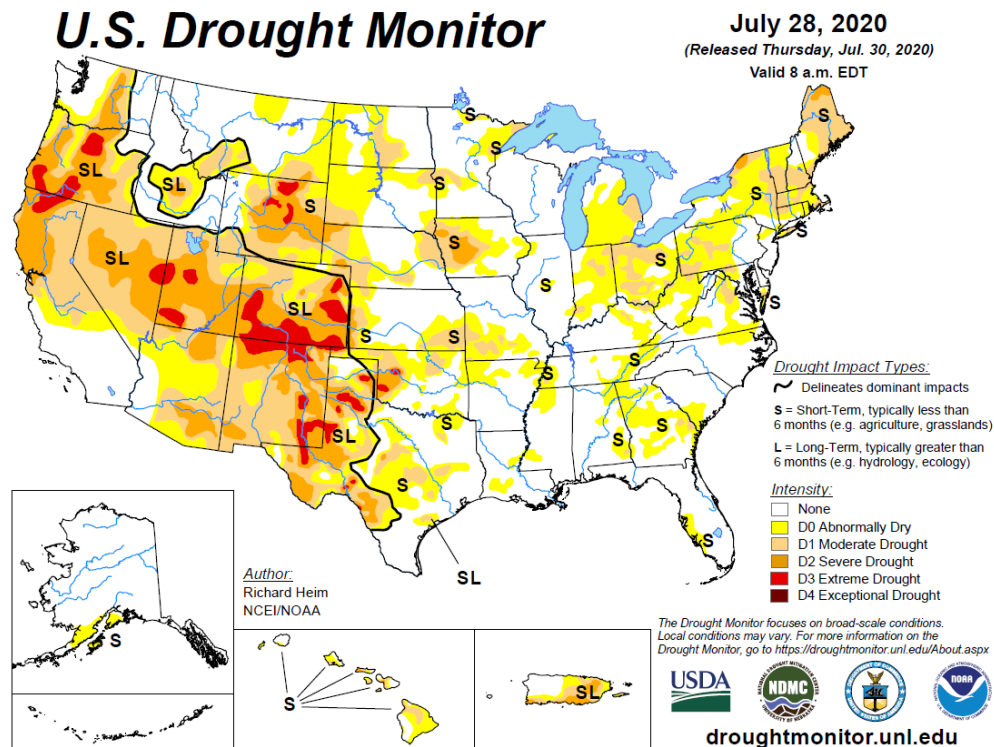


Figure 1. National Drought Mitigation Center U.S. Drought Monitor for July 28, 2020.

# U.S. Seasonal Drought Outlook

## Drought Tendency During the Valid Period

Valid for July 16 - October 31, 2020  
Released July 16

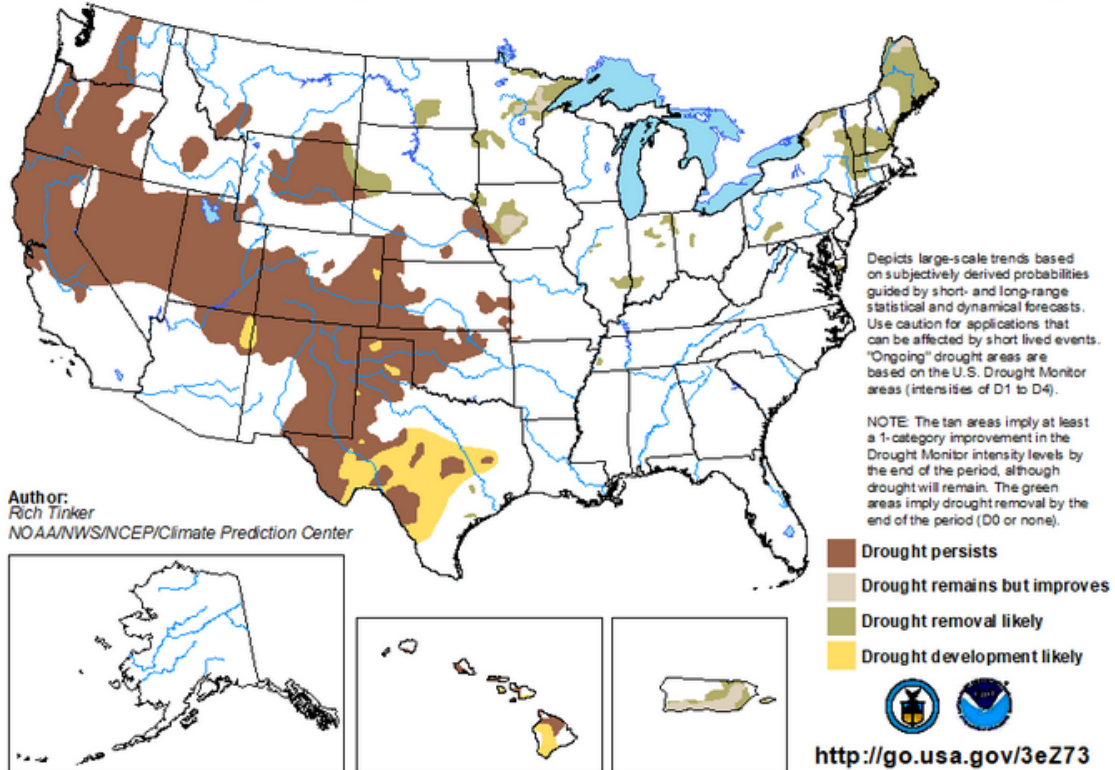


Figure 2. NWS CPC Seasonal Drought Outlook.

## Precipitation

Monthly precipitation accumulations are shown using High Plains Regional Climate Center images available at <http://www.hprcc.unl.edu/>. The July precipitation accumulation map is shown in **Figure 3** as a percent of normal precipitation. July precipitation varied across the Basin. Most of Montana, Wyoming, Iowa, and northern Colorado had as low as 25% of normal precipitation. Conversely, most of Kansas, Missouri, eastern North Dakota, central South Dakota, and central Nebraska had as high as 200% of normal precipitation.

Percent of Normal Precipitation (%)  
7/1/2020 – 7/31/2020

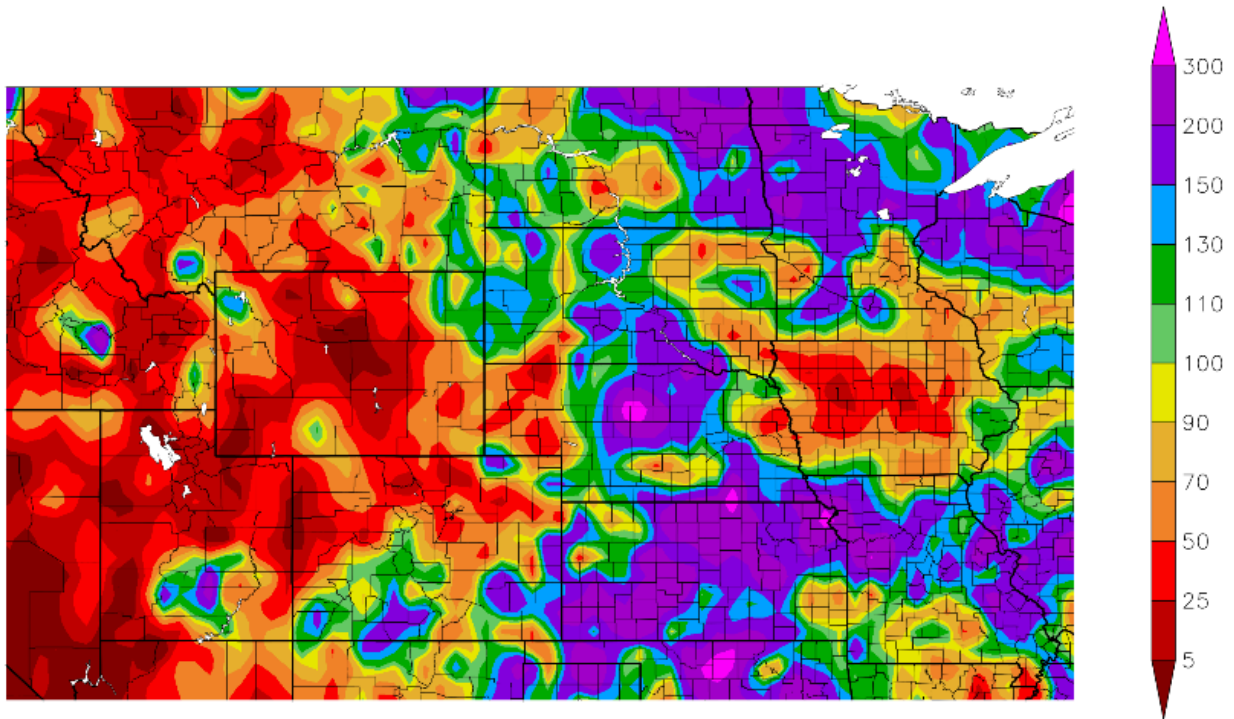


Figure 3. July 2020 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Since May 1, the Basin has received approximately normal precipitation (see **Figure 4**), with some areas of lower precipitation in Wyoming, Colorado, North Dakota, Nebraska and Iowa. There have also been areas of higher precipitation in Montana, South Dakota, Nebraska, and Kansas.

Percent of Normal Precipitation (%)  
5/1/2020 – 7/31/2020

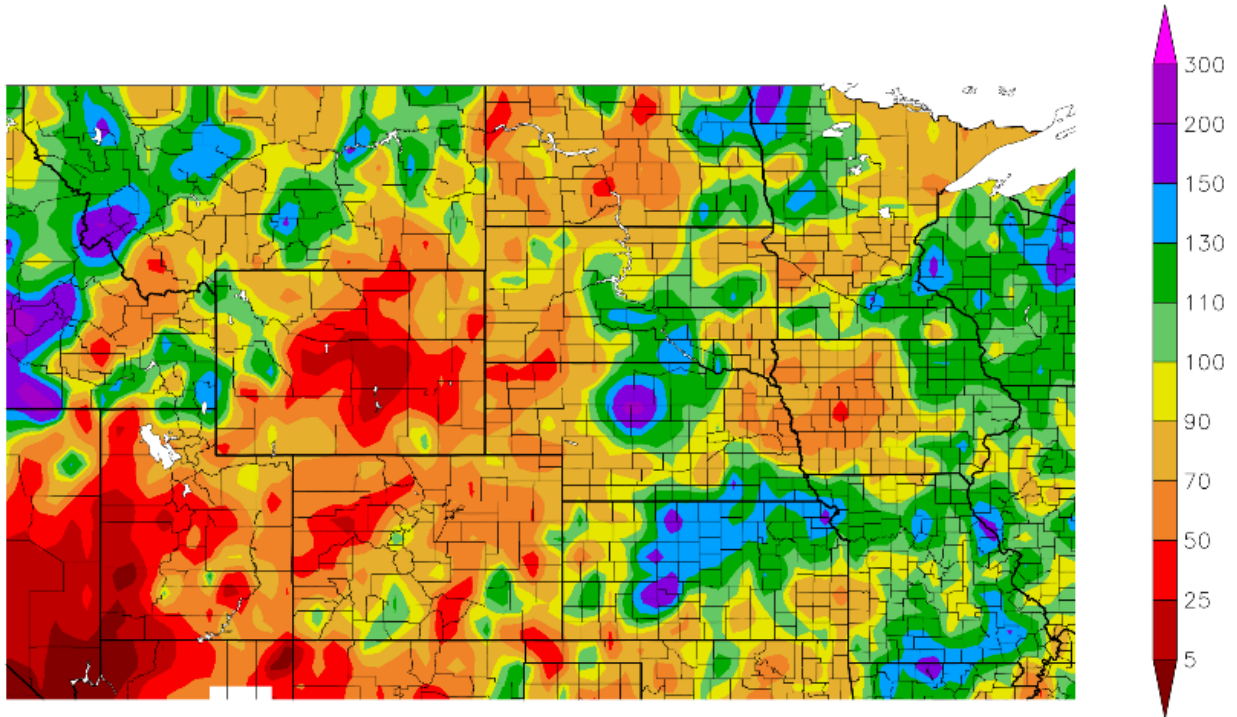


Figure 4. May 1 – July 31 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

### Temperature

July temperature departures in degrees Fahrenheit (deg F) in **Figure 5** were generally near normal, with 2 to 4 deg F above or below normal. Temperature departures were cooler in the northwest and got warmer as you moved southeast.

May-June-July temperature departures are shown in **Figure 6**. The past three month's temperature departures followed the same pattern as the past month.

Departure from Normal Temperature (F)  
7/1/2020 – 7/31/2020

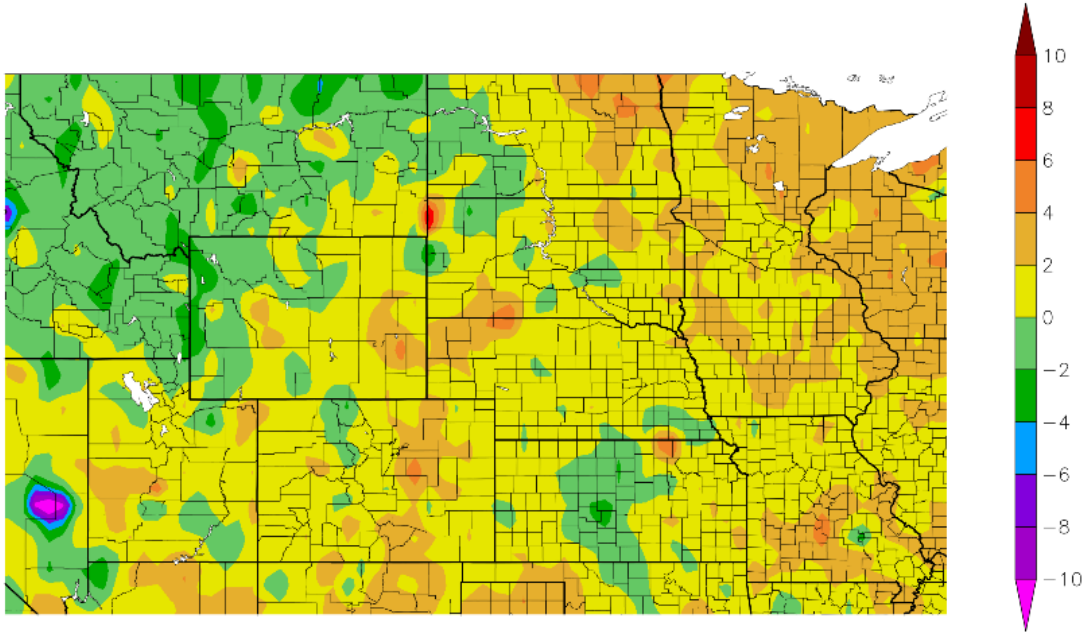


Figure 5. July 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Departure from Normal Temperature (F)  
5/1/2020 – 7/31/2020

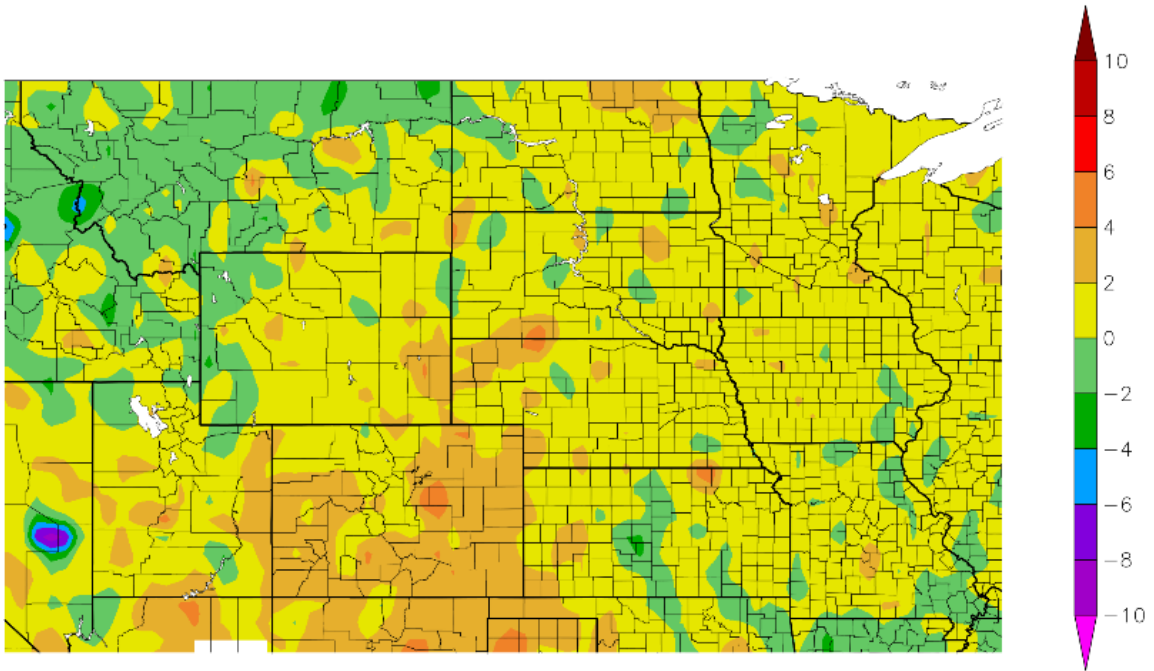
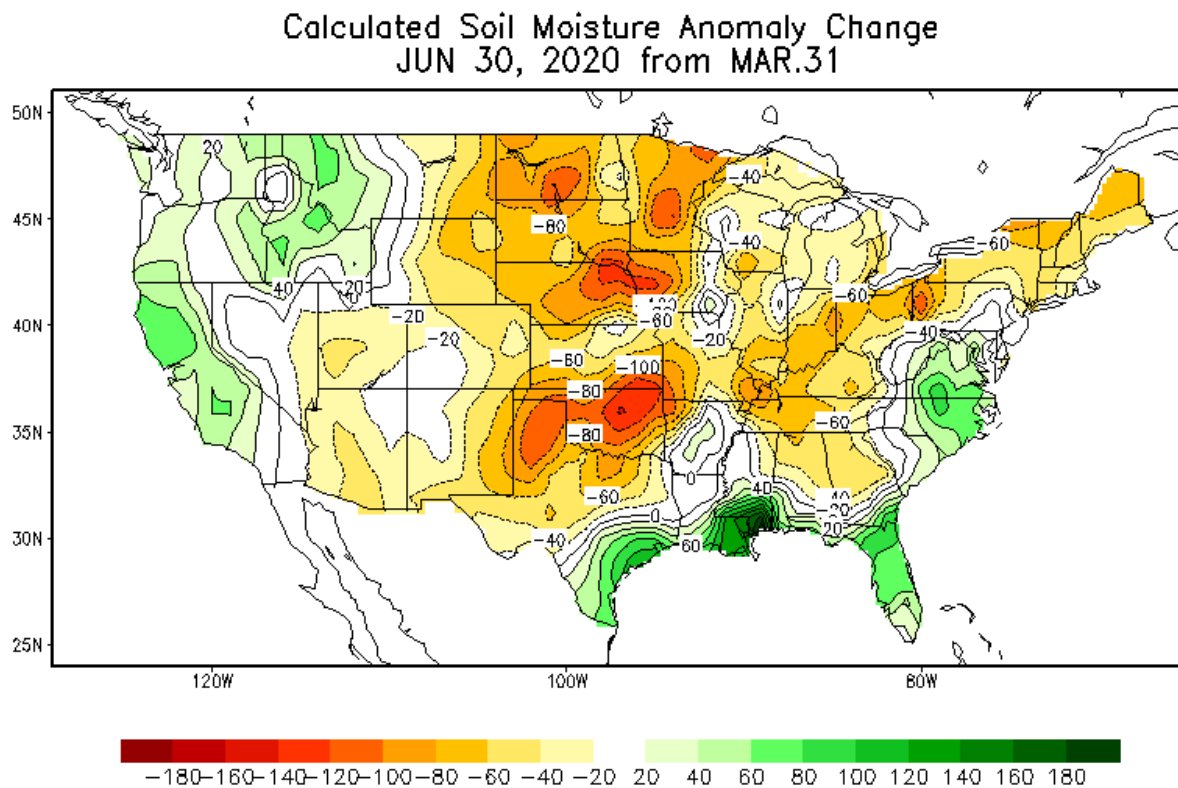


Figure 6. May-June-July 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

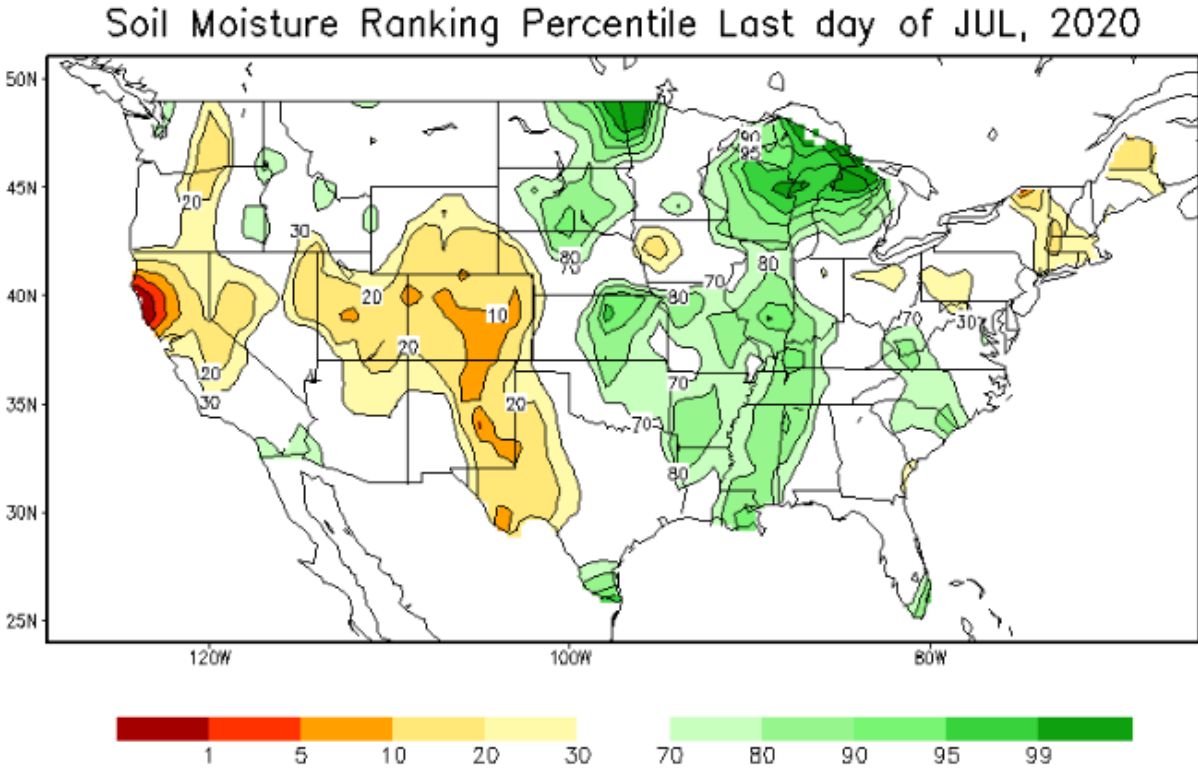
## Soil Moisture

Soil moisture is factored into the forecast as an indicator of wet or dry hydrologic basin conditions. Typically, when soil moisture conditions are wet or greater than normal, rainfall and snowmelt runoff is greater than when soil moisture is dry or less than normal. Not only is soil moisture a physical parameter that influences runoff, it can be used as an indicator of future runoff.

Soil moisture percentiles on March 31 based on the CPC's soil moisture model ranged from the 70<sup>th</sup> to 99<sup>th</sup> percentile ranking. Much of eastern Montana, North Dakota, South Dakota and Nebraska soils ranked above the 95<sup>th</sup> percentile, indicating soil conditions were very wet. Since March 31, soils have dried out considerably (see **Figure 7**). Based on the CPC's soil moisture model, the soil moisture anomaly had decreased by 60 to 140 mm over most of the Basin by the end of June. Soil moisture rebounded some during July. By the end of July, soil moisture was back up to the 70<sup>th</sup> to 90<sup>th</sup> percentile over much of the Basin (see **Figure 8**). Notable exceptions are in Colorado, where soil moisture is in the 5<sup>th</sup> to 10<sup>th</sup> percentile in several areas.



**Figure 7. NOAA CPC Soil Moisture Anomaly Change (mm) March 31 to June 30. Source: [https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)**



**Figure 8. Calculated soil moisture ranking percentile. Source:**  
[https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

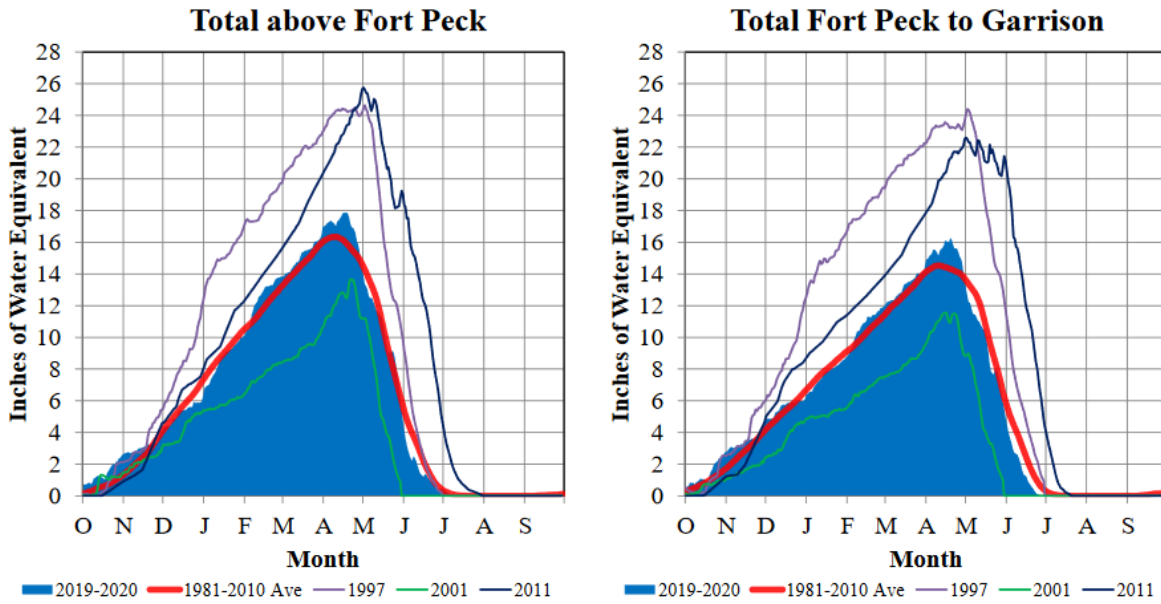
### Mountain Snowpack

Mountain snowpack is the primary factor used to predict May, June and July runoff volumes in the Fort Peck and Fort Peck to Garrison reaches. As the date of peak snowpack accumulation, usually around April 15, approaches, the correlation between the level of mountain snowpack and May, June and July runoff increases. Mountain snowpack becomes a better predictor of Fort Peck and Garrison reach runoff once it reaches its peak.

**Figure 9** includes time-series plots of the mountain SWE beginning on October 1, 2019 based on the NRCS SNOTEL data for the basin above Fort Peck and the incremental basin from Fort Peck to Garrison. The current average SWE values (shaded blue area) are plotted against the 1981-2010 basin average SWE (bold red line), a recent low SWE year in 2001 (green line), and two historic high SWE years occurring in 1997 (purple) and 2011 (dark blue).

# Missouri River Basin – Mountain Snowpack Water Content 2019-2020 with comparison plots from 1997\*, 2001\*, and 2011

5-Jul-2020



On July 5, 2020 the mountain Snow Water Equivalent (SWE) in the “Total above Fort Peck” reach was less than an inch, 81% of the July 5 average. The mountain SWE in the “Total Fort Peck to Garrison” reach has melted. The “Total above Fort Peck” reach snowpack peaked on April 16 at 17.9”, 109% of the normal April 15 peak. The “Total Fort Peck to Garrison” reach snowpack peaked on April 19 at 16.3”, 112% of the normal April 15 peak.

\*Generally considered the high and low year of the last 25-year period, respectively

Provisional data. Subject to revision.

**Figure 9. Mountain snowpack water content on July 5, 2020 compared to normal and historic conditions. Corps of Engineers - Missouri River Basin Water Management.**

Mountain snowpack peaked in the Fort Peck reach at 17.9 inches (109% of average) on April 16. Mountain snowpack peaked in the Garrison reach at 16.3 inches (112% of average) on April 19. Mountain snowpack normally peaks on April 15. Mountain snowpack as of July 5 had essentially melted in both reaches. Inflows into Fort Peck and Garrison have peaked and receded in both the Fort Peck and Garrison reaches.

## **Climate Outlook**

MRBWM participates in the monthly North Central U.S. Climate/Drought Outlook Webinar coordinated through NOAA, the regional climate centers, and the American Association of State Climatologists (AASC). These webinars provide updates on near-term climate outlooks and impacts including the ENSO climate pattern and its implications on winter temperature and precipitation patterns in the Missouri Basin.

### **ENSO (El Niño Southern Oscillation)**

The latest ENSO Outlook indicates that ENSO-neutral conditions are present, and will likely remain neutral during the Northern Hemisphere summer 2020. During ENSO-neutral conditions there are no strong climate indicators to provide much certainty on the precipitation and temperature outlooks beyond the winter and early spring seasons. There is a 50-55% chance of La Niña development during the Northern Hemisphere fall, and continuing into winter with a 50% chance.

### **Temperature and Precipitation Outlooks**

The CPC outlooks provide the forecasted probability (or chance) of occurrence of future weather conditions during periods ranging from 1 to 12 months into the future. The CPC outlooks are available at <http://www.cpc.ncep.noaa.gov/>.

The CPC temperature outlook for the forecast period from August 11-15 is shown in **Figure 10**. The outlook is indicating an increase in the chances for below-normal temperatures in western Montana, with an increase in the chances for above-normal temperatures across the rest of the Basin. With regard to precipitation, there is an increase in the chances for below-normal precipitation in Colorado, Wyoming, Nebraska and Kansas. During the month of August (**Figure 11**), the temperature outlook is indicating increased chances for above-normal temperatures in western Montana, with equal chances in the remainder of the upper Basin and increased chances for below-normal temperatures in the lower Basin. With regard to precipitation for August, there are increased chances of above-normal precipitation in the upper Basin, Nebraska, and Iowa.

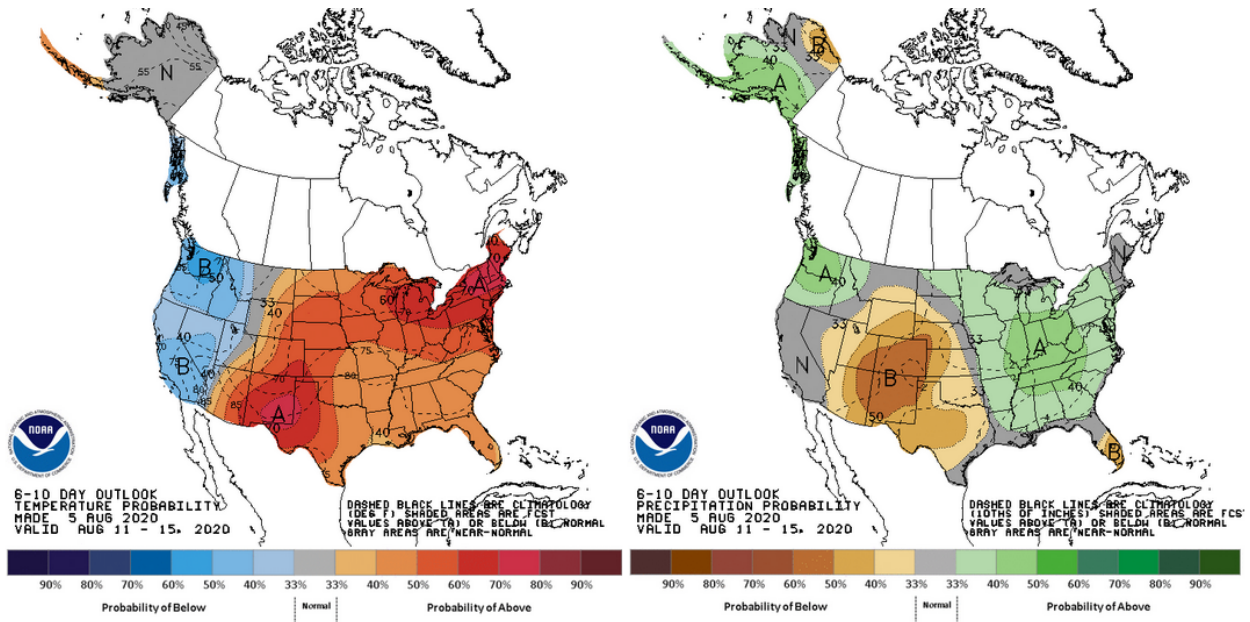


Figure 10. CPC 6-10 Day temperature and precipitation outlooks through August 15, 2020.

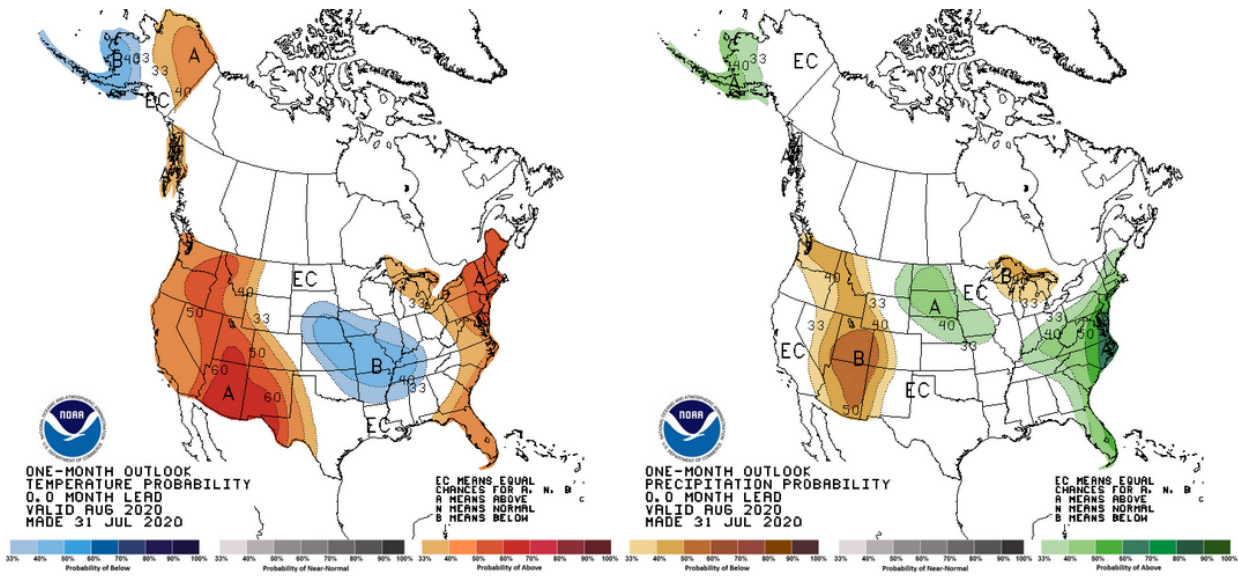


Figure 11. CPC August 2020 temperature and precipitation outlooks.

Three-month temperature and precipitation outlooks for the three-month periods from September through December 2020 are shown below in **Figure 12** and **Figure 13**. During September-October-November 2020 (**Figure 12**), the CPC indicates increased chances for above-normal temperatures across the entire Basin. With regard to precipitation, there are increased chances for above-normal precipitation in Montana and western North Dakota, with equal chances over the remainder of the Basin.

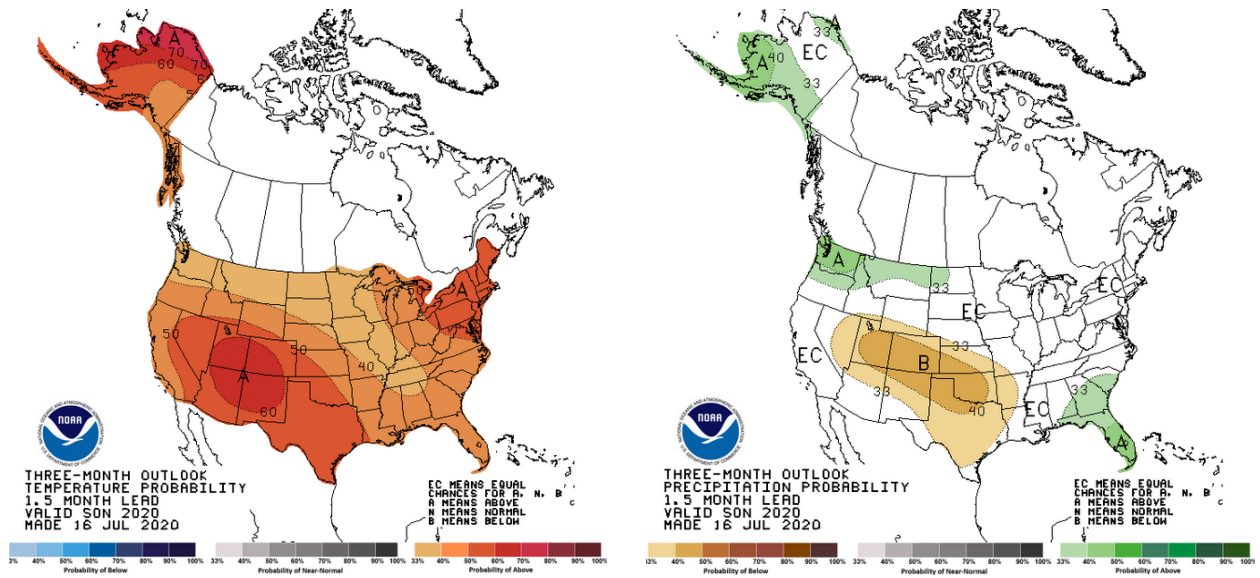


Figure 12. CPC September-October-November 2020 temperature and precipitation outlooks.

During the December 2020-January-February 2021 forecast period (**Figure 13**), there are equal chances for temperature throughout the entire Missouri Basin. With regard to precipitation during the December 2020-January-February 2021 period, CPC is indicating increased chances for above-normal precipitation in most of the Basin.

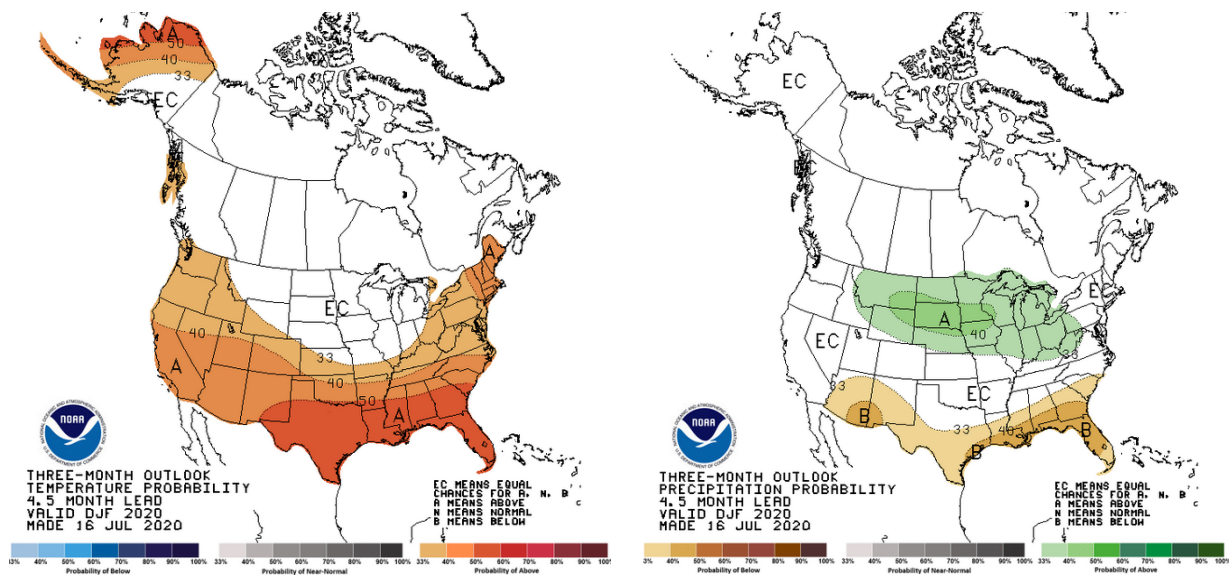


Figure 13. CPC December 2020-January-February 2021 temperature and precipitation outlooks.

## Summary

In summary, the 2020 calendar year runoff forecast is **30.9 MAF (120% of average)**. The August 1 calendar year runoff forecast is about midway between an upper quartile and upper decile runoff volume.

**Upper Missouri River Basin  
September 2020 Calendar Year Runoff Forecast  
September 1, 2020**

**U.S. Army Corps of Engineers, Northwestern Division  
Missouri River Basin Water Management  
Omaha, NE**

**Calendar Year Runoff Forecast**

**Explanation and Purpose of Forecast**

The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. The Calendar Year Runoff Forecast is available at <http://www.nwd-mr.usace.army.mil/rcc/reports/runoff.pdf>. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows in million acre-feet (MAF) from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri Basin above Sioux City (upper Basin). The Calendar Year Runoff Forecast is used in the Monthly Study simulation model to plan future system regulation in order to meet the authorized project purposes throughout the calendar year.

**Observed Runoff**

August precipitation was drier than normal across the Basin, particularly in the western portions of the Basin. Most of Montana, Wyoming, Nebraska, Iowa, and Colorado had as low as 2-25% of normal precipitation while most of North Dakota and South Dakota ranged from 50-100% percent of precipitation with small areas of near-normal precipitation. This resulted in August runoff of 1.0 MAF (74% of average) in the upper Basin above Sioux City, and 0.7 MAF (61% of average) for the upper Basin above Gavins Point Dam. August runoff was above average in the lower three reaches (Fort Randall, Gavins Point, and Sioux City), below average in the Oahe reach (89% of average), and well below average in the Fort Peck and Garrison reaches, 50% and 31% of average, respectively.

**2020 Calendar Year Forecast Synopsis**

The 2020 calendar year runoff forecast for the upper Missouri Basin above Sioux City, IA is **30.6 MAF, 119% of average**. The 2020 calendar year runoff forecast for the Missouri Basin above Gavins Point is **24.8 MAF, 106% of average**. Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next 4 months, expected inflow could range

from the 31.6 MAF upper basic forecast to the 29.8 MAF lower basic forecast. The upper and lower basic forecasts are used in long-term regulation planning models to “bracket” the range of expected runoff given much wetter or drier conditions, respectively. Given that 4 months are being forecast for this September 1 forecast (8 months observed/4 months forecast), the range of possible wetter-than-expected (upper basic) and drier-than-expected (lower basic) conditions are smaller than during the summer. The result is a range or “bracket” for each reach, and thus, for the total runoff forecast.

## Current Conditions

### Drought Analysis

The National Drought Mitigation Center’s drought monitor for August 25, 2020 is shown in **Figure 1**. The drought monitor is available at <http://droughtmonitor.unl.edu/>. The U.S. Drought Monitor shows D3 “extreme drought” conditions are present in Colorado and small areas in Wyoming and Iowa. Larger areas of D2 “severe drought” are also present in those states, and also in western Iowa. There are small areas of D1 “moderate drought” and D0 “abnormally dry” conditions present in every state in the Basin. The National Weather Service (NWS) Climate Prediction Center’s (CPC) Seasonal Drought Outlook in **Figure 2**, which extends through the end of November, shows the drought in southern Montana, Wyoming, Colorado, Kansas and Nebraska persisting and expanding, with improvement and removal likely elsewhere.

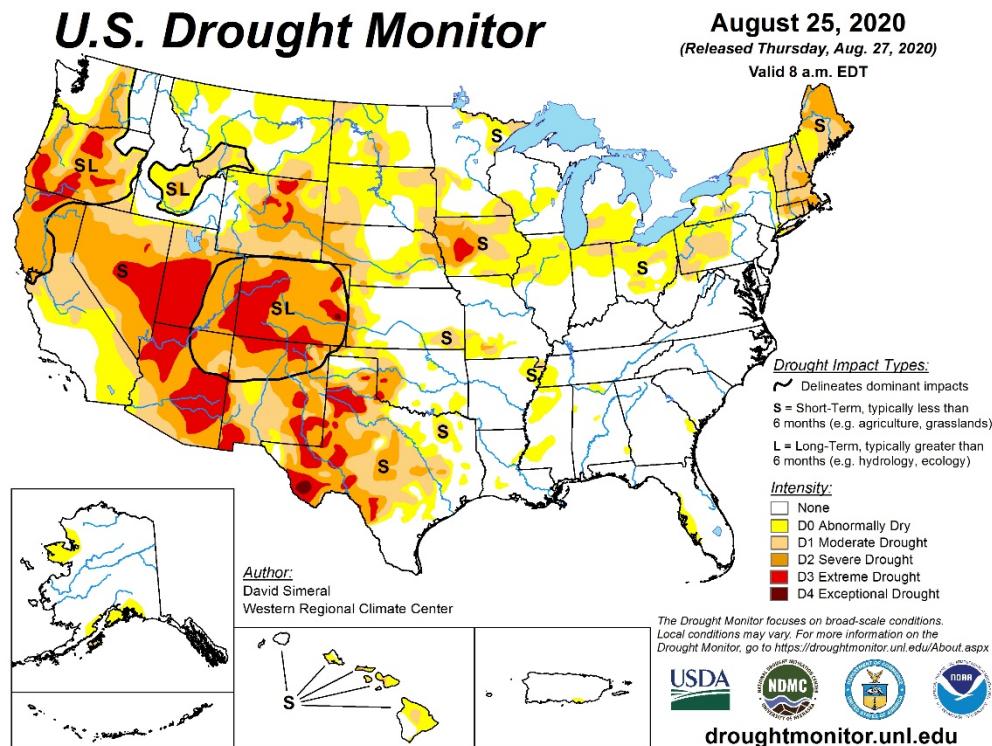


Figure 1. National Drought Mitigation Center U.S. Drought Monitor for August 25, 2020.

**U.S. Seasonal Drought Outlook**  
**Drought Tendency During the Valid Period**

Valid for August 20 - November 30, 2020  
 Released August 20

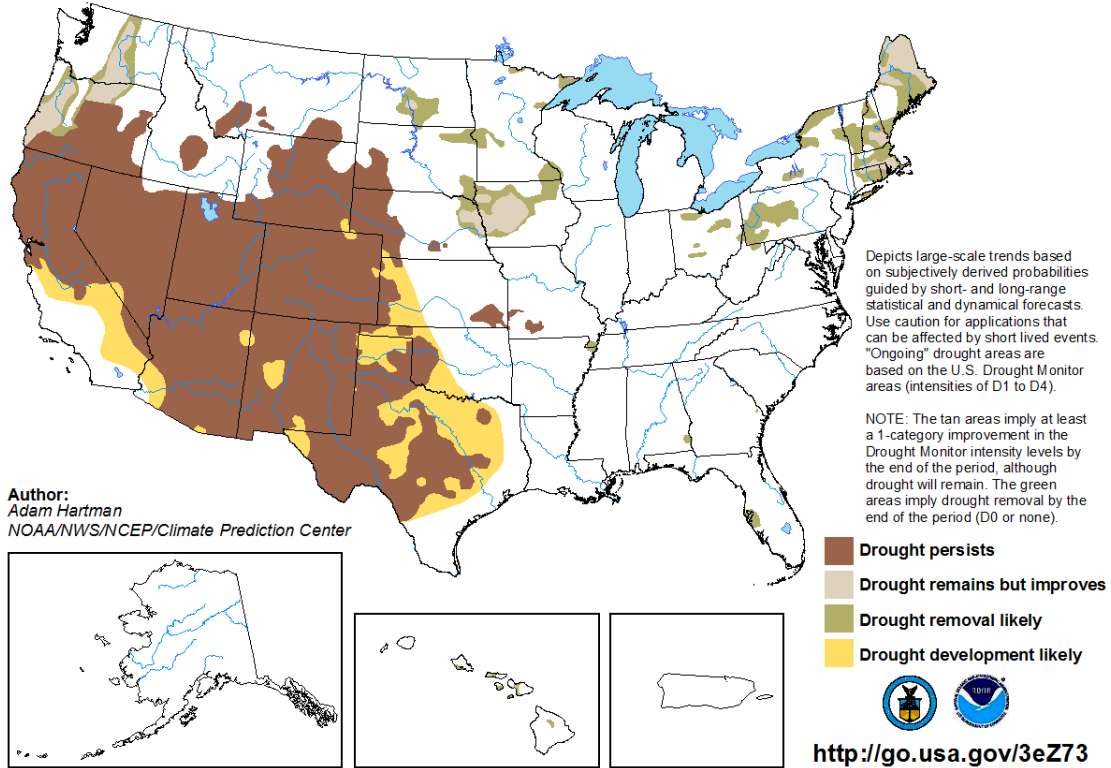


Figure 2. NWS CPC Seasonal Drought Outlook.

**Precipitation**

Monthly precipitation accumulations are shown using High Plains Regional Climate Center images available at <http://www.hprcc.unl.edu/>. The August precipitation accumulation map is shown in **Figure 3** as a percent of normal precipitation. August precipitation was drier than normal across the Basin, particularly in the western portions of the Basin. Most of Montana, Wyoming, Nebraska, Iowa, and Colorado had as low as 2-25% of normal precipitation while most of North Dakota and South Dakota ranged from 50-100% percent of precipitation with small areas near normal precipitation.

Percent of Normal Precipitation (%)  
8/1/2020 – 8/31/2020

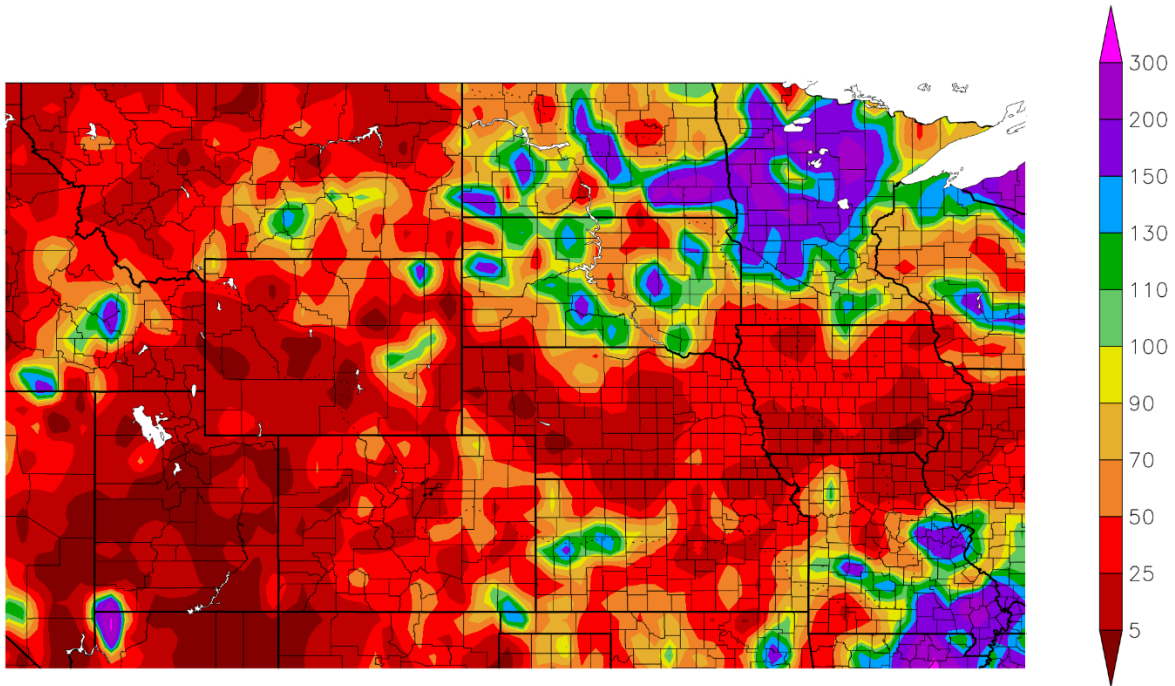


Figure 3. July 2020 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Since June 1, the Basin has received below-normal precipitation (see **Figure 4**), with some localized areas of near normal precipitation in Montana, South Dakota, Nebraska, and Kansas. Larger areas of 5-25 and 25-50 percent of normal precipitation have developed in Wyoming, Colorado, and western Nebraska.

## Percent of Normal Precipitation (%) 6/1/2020 – 8/31/2020

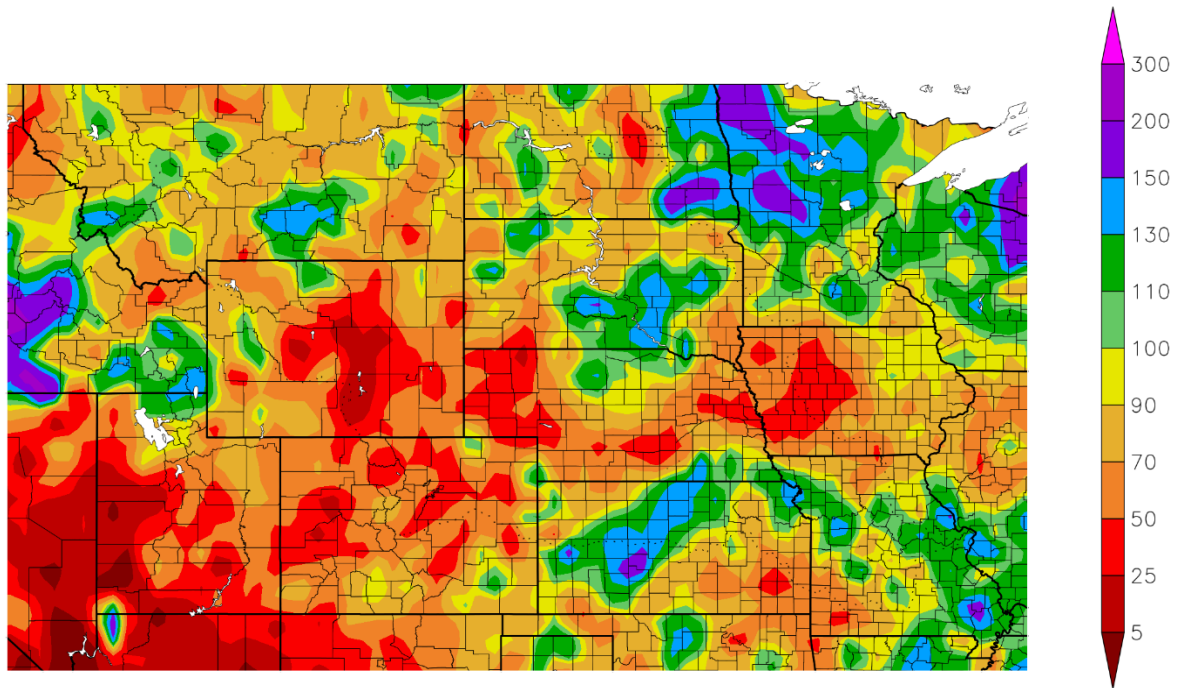


Figure 4. June 1 – August 31 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

### Temperature

August temperature departures in degrees Fahrenheit (deg F) in **Figure 5** were generally near normal, with 2 to 4 deg F above or below normal. Temperature departures were warmer in the western portions of the basin and were cooler in the southeastern portions of the basin.

June-July-August temperature departures are shown in **Figure 6**. The past three month's temperature departures were generally warmer than the 1-month trend. Most of the Basin was warmer than normal except for Montana and southeastern portion of the Basin, which were near normal.

Departure from Normal Temperature (F)  
8/1/2020 – 8/31/2020

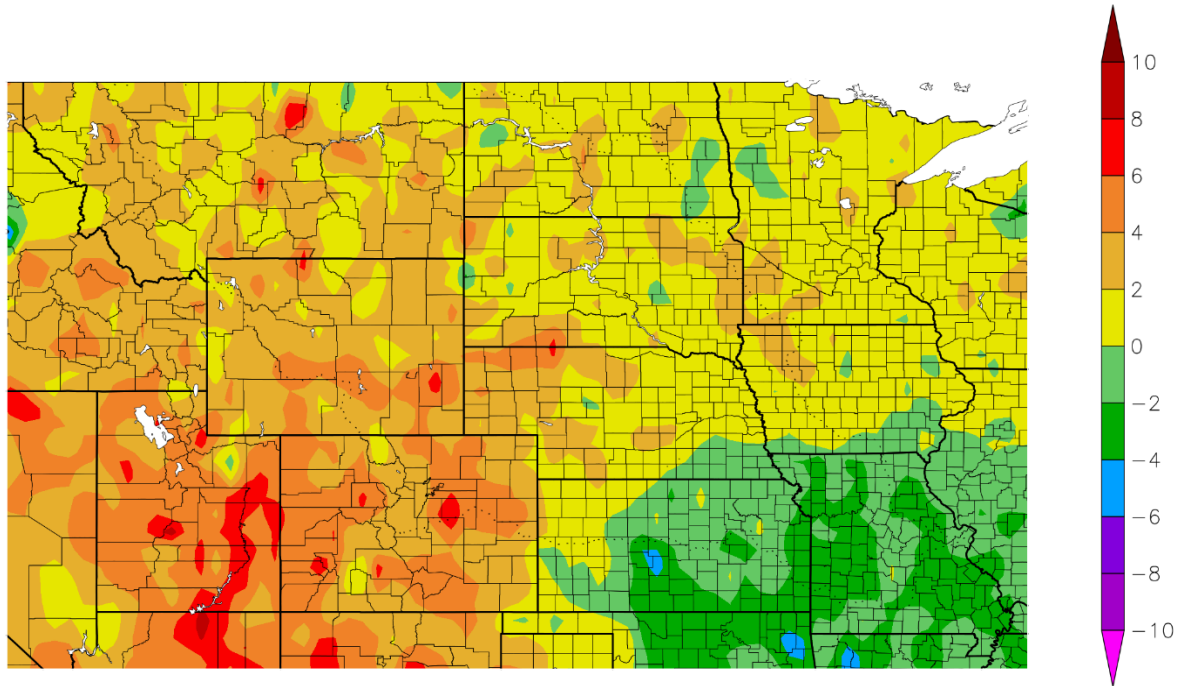


Figure 5. August 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Departure from Normal Temperature (F)  
6/1/2020 – 8/31/2020

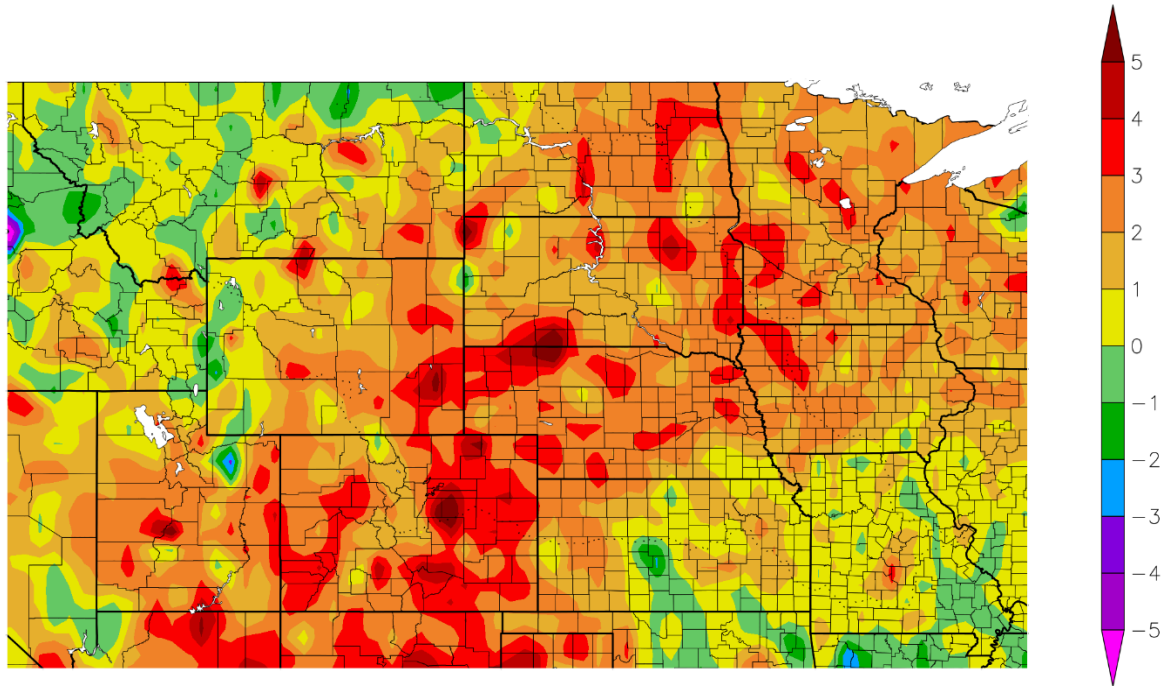
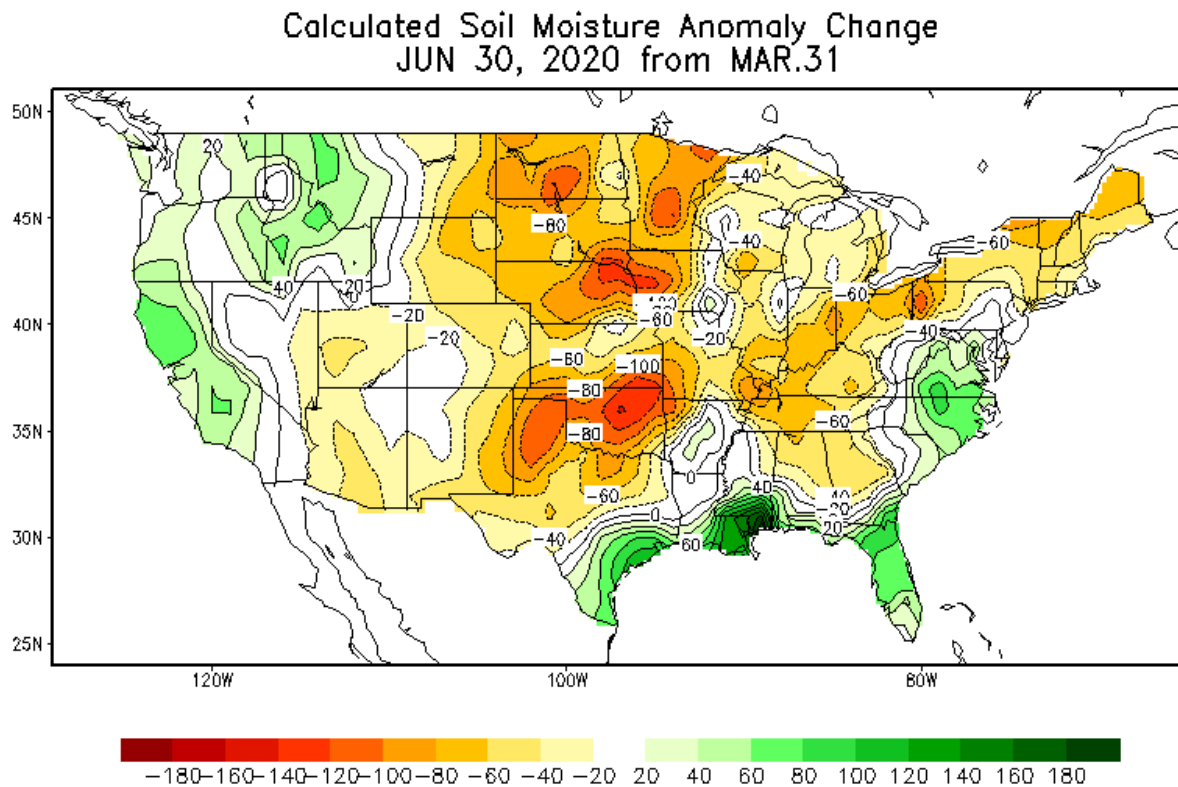


Figure 6. June-July-August 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

## Soil Moisture

Soil moisture is factored into the forecast as an indicator of wet or dry hydrologic basin conditions. Typically, when soil moisture conditions are wet or greater than normal, rainfall and snowmelt runoff is greater than when soil moisture is dry or less than normal. Not only is soil moisture a physical parameter that influences runoff, it can be used as an indicator of future runoff.

Soil moisture percentiles on March 31 based on the CPC's soil moisture model ranged from the 70<sup>th</sup> to 99<sup>th</sup> percentile ranking. Much of eastern Montana, North Dakota, South Dakota and Nebraska soils ranked above the 95<sup>th</sup> percentile, indicating soil conditions were very wet. Since March 31, soils have dried out considerably (see **Figure 7**). Based on the CPC's soil moisture model, the soil moisture anomaly had decreased by 60 to 140 mm over most of the Basin by the end of June. Soil moisture rebounded some during July. Since the end of June, soil moisture has continued to dry over parts of the basin of the Basin. Currently, 1-5 percent ranking covers most of Colorado, parts of Wyoming, and Nebraska (see **Figure 8**). Areas with 5-10 and 10-20 soil moisture percentiles have expanded in Wyoming, Nebraska, and Iowa.



**Figure 7. NOAA CPC Soil Moisture Anomaly Change (mm) March 31 to June 30. Source:**  
[https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

Calculated Soil Moisture Ranking Percentile  
SEP 01, 2020

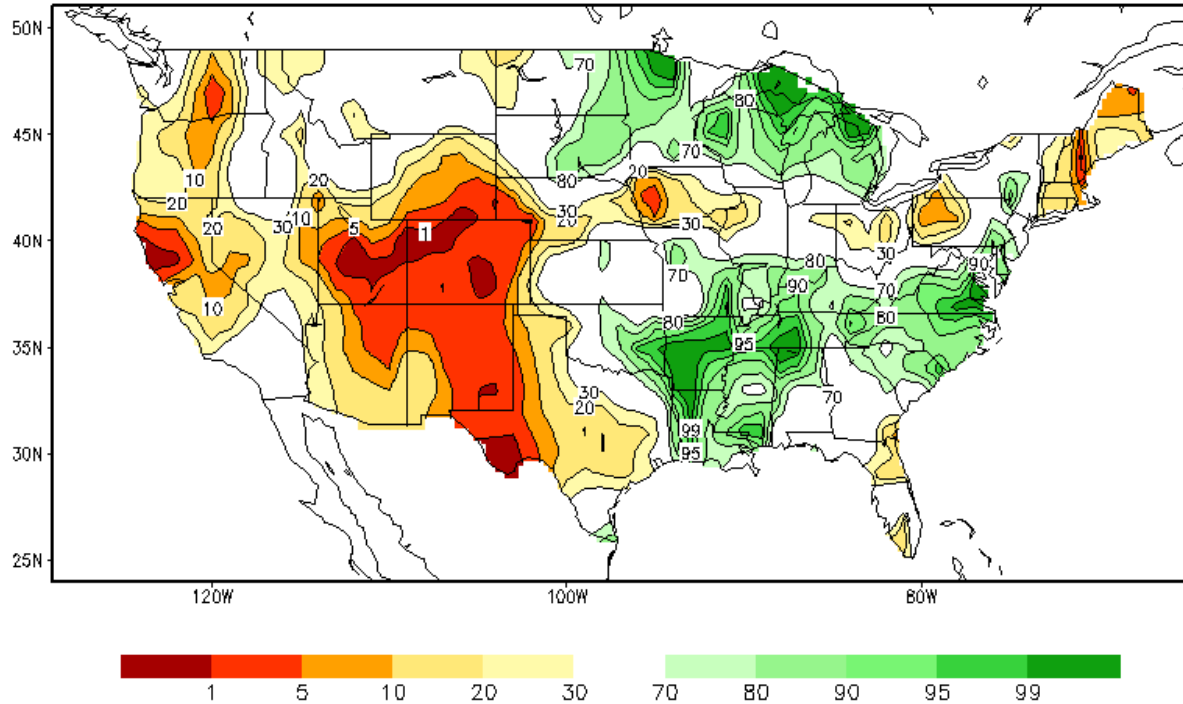


Figure 8. Calculated soil moisture ranking percentile. Source: [https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

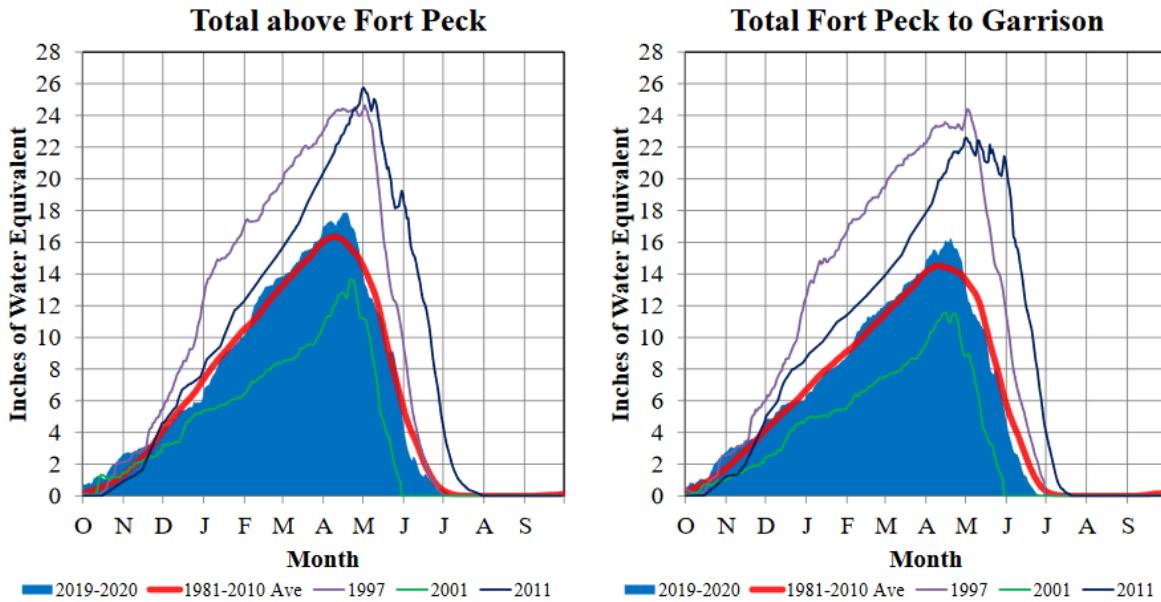
### Mountain Snowpack

Mountain snowpack is the primary factor used to predict May, June and July runoff volumes in the Fort Peck and Fort Peck to Garrison reaches. As the date of peak snowpack accumulation, usually around April 15, approaches, the correlation between the level of mountain snowpack and May, June and July runoff increases. Mountain snowpack becomes a better predictor of Fort Peck and Garrison reach runoff once it reaches its peak.

**Figure 9** includes time-series plots of the mountain SWE beginning on October 1, 2019 based on the NRCS SNOTEL data for the basin above Fort Peck and the incremental basin from Fort Peck to Garrison. The current average SWE values (shaded blue area) are plotted against the 1981-2010 basin average SWE (bold red line), a recent low SWE year in 2001 (green line), and two historic high SWE years occurring in 1997 (purple) and 2011 (dark blue).

# Missouri River Basin – Mountain Snowpack Water Content 2019-2020 with comparison plots from 1997\*, 2001\*, and 2011

5-Jul-2020



On July 5, 2020 the mountain Snow Water Equivalent (SWE) in the “Total above Fort Peck” reach was less than an inch, 81% of the July 5 average. The mountain SWE in the “Total Fort Peck to Garrison” reach has melted. The “Total above Fort Peck” reach snowpack peaked on April 16 at 17.9”, 109% of the normal April 15 peak. The “Total Fort Peck to Garrison” reach snowpack peaked on April 19 at 16.3”, 112% of the normal April 15 peak.

\*Generally considered the high and low year of the last 25-year period, respectively

Provisional data. Subject to revision.

**Figure 9. Mountain snowpack water content on July 5, 2020 compared to normal and historic conditions. Corps of Engineers - Missouri River Basin Water Management.**

Mountain snowpack peaked in the Fort Peck reach at 17.9 inches (109% of average) on April 16. Mountain snowpack peaked in the Garrison reach at 16.3 inches (112% of average) on April 19. Mountain snowpack normally peaks on April 15. Mountain snowpack as of July 5 had essentially melted in both reaches. Inflows into Fort Peck and Garrison have peaked and receded in both the Fort Peck and Garrison reaches.

## **Climate Outlook**

MRBWM participates in the monthly North Central U.S. Climate/Drought Outlook Webinar coordinated through NOAA, the regional climate centers, and the American Association of State Climatologists (AASC). These webinars provide updates on near-term climate outlooks and impacts including the ENSO climate pattern and its implications on winter temperature and precipitation patterns in the Missouri Basin.

### **ENSO (El Niño Southern Oscillation)**

The latest ENSO Outlook indicates that ENSO-neutral conditions are present, but there is 60% chance of La Niña developing during Northern Hemisphere fall 2020. There is also a 55% chance that the La Niña will continue through winter 2020-2021. During ENSO-neutral conditions there are no strong climate indicators to provide much certainty on the precipitation and temperature outlooks beyond the winter and early spring seasons. During La Niña winters, the probability for a colder-than-normal and slightly wetter-than-normal weather pattern in the Northern Rockies and Northern Plains is higher.

### **Temperature and Precipitation Outlooks**

The CPC outlooks provide the forecasted probability (or chance) of occurrence of future weather conditions during periods ranging from 1 to 12 months into the future. The CPC outlooks are available at <http://www.cpc.ncep.noaa.gov/>.

The CPC temperature outlook for the forecast period from September 7-11 is shown in **Figure 10**. The outlook is indicating an increase in the chances for below-normal temperatures over the entire Basin. Regarding precipitation, there is an increase in the chances for below-normal precipitation over the central portion of the Basin. During the month of September (**Figure 11**), the temperature outlook is indicating increased chances for below-normal temperatures in the eastern portion of the Basin and increased chances of above-normal temperatures in the western portion of the Basin. The remainder of the Basin has equal chances for above- and below-normal temperatures. Regarding precipitation for September, there are increased chances of below-normal precipitation in the upper Basin, Nebraska, and Iowa.

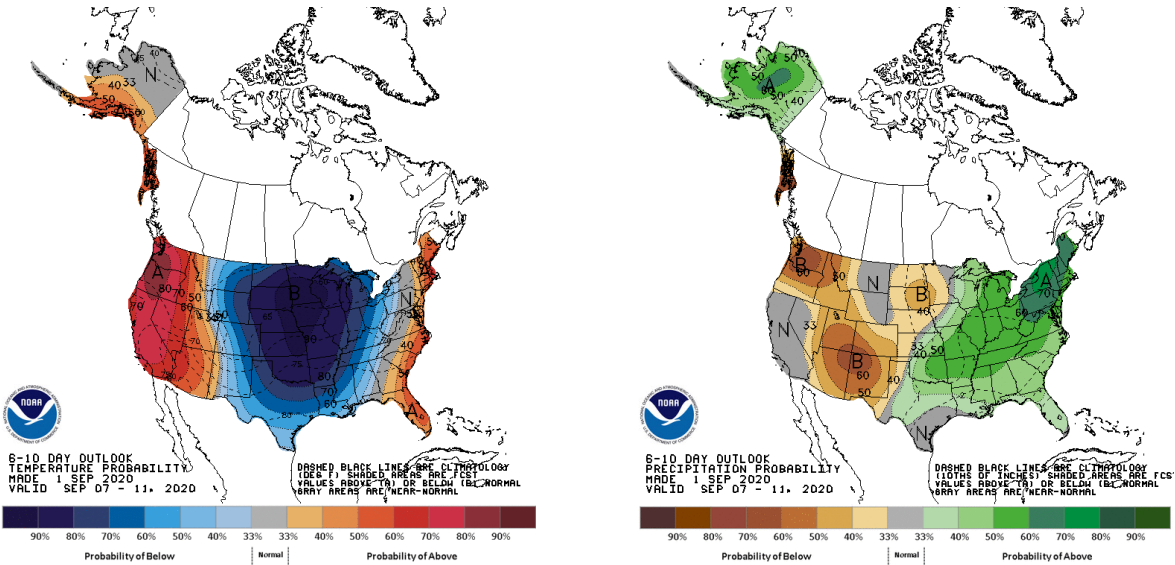


Figure 10. CPC 6-10 Day temperature and precipitation outlooks through September 11, 2020.

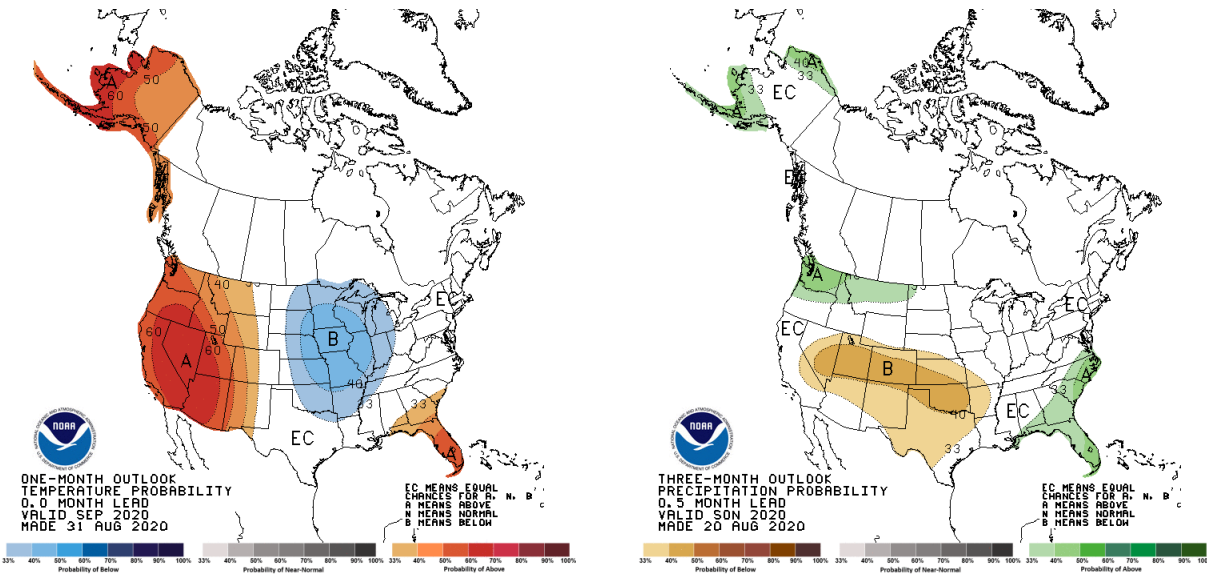


Figure 11. CPC September 2020 temperature and precipitation outlooks.

Three-month temperature and precipitation outlooks for the three-month periods from October 2020 through March 2021 are shown below in **Figure 12** and **Figure 13**. During October-November-December 2020 (**Figure 12**), the CPC indicates increased chances for above-normal temperatures across the entire Basin. Regarding precipitation, there are increased chances for above-normal precipitation in Montana, North Dakota, and South Dakota, with equal chances over the remainder of the Basin.

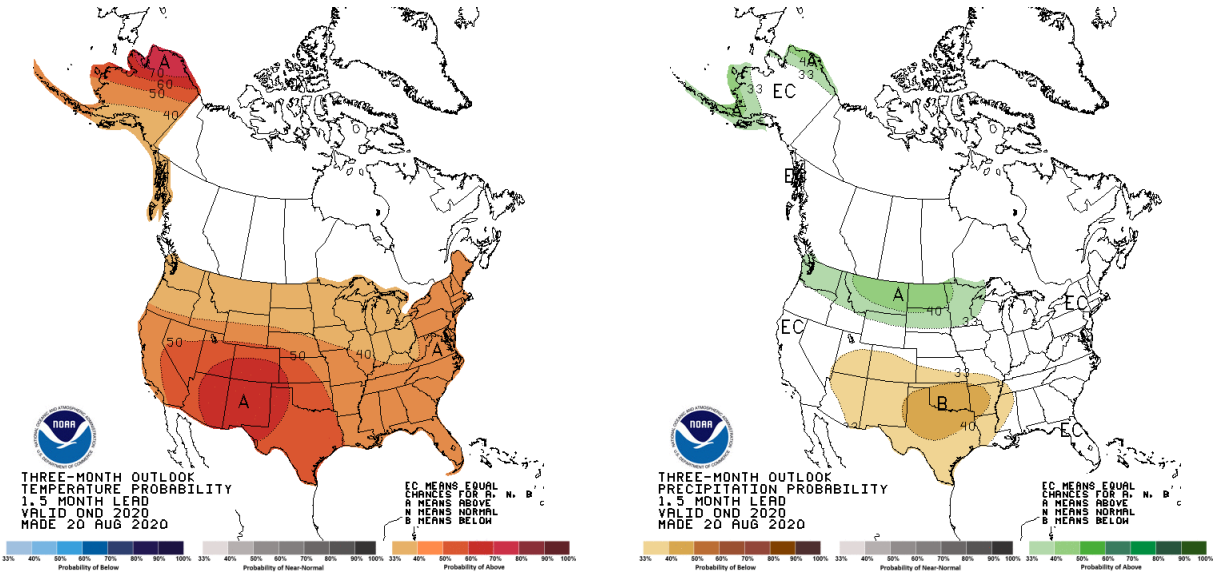


Figure 12. CPC October-November-December 2020 temperature and precipitation outlooks.

During the January-March 2021 outlook period (**Figure 13**), there are increased chances of below normal temperatures in Montana and western North Dakota with equal chances for above- and below-normal temperatures throughout the rest of the Missouri Basin. Regarding precipitation during the January-March 2021 period, CPC is indicating increased chances for above-normal precipitation in most of the upper Basin and equal chances in the lower Basin.

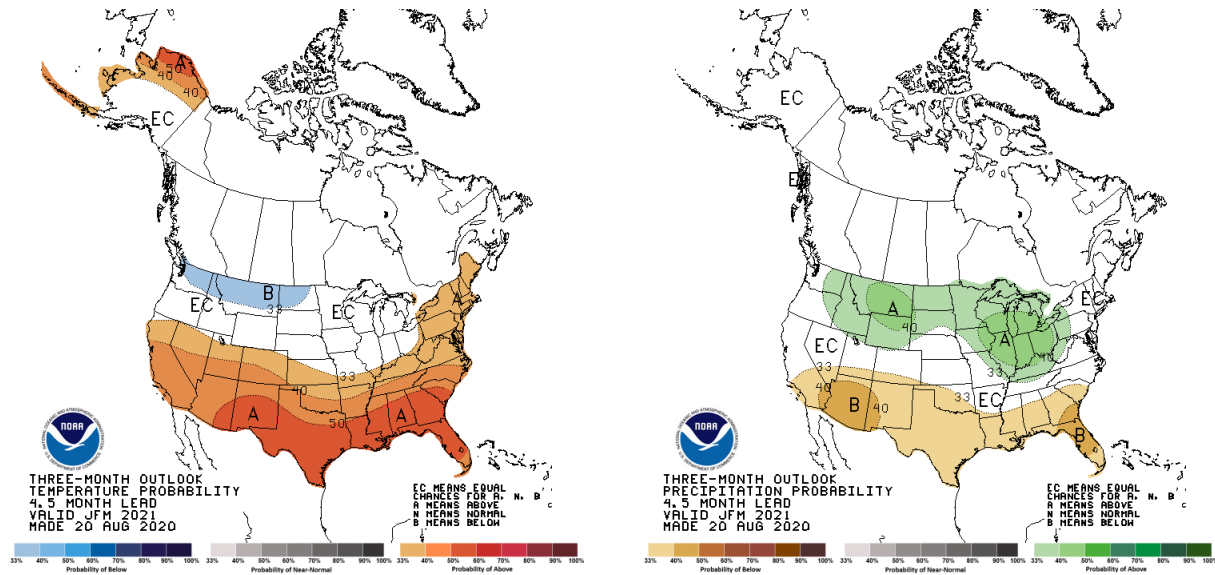


Figure 13. CPC January-March 2021 temperature and precipitation outlooks.

## Summary

In summary, the 2020 calendar year runoff forecast is **30.6 MAF (119% of average)**. The September 1 calendar year runoff forecast is just below an upper quartile runoff volume.

**Upper Missouri River Basin  
October 2020 Calendar Year Runoff Forecast  
October 1, 2020**

**U.S. Army Corps of Engineers, Northwestern Division  
Missouri River Basin Water Management  
Omaha, NE**

**Calendar Year Runoff Forecast**

**Explanation and Purpose of Forecast**

The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. The Calendar Year Runoff Forecast is available at <http://www.nwd-mr.usace.army.mil/rcc/reports/runoff.pdf>. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows in million acre-feet (MAF) from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri Basin above Sioux City (upper Basin). The Calendar Year Runoff Forecast is used in the Monthly Study simulation model to plan future system regulation in order to meet the authorized project purposes throughout the calendar year.

**Observed Runoff**

September precipitation was drier than normal across the Basin, with 25 to 50% of normal precipitation observed over the majority of the Basin. This resulted in September runoff of 0.8 MAF (69% of average) in the upper Basin above Sioux City, and 0.7 MAF (65% of average) for the upper Basin above Gavins Point Dam. September runoff remained above average in the lower two reaches (Gavins Point and Sioux City), below average in the Fort Randall and Fort Peck reaches, and well below average in the Garrison and Oahe reaches.

**2020 Calendar Year Forecast Synopsis**

The 2020 calendar year runoff forecast for the upper Missouri Basin above Sioux City, IA is **30.2 MAF, 117% of average**. The 2020 calendar year runoff forecast for the Missouri Basin above Gavins Point is **24.4 MAF, 105% of average**. Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next 3 months, expected inflow could range from the 30.8 MAF upper basic forecast to the 29.7 MAF lower basic forecast. The upper and lower basic forecasts are used in long-term regulation planning models to “bracket” the range of expected runoff given much wetter or drier conditions, respectively. Given that 3 months are

being forecast for this October 1 forecast (9 months observed/3 months forecast), the range of possible wetter-than-expected (upper basic) and drier-than-expected (lower basic) conditions are smaller than during the summer. The result is a range or “bracket” for each reach, and thus, for the total runoff forecast.

## Current Conditions

### Drought Analysis

The National Drought Mitigation Center’s drought monitor for September 29, 2020 is shown in **Figure 1**. The drought monitor is available at <http://droughtmonitor.unl.edu/>. The U.S. Drought Monitor shows D3 “extreme drought” conditions are present in Colorado and areas of Wyoming and Nebraska. Larger areas of D2 “severe drought” are also present in those states, and also in western Iowa, southwestern South Dakota, northern North Dakota, and eastern Montana. There are areas of D1 “moderate drought” and D0 “abnormally dry” conditions present in every state in the Basin. The National Weather Service (NWS) Climate Prediction Center’s (CPC) Seasonal Drought Outlook in **Figure 2**, which extends through the end of December, shows the drought in North Dakota, South Dakota, Wyoming, Colorado, Kansas, Iowa and Nebraska persisting and expanding, with improvement and removal only likely in areas of Montana.

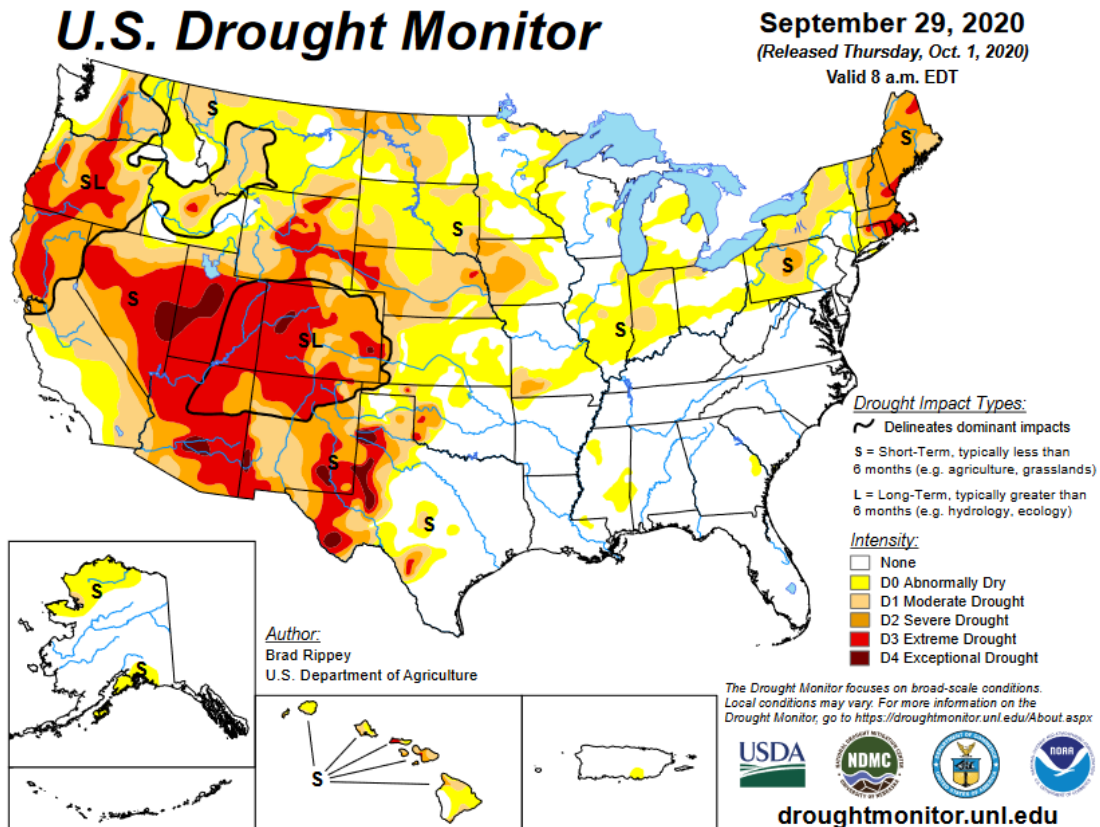


Figure 1. National Drought Mitigation Center U.S. Drought Monitor for September 29, 2020.

**U.S. Seasonal Drought Outlook**  
**Drought Tendency During the Valid Period**

Valid for September 17 - December 31, 2020  
 Released September 17

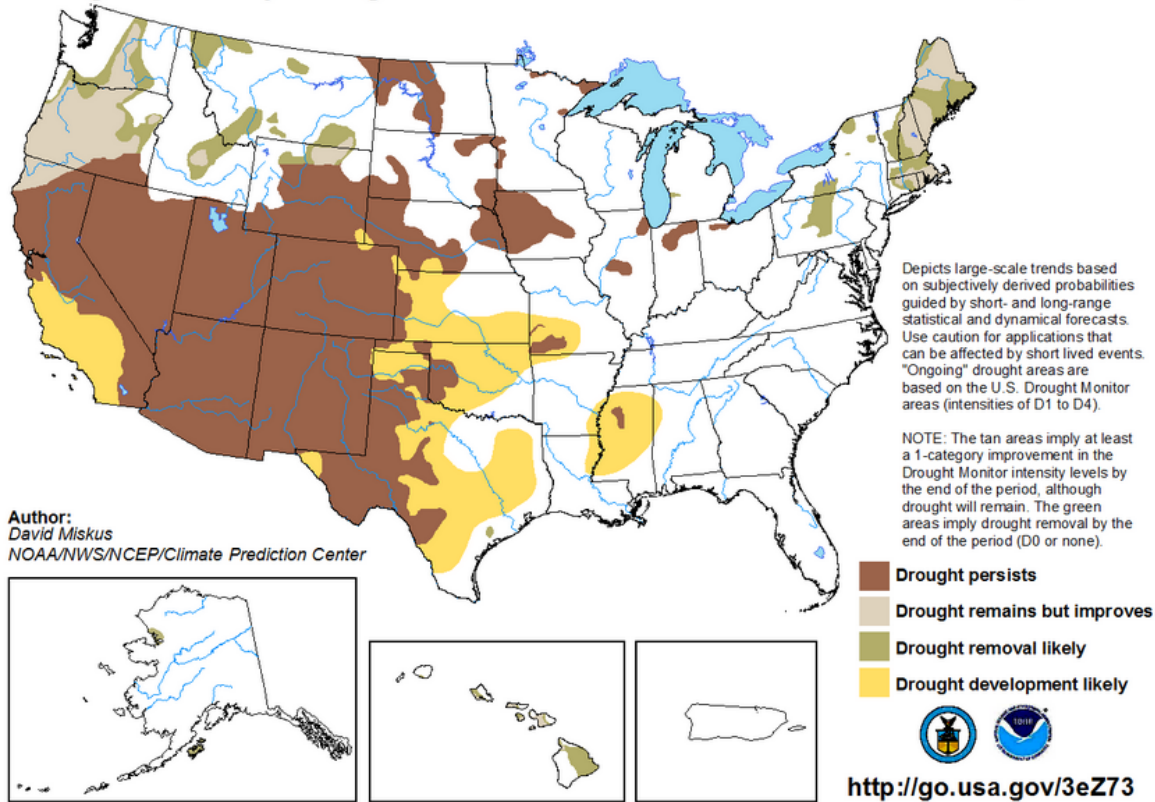


Figure 2. NWS CPC Seasonal Drought Outlook.

**Precipitation**

Monthly precipitation accumulations are shown using High Plains Regional Climate Center images available at <http://www.hprcc.unl.edu/>. The September precipitation accumulation map is shown in **Figure 3** as a percent of normal precipitation. September precipitation was drier than normal across the Basin, particularly in the Dakotas and Nebraska. Most of those areas received 5-50% of normal precipitation. Northern Montana and eastern Iowa were the only large areas of above-normal precipitation in the Basin.

Percent of Normal Precipitation (%)  
9/1/2020 – 9/30/2020

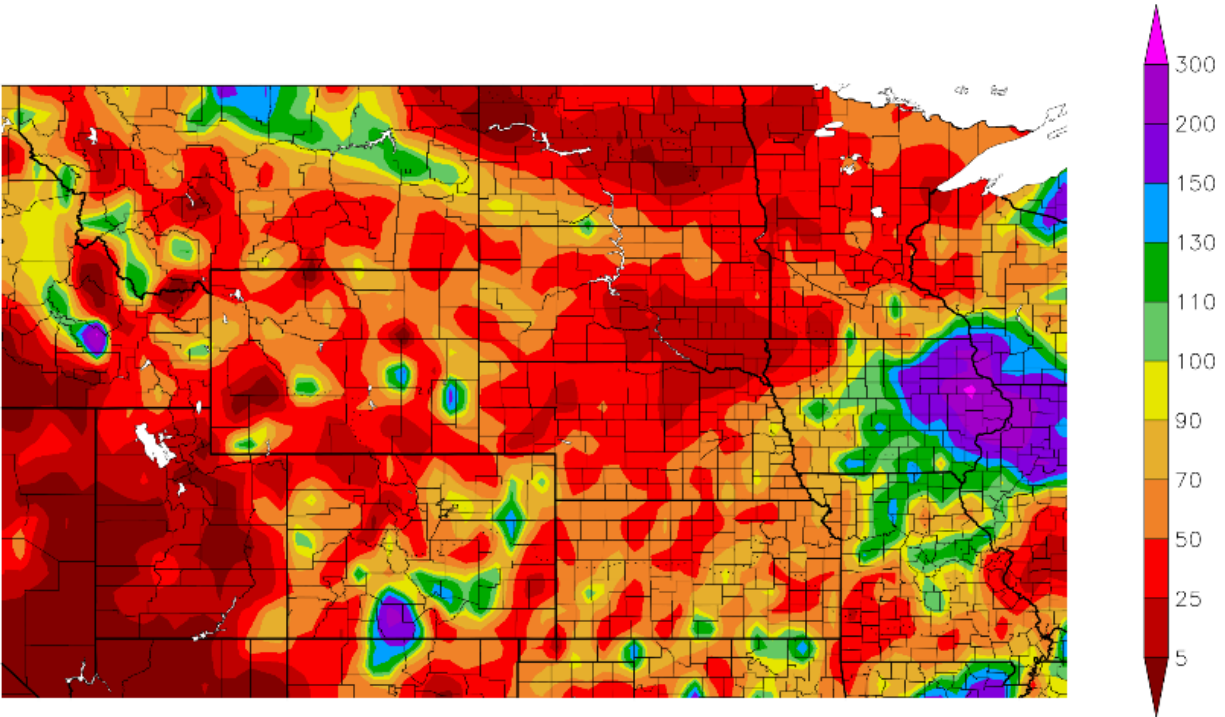


Figure 3. September 2020 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Since July 1, the western half of the Basin and Iowa have received below-normal precipitation (see **Figure 4**), with the eastern portion of the Basin receiving near-normal precipitation. Larger areas of 5-25 and 25-50 percent of normal precipitation have developed in Wyoming, Colorado, and western Nebraska.

## Percent of Normal Precipitation (%) 7/1/2020 – 9/30/2020

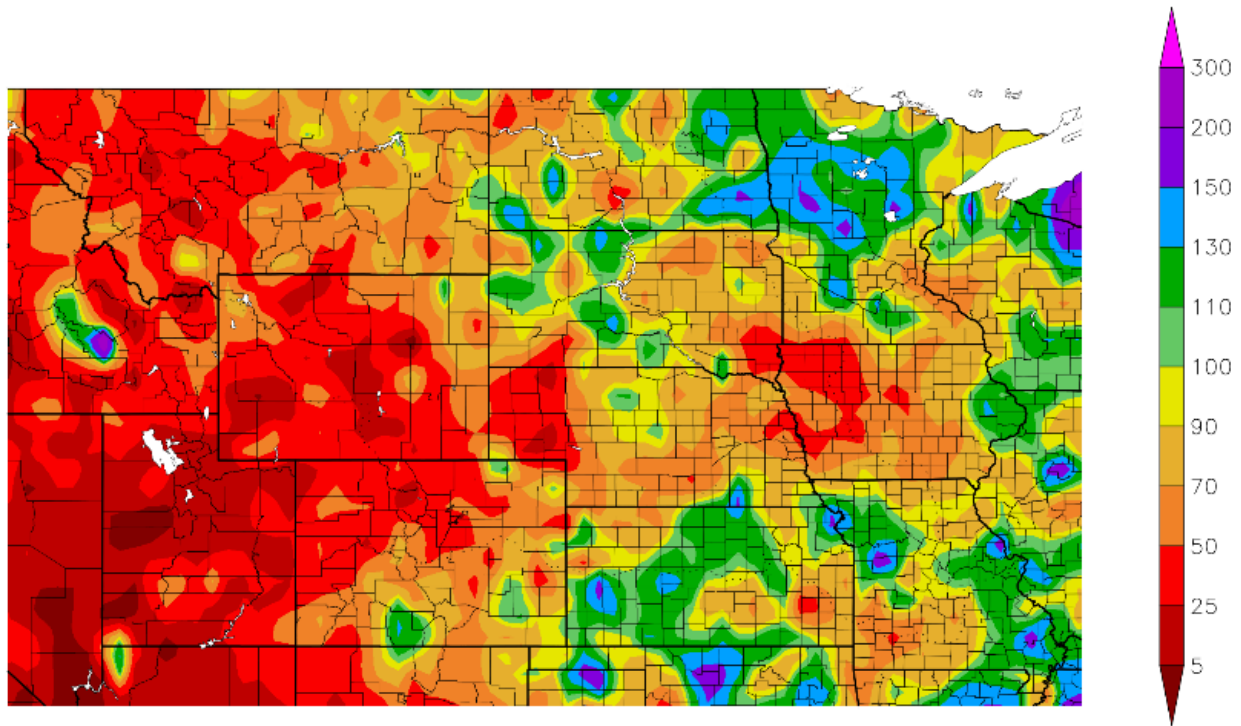


Figure 4. July 1 – September 30 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

### Temperature

September temperature departures in degrees Fahrenheit (deg F) in **Figure 5** were generally near normal across most of the Basin, with areas of warmer-than-normal temperatures in Montana, and cooler-than-normal temperatures in Kansas. Temperature departures were warmer in the western portions of the basin and were cooler in the southeastern portions of the Basin.

July-August-September temperature departures are shown in **Figure 6**. The past three month's temperature departures were generally around 2 degrees warmer than the 1-month trend. Most of the Basin was warmer than normal except for the southeastern portion of the Basin, which was generally around 2 degrees cooler than normal.

Departure from Normal Temperature (F)  
9/1/2020 – 9/30/2020

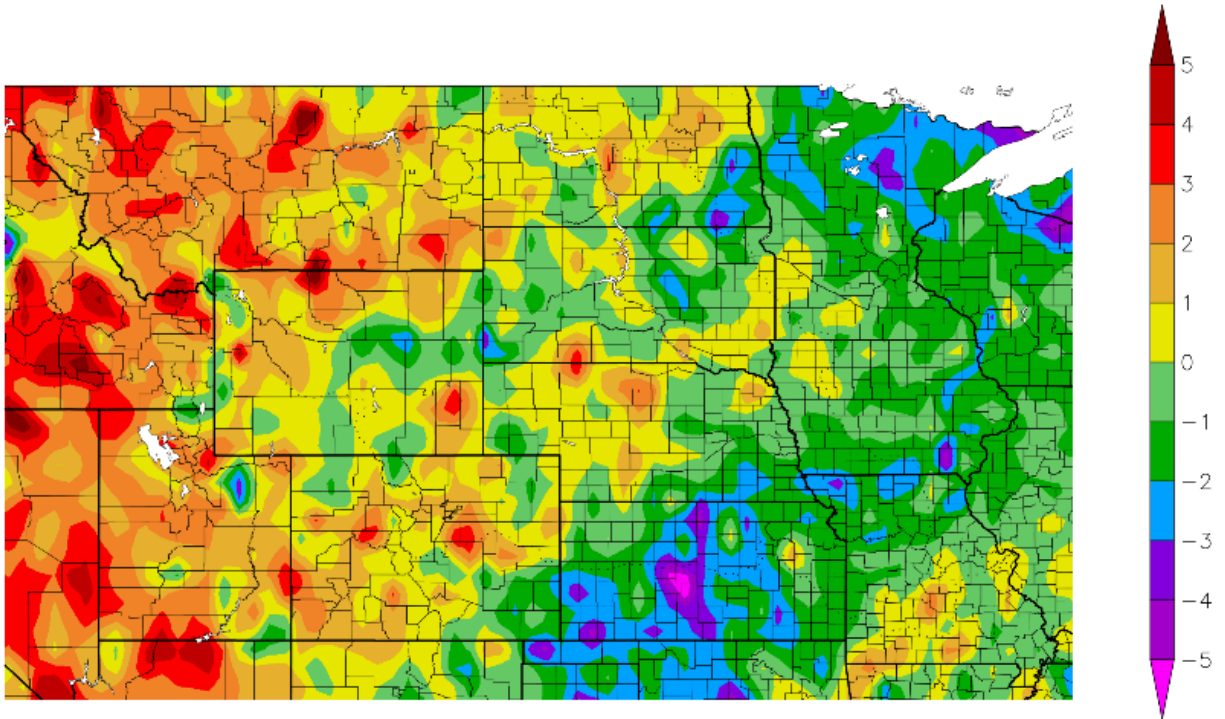


Figure 5. September 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Departure from Normal Temperature (F)  
7/1/2020 – 9/30/2020

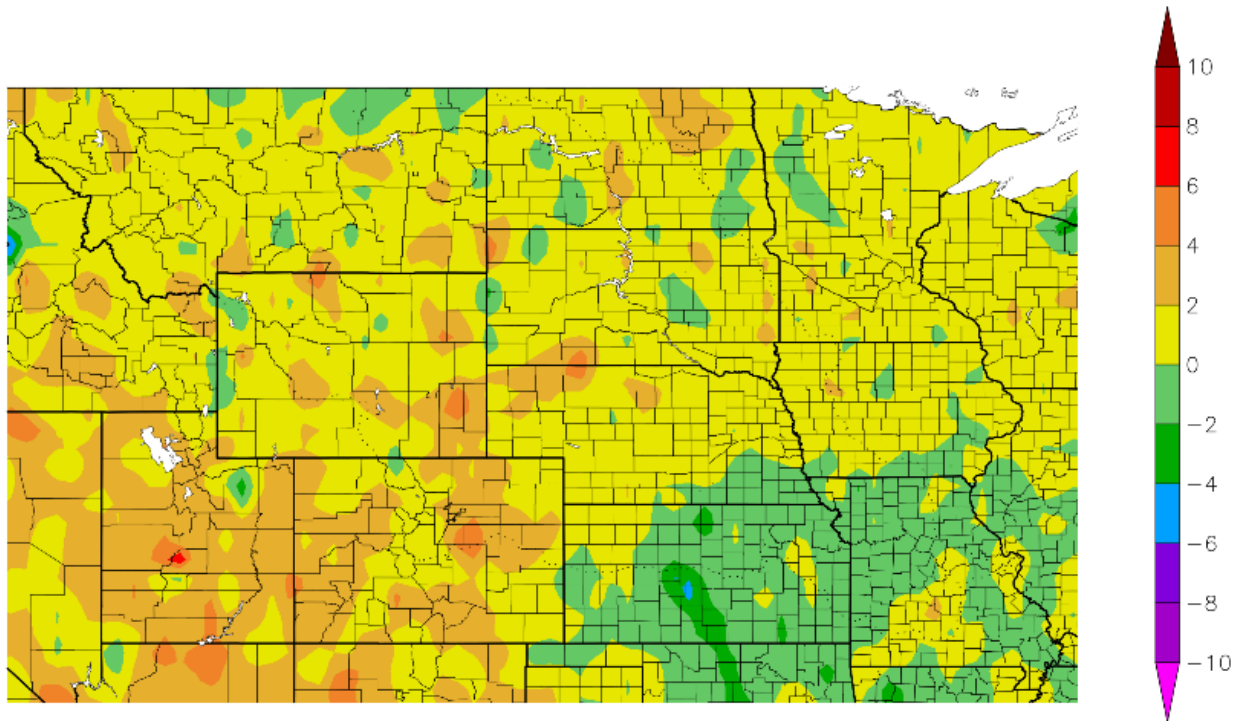
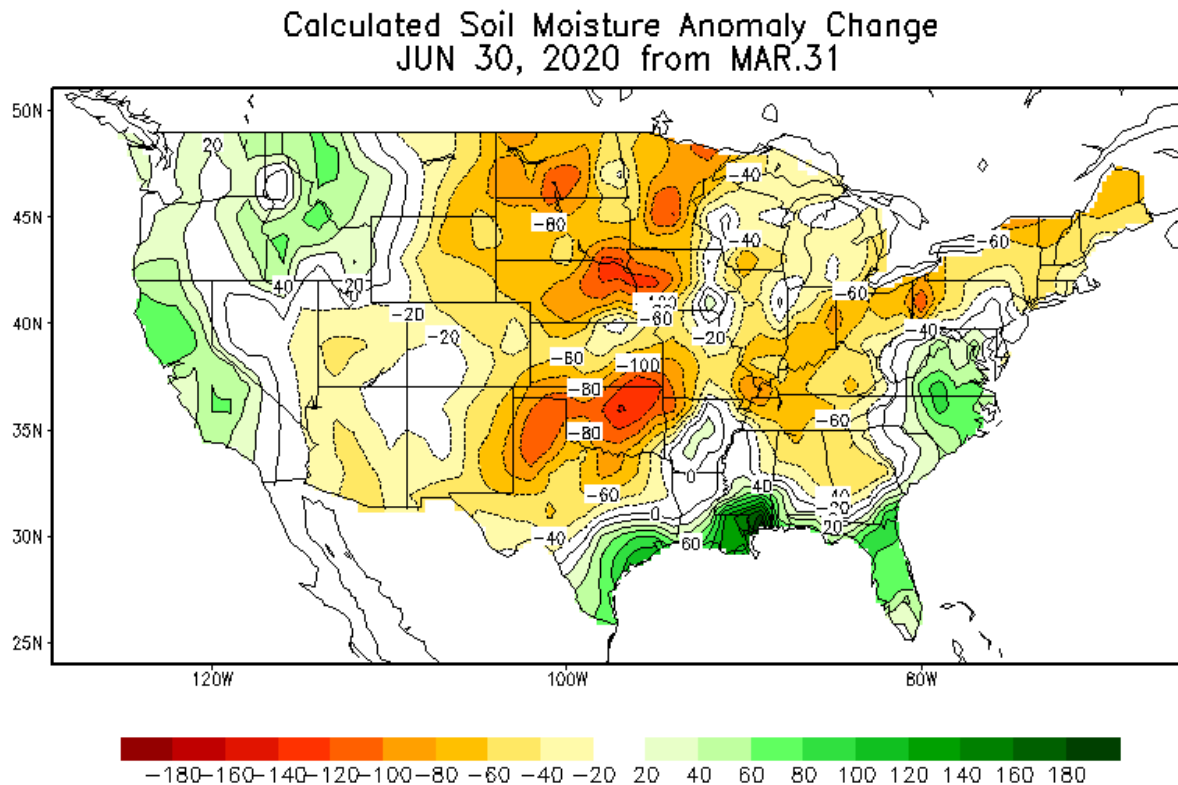


Figure 6. July-August-September 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

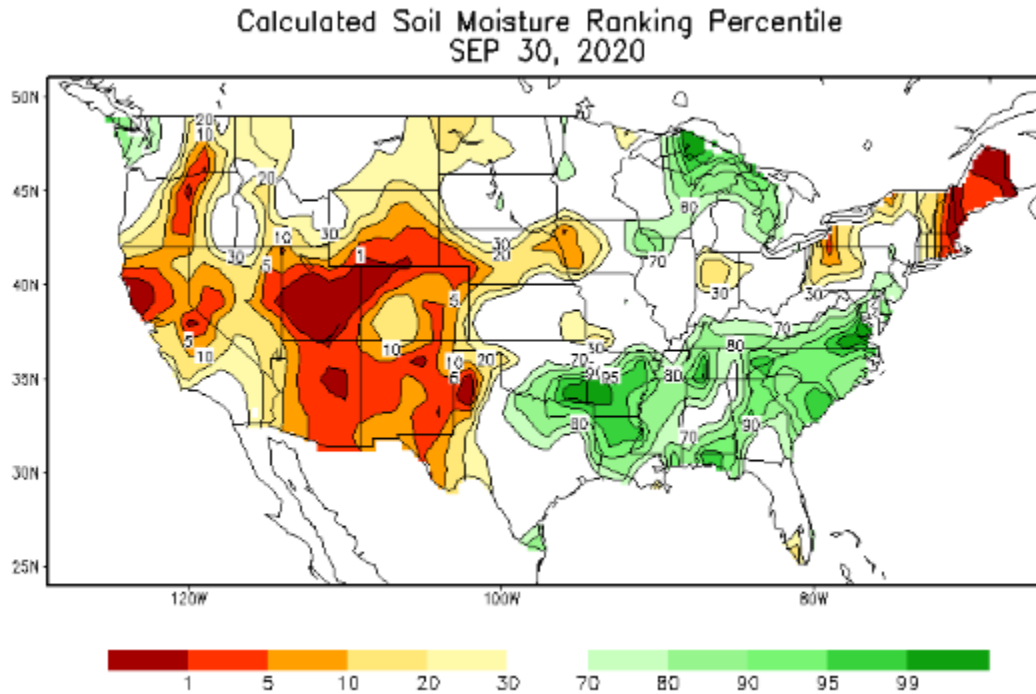
## Soil Moisture

Soil moisture is factored into the forecast as an indicator of wet or dry hydrologic basin conditions. Typically, when soil moisture conditions are wet or greater than normal, rainfall and snowmelt runoff is greater than when soil moisture is dry or less than normal. Not only is soil moisture a physical parameter that influences runoff, it can be used as an indicator of future runoff.

Soil moisture percentiles on March 31 based on the CPC's soil moisture model ranged from the 70<sup>th</sup> to 99<sup>th</sup> percentile ranking. Much of eastern Montana, North Dakota, South Dakota and Nebraska soils ranked above the 95<sup>th</sup> percentile, indicating soil conditions were very wet. Since March 31, soils have dried out considerably (see **Figure 7**). Based on the CPC's soil moisture model, the soil moisture anomaly had decreased by 60 to 140 mm over most of the Basin by the end of June. Soil moisture rebounded some during July. Since the end of June, soil moisture has continued to dry over parts of the basin of the Basin. Currently, 1-5 percent ranking covers areas of Colorado, Wyoming, and Nebraska (see **Figure 8**). Larger areas with 5-10 and 10-30 soil moisture percentiles are present in Wyoming, Colorado, Montana, North Dakota, Nebraska, and Iowa.



**Figure 7. NOAA CPC Soil Moisture Anomaly Change (mm) March 31 to June 30. Source: [https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)**



**Figure 8. Calculated soil moisture ranking percentile. Source:**  
[https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

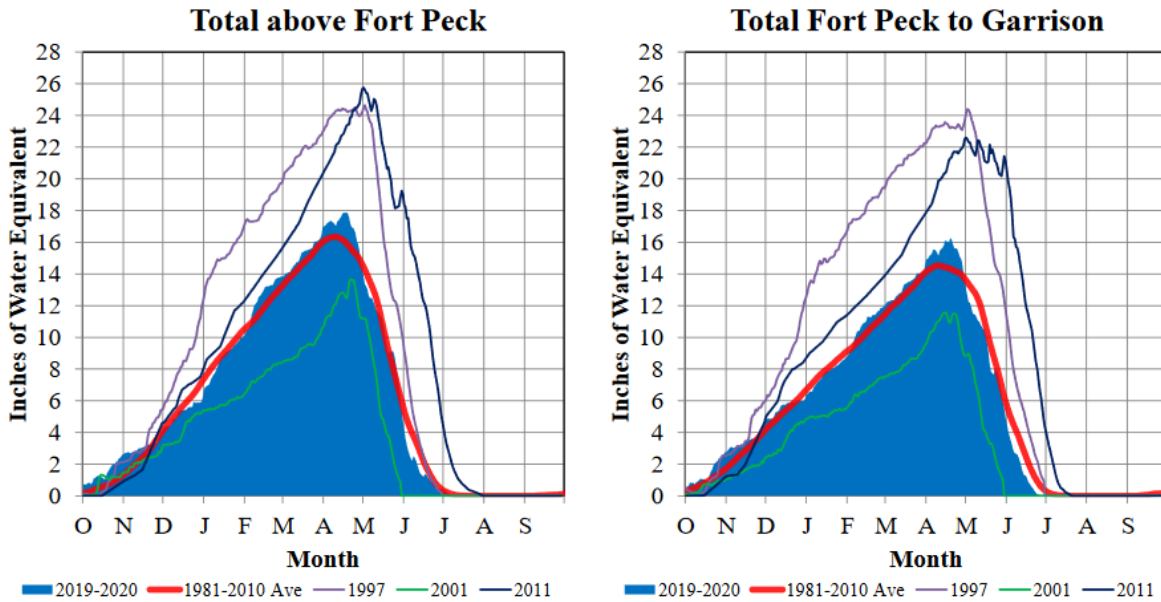
### Mountain Snowpack

Mountain snowpack is the primary factor used to predict May, June and July runoff volumes in the Fort Peck and Fort Peck to Garrison reaches. As the date of peak snowpack accumulation, usually around April 15, approaches, the correlation between the level of mountain snowpack and May, June and July runoff increases. Mountain snowpack becomes a better predictor of Fort Peck and Garrison reach runoff once it reaches its peak.

**Figure 9** includes time-series plots of the mountain SWE beginning on October 1, 2019 based on the NRCS SNOTEL data for the basin above Fort Peck and the incremental basin from Fort Peck to Garrison. The current average SWE values (shaded blue area) are plotted against the 1981-2010 basin average SWE (bold red line), a recent low SWE year in 2001 (green line), and two historic high SWE years occurring in 1997 (purple) and 2011 (dark blue).

# Missouri River Basin – Mountain Snowpack Water Content 2019-2020 with comparison plots from 1997\*, 2001\*, and 2011

5-Jul-2020



On July 5, 2020 the mountain Snow Water Equivalent (SWE) in the “Total above Fort Peck” reach was less than an inch, 81% of the July 5 average. The mountain SWE in the “Total Fort Peck to Garrison” reach has melted. The “Total above Fort Peck” reach snowpack peaked on April 16 at 17.9”, 109% of the normal April 15 peak. The “Total Fort Peck to Garrison” reach snowpack peaked on April 19 at 16.3”, 112% of the normal April 15 peak.

\*Generally considered the high and low year of the last 25-year period, respectively

Provisional data. Subject to revision.

**Figure 9. Mountain snowpack water content on July 5, 2020 compared to normal and historic conditions. Corps of Engineers - Missouri River Basin Water Management.**

Mountain snowpack peaked in the Fort Peck reach at 17.9 inches (109% of average) on April 16. Mountain snowpack peaked in the Garrison reach at 16.3 inches (112% of average) on April 19. Mountain snowpack normally peaks on April 15. Mountain snowpack as of July 5 had essentially melted in both reaches. Inflows into Fort Peck and Garrison have peaked and receded in both the Fort Peck and Garrison reaches.

## **Climate Outlook**

MRBWM participates in the monthly North Central U.S. Climate/Drought Outlook Webinar coordinated through NOAA, the regional climate centers, and the American Association of State Climatologists (AASC). These webinars provide updates on near-term climate outlooks and impacts including the ENSO climate pattern and its implications on winter temperature and precipitation patterns in the Basin.

### **ENSO (El Niño Southern Oscillation)**

The latest ENSO Outlook indicates that La Niña conditions are present and are likely to continue through the Northern Hemisphere winter. During La Niña winters, the probability for a colder-than-normal and slightly wetter-than-normal weather pattern in the Northern Rockies and Northern Plains is higher.

### **Temperature and Precipitation Outlooks**

The CPC outlooks provide the forecasted probability (or chance) of occurrence of future weather conditions during periods ranging from 1 to 12 months into the future. The CPC outlooks are available at <http://www.cpc.ncep.noaa.gov/>.

The CPC temperature outlook for the forecast period from October 7-11 is shown in **Figure 10**. The outlook is indicating an increase in the chances for above-normal temperatures and below-normal precipitation over the entire Basin. During the month of October (**Figure 11**), the outlook is indicating increased chances for above-normal temperatures and below-normal precipitation over the entire Basin.

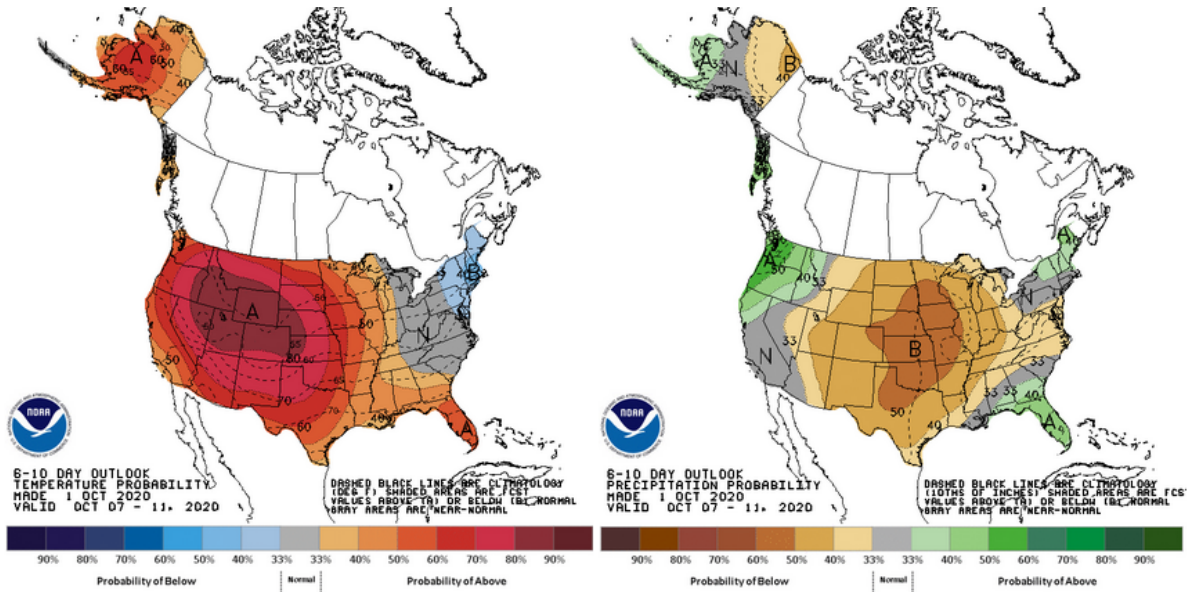


Figure 10. CPC 6-10 Day temperature and precipitation outlooks through October 11, 2020.

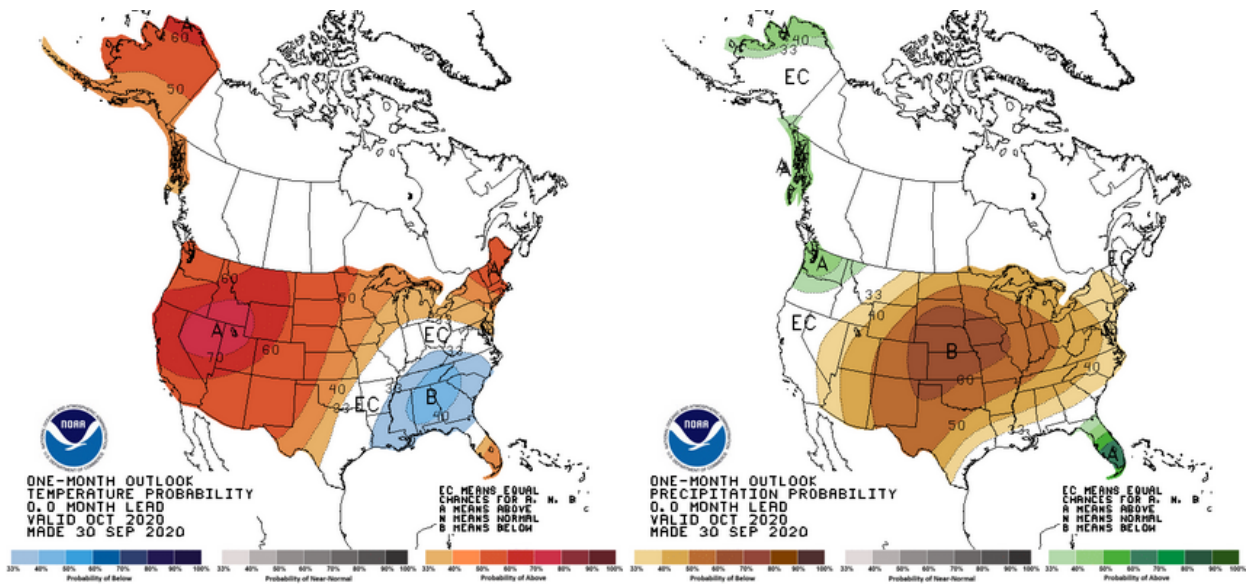


Figure 11. CPC October 2020 temperature and precipitation outlooks.

Three-month temperature and precipitation outlooks for the three-month periods from November 2020 through January 2021 are shown below in **Figure 12**. During November-December 2020-January 2021, the CPC indicates increased chances for above-normal temperatures across the entire Basin. Regarding precipitation, there are increased chances for above-normal precipitation in Montana, North Dakota, and South Dakota, with equal chances over the remainder of the Basin.

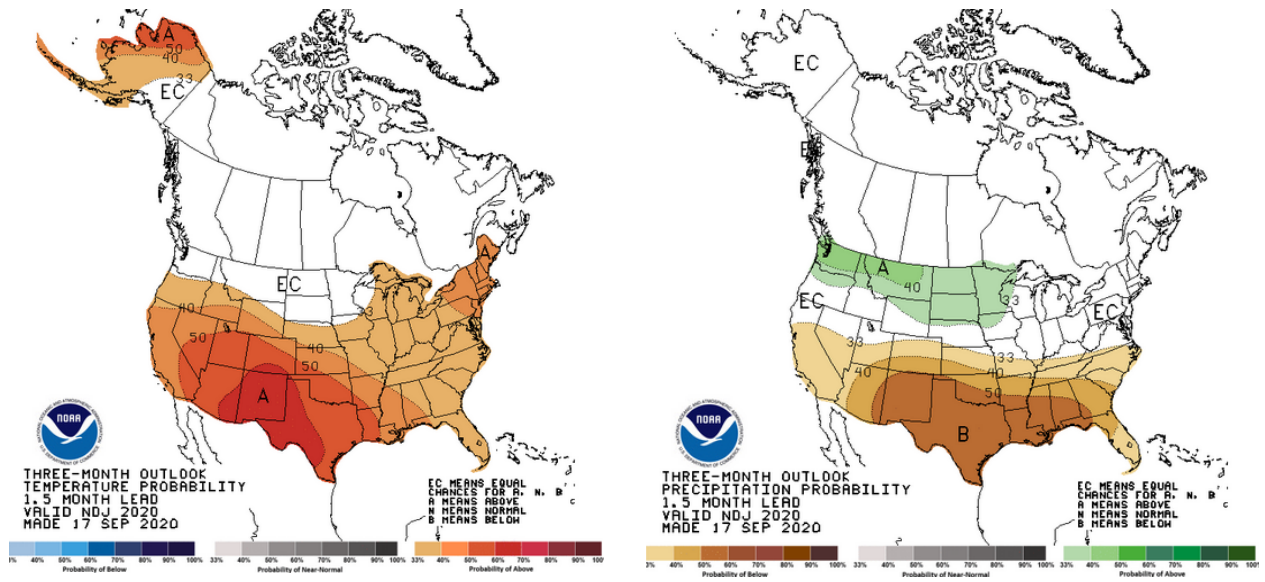


Figure 12. CPC November-December 2020-January 2021 temperature and precipitation outlooks.

## Summary

In summary, the 2020 calendar year runoff forecast is **30.2 MAF (117% of average)**. The October 1 calendar year runoff forecast is just below an upper quartile runoff volume.

**Upper Missouri River Basin  
November 2020 Calendar Year Runoff Forecast  
November 1, 2020**

**U.S. Army Corps of Engineers, Northwestern Division  
Missouri River Basin Water Management  
Omaha, NE**

**Calendar Year Runoff Forecast**

**Explanation and Purpose of Forecast**

The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. The Calendar Year Runoff Forecast is available at <http://www.nwd-mr.usace.army.mil/rcc/reports/runoff.pdf>. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows in million acre-feet (MAF) from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri Basin above Sioux City (upper Basin). The Calendar Year Runoff Forecast is used in the Monthly Study simulation model to plan future system regulation in order to meet the authorized project purposes throughout the calendar year.

**Observed Runoff**

October precipitation was drier than normal across much of the Basin, with 25 to 50% of normal precipitation observed over most of Basin. The exception was Montana where portions of the state received 200 to 400% of normal precipitation. This resulted in October runoff of 0.8 MAF (69% of average) in the upper Basin above Sioux City, and 0.8 MAF (68% of average) for the upper Basin above Gavins Point Dam. October runoff was above average in the Gavins Point and Oahe reaches, near average in the Fort Peck reach, below average in the Sioux City reach, and well below average in the Garrison and Fort Randall reaches.

**2020 Calendar Year Forecast Synopsis**

The 2020 calendar year runoff forecast for the upper Missouri Basin above Sioux City, IA is **30.2 MAF, 117% of average**. The 2020 calendar year runoff forecast for the Missouri Basin above Gavins Point is **24.4 MAF, 105% of average**. Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next 2 months, expected inflow could range from the 30.8 MAF upper basic forecast to the 29.7 MAF lower basic forecast. The upper and lower basic forecasts are used in long-term regulation planning models to “bracket” the range of

expected runoff given much wetter or drier conditions, respectively. Given that 2 months are being forecast for this November 1 forecast (10 months observed/2 months forecast), the range of possible wetter-than-expected (upper basic) and drier-than-expected (lower basic) conditions are smaller than during the summer. The result is a range or “bracket” for each reach, and thus, for the total runoff forecast.

## Current Conditions

### Drought Analysis

The National Drought Mitigation Center’s drought monitor for October 27, 2020 is shown in **Figure 1**. The drought monitor is available at <http://droughtmonitor.unl.edu/>. The U.S. Drought Monitor shows D3 “extreme drought” conditions are present in Colorado and areas of Wyoming and Nebraska. Larger areas of D2 “severe drought” are also present in those states, and also in western Iowa, southwestern South Dakota, northern North Dakota, and eastern Montana. There are areas of D1 “moderate drought” and D0 “abnormally dry” conditions present in every state in the Basin. The National Weather Service (NWS) Climate Prediction Center’s (CPC) Seasonal Drought Outlook in **Figure 2**, which extends through the end of January, shows the drought in North Dakota, South Dakota, Wyoming, Colorado, Kansas, Iowa and Nebraska persisting and expanding, with improvement and removal only likely in areas of Montana.

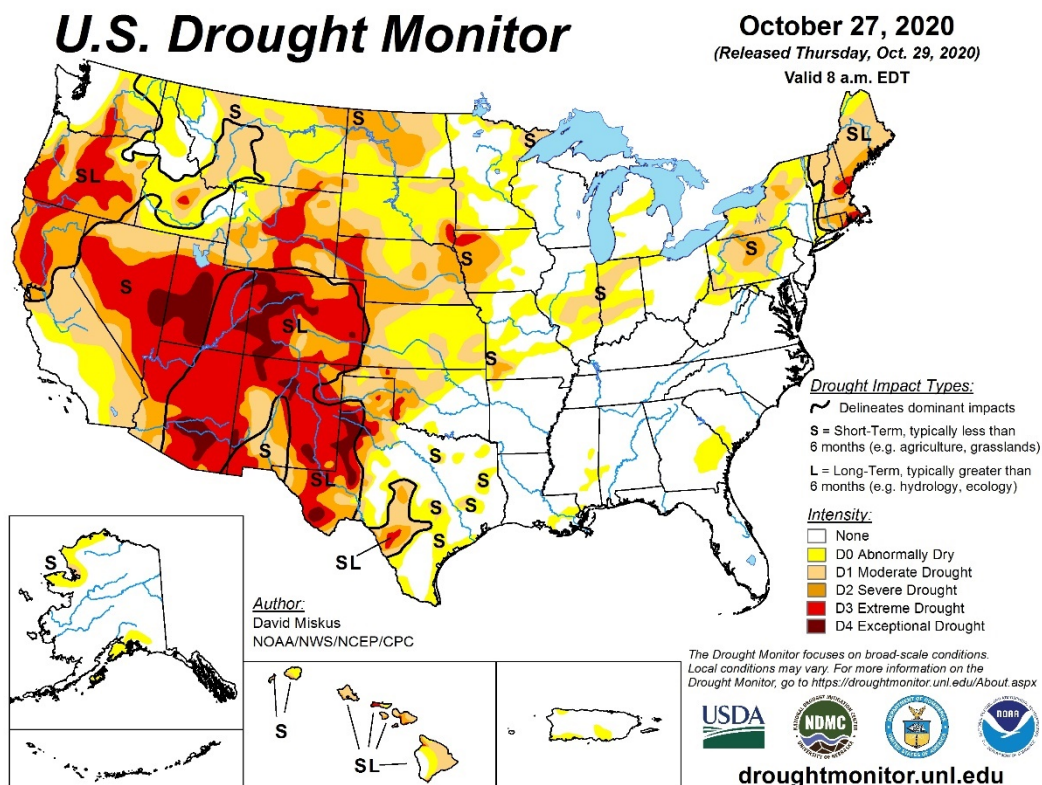


Figure 1. National Drought Mitigation Center U.S. Drought Monitor for October 27, 2020.

**U.S. Seasonal Drought Outlook**  
**Drought Tendency During the Valid Period**

Valid for October 15, 2020 - January 31, 2021  
 Released October 15, 2020

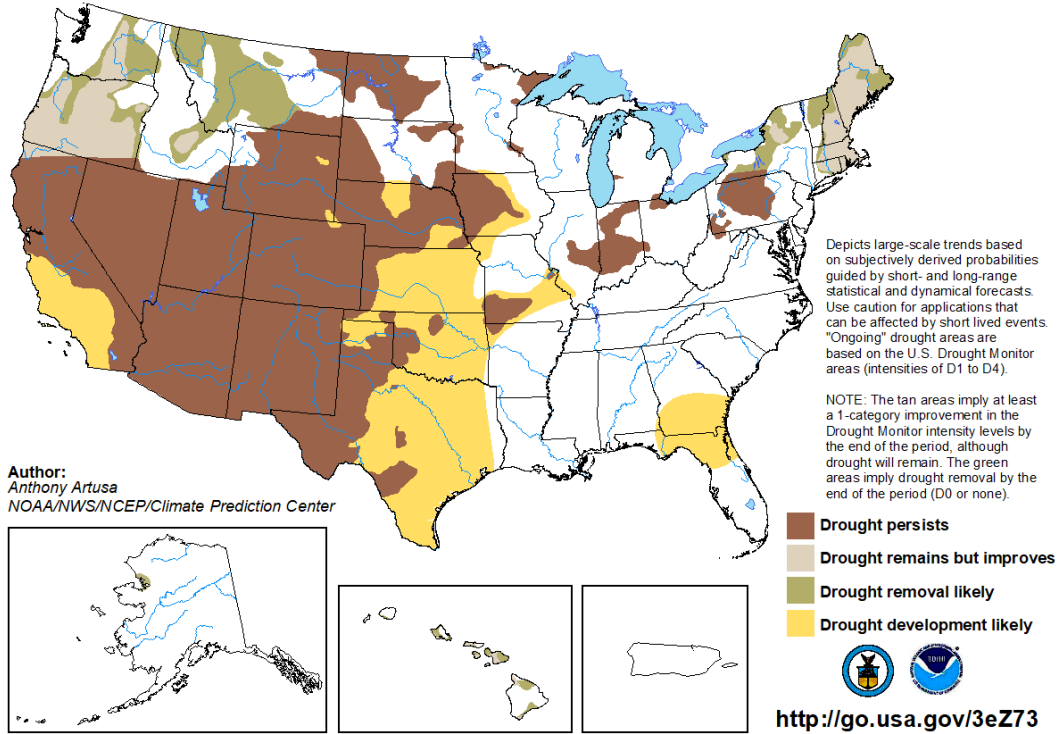


Figure 2. NWS CPC Seasonal Drought Outlook.

**Precipitation**

Monthly precipitation accumulations are shown using High Plains Regional Climate Center images available at <http://www.hprcc.unl.edu/>. The October precipitation accumulation map is shown in **Figure 3** as a percent of normal precipitation. October precipitation was drier than normal across much of the Basin. Most of those areas received 25-50% of normal precipitation. Western and central Montana were the only large areas of above-normal precipitation in the Basin.

Percent of Normal Precipitation (%)  
10/1/2020 – 10/31/2020

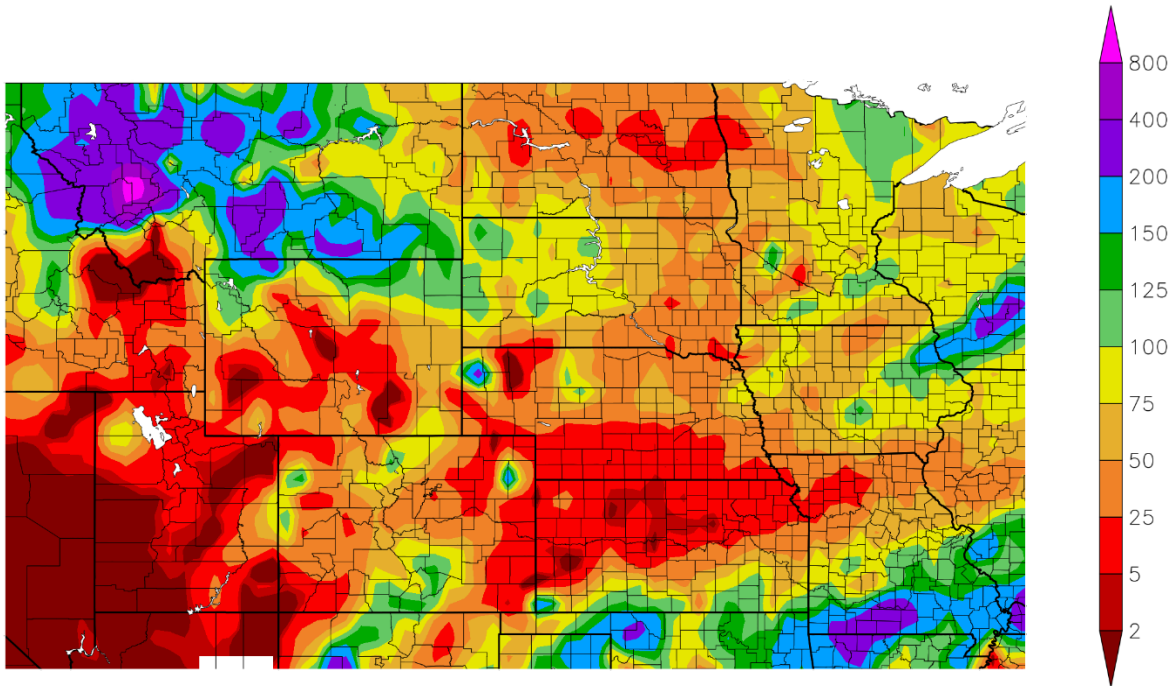


Figure 3. September 2020 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Since August 1, most of the Basin has received below-normal precipitation (see **Figure 4**), with only small areas in Montana and North Dakota receiving near-normal precipitation. Larger areas of 5-25 and 25-50 percent of normal precipitation have developed in Wyoming, Colorado, Nebraska, and Kansas.

## Percent of Normal Precipitation (%) 8/1/2020 – 10/31/2020

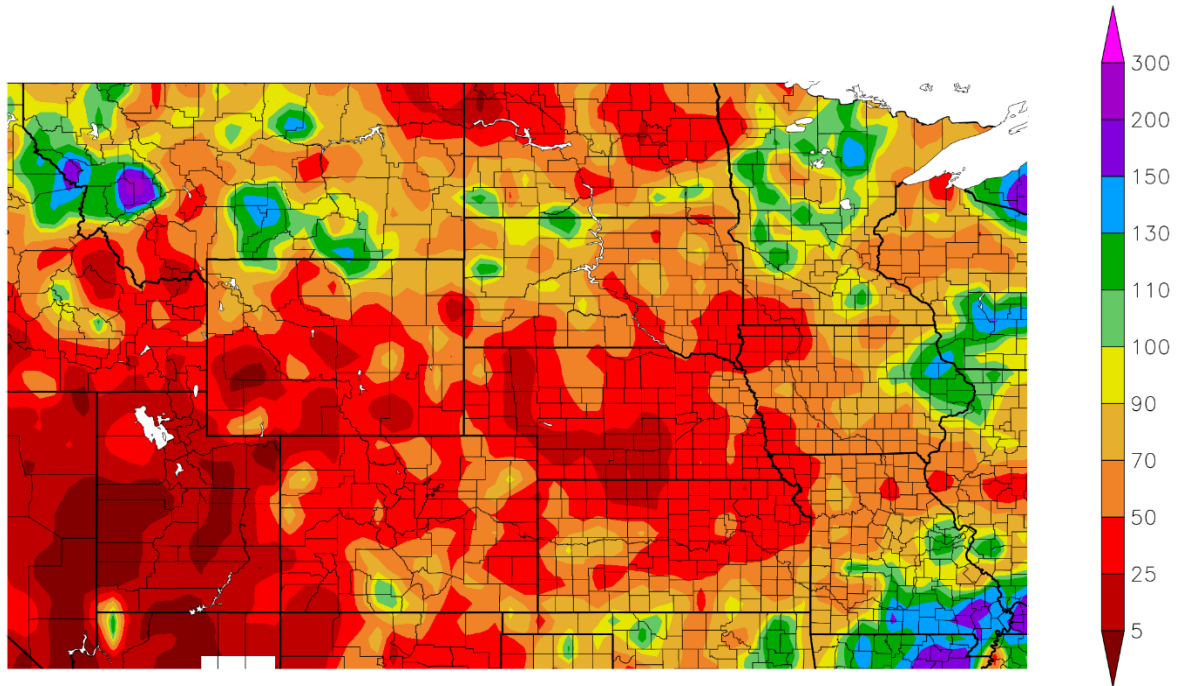


Figure 4. August 1 – October 31 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

### Temperature

October temperature departures in degrees Fahrenheit (deg F) in **Figure 5** were cooler in central and eastern Montana, North Dakota, and South Dakota. The remainder of the Basin had temperature departures near normal.

August-September-October temperature departures are shown in **Figure 6**. The past three month's temperature departures were generally near normal for the entire Basin with slightly warmer departures from normal temperatures in the western portion of the Basin compared to the eastern portion of the Basin.

Departure from Normal Temperature (F)  
10/1/2020 – 10/31/2020

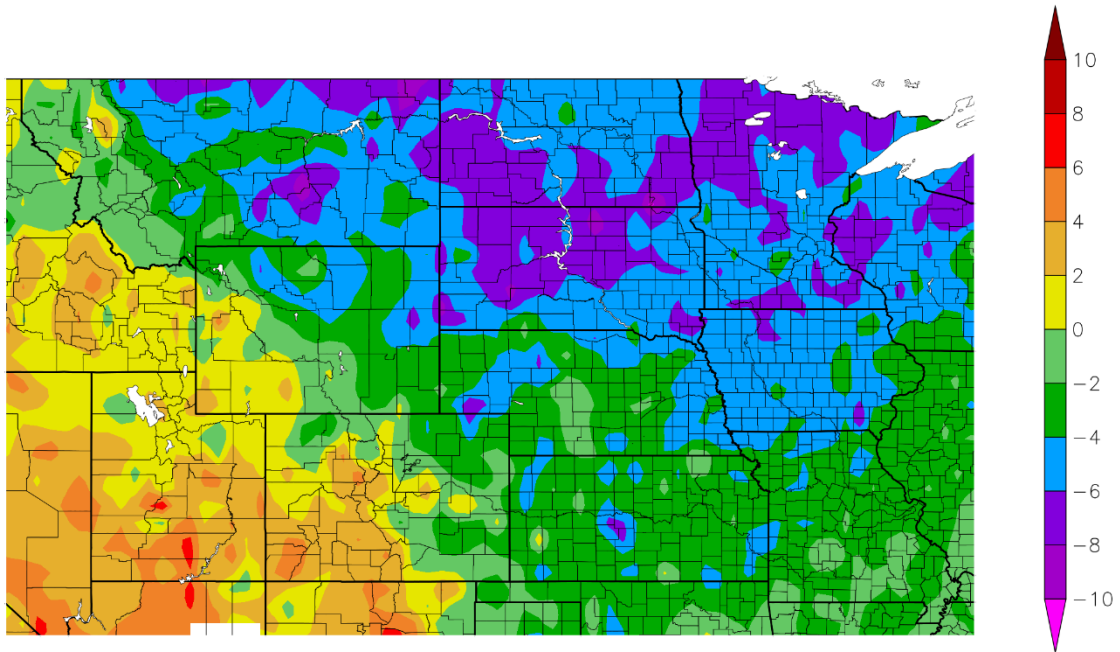


Figure 5. October 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Departure from Normal Temperature (F)  
8/1/2020 – 10/31/2020

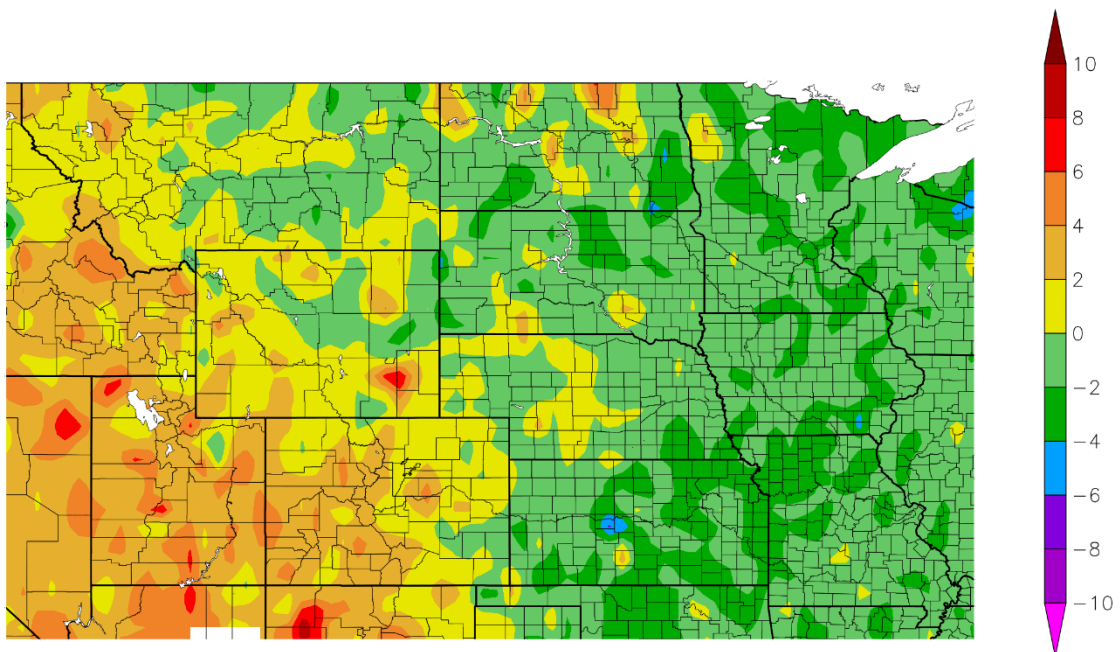
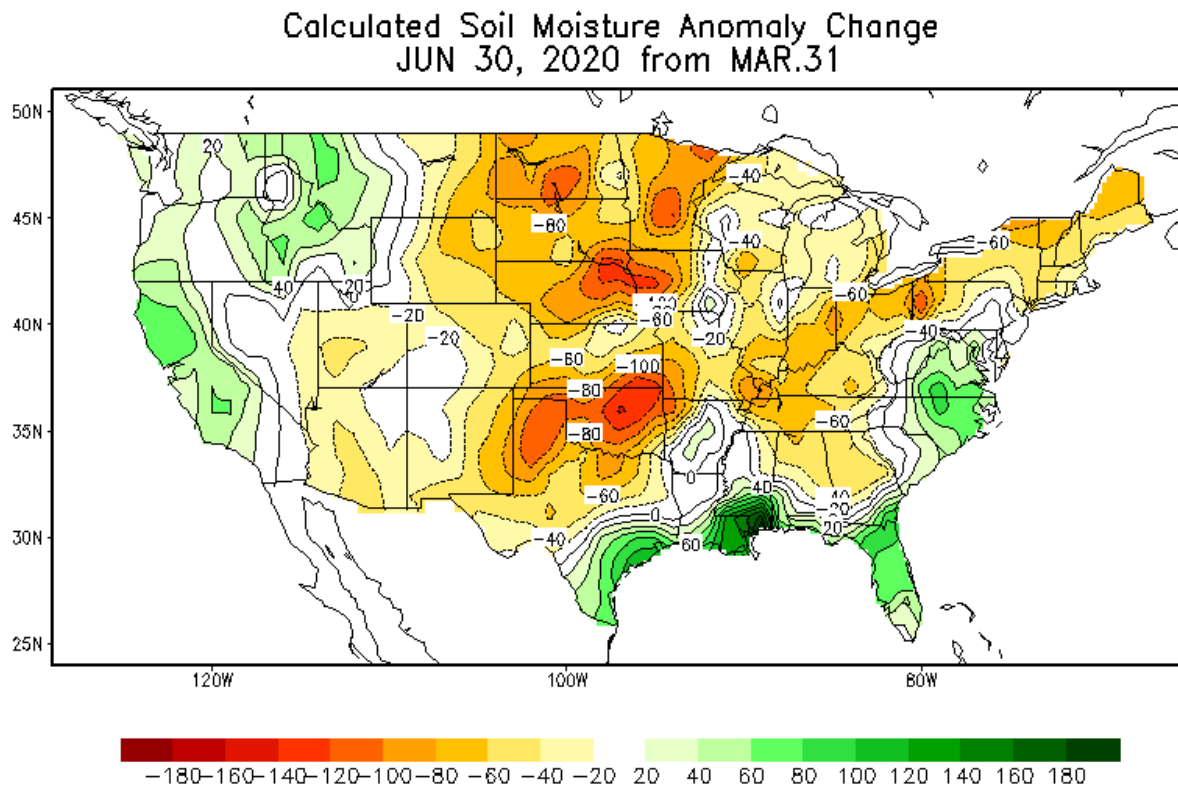


Figure 6. August-September-October 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

## Soil Moisture

Soil moisture is factored into the forecast as an indicator of wet or dry hydrologic basin conditions. Typically, when soil moisture conditions are wet or greater than normal, rainfall and snowmelt runoff is greater than when soil moisture is dry or less than normal. Not only is soil moisture a physical parameter that influences runoff, it can be used as an indicator of future runoff.

Soil moisture percentiles on March 31 based on the CPC's soil moisture model ranged from the 70<sup>th</sup> to 99<sup>th</sup> percentile ranking. Much of eastern Montana, North Dakota, South Dakota and Nebraska soils ranked above the 95<sup>th</sup> percentile, indicating soil conditions were very wet. Since March 31, soils have dried out considerably (see **Figure 7**). Based on the CPC's soil moisture model, the soil moisture anomaly had decreased by 60 to 140 mm over most of the Basin by the end of June. Soil moisture rebounded some during July. Since the end of June, soil moisture has continued to dry over parts of the basin of the Basin. Currently, 1-5 percent ranking covers areas of Colorado, Wyoming, and Nebraska (see **Figure 8**). Larger areas with 5-10 and 10-30 soil moisture percentiles are present in Wyoming, Colorado, North Dakota, Nebraska, and Iowa.



**Figure 7. NOAA CPC Soil Moisture Anomaly Change (mm) March 31 to June 30. Source:**  
[https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

## Calculated Soil Moisture Ranking Percentile NOV 01, 2020

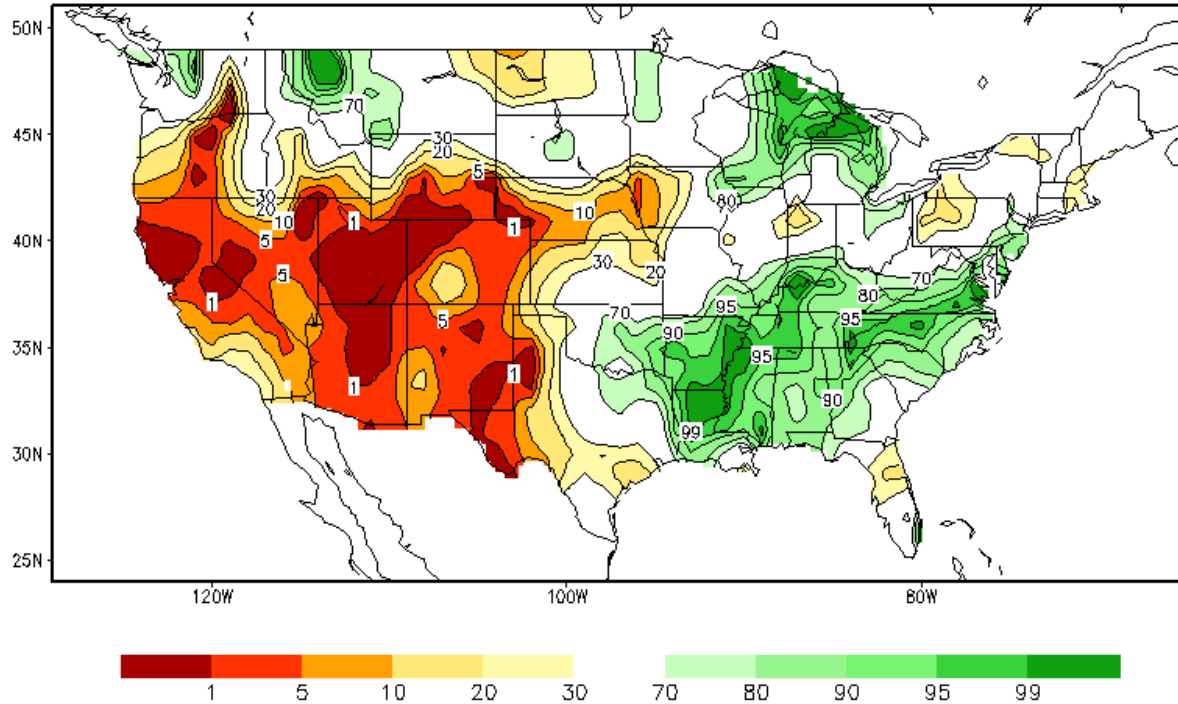


Figure 8. Calculated soil moisture ranking percentile. Source: [https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

### **Mountain Snowpack**

Mountain snowpack is the primary factor used to predict May, June and July runoff volumes in the Fort Peck and Fort Peck to Garrison reaches. As the date of peak snowpack accumulation, usually around April 15, approaches, the correlation between the level of mountain snowpack and May, June and July runoff increases. Mountain snowpack becomes a better predictor of Fort Peck and Garrison reach runoff once it reaches its peak. In November, the mountain snowpack accumulation period has only begun and is not used in the remaining forecast months of 2020.

### **Climate Outlook**

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## **ENSO (El Niño Southern Oscillation)**

The latest ENSO Outlook indicates that La Niña conditions are present and are likely to continue through the Northern Hemisphere winter and spring. During La Niña winters, the probability for a colder-than-normal and slightly wetter-than-normal weather pattern in the Northern Rockies and Northern Plains is higher.

## **Temperature and Precipitation Outlooks**

The CPC outlooks provide the forecasted probability (or chance) of occurrence of future weather conditions during periods ranging from 1 to 12 months into the future. The CPC outlooks are available at <http://www.cpc.ncep.noaa.gov/>.

The CPC temperature outlook for the forecast period from November 7-11 is shown in **Figure 9**. The outlook is indicating an increase in the chances for below-normal temperatures and above-normal precipitation over the entire Basin. During the month of November (**Figure 10**), the outlook is indicating increased chances for above-normal temperatures and below-normal precipitation in the southern portions of the Basin. The outlook is also showing equal chances for above-, below-, and normal temperatures in the northern portions of the Basin and slight increased chances for above-normal precipitation in Montana.

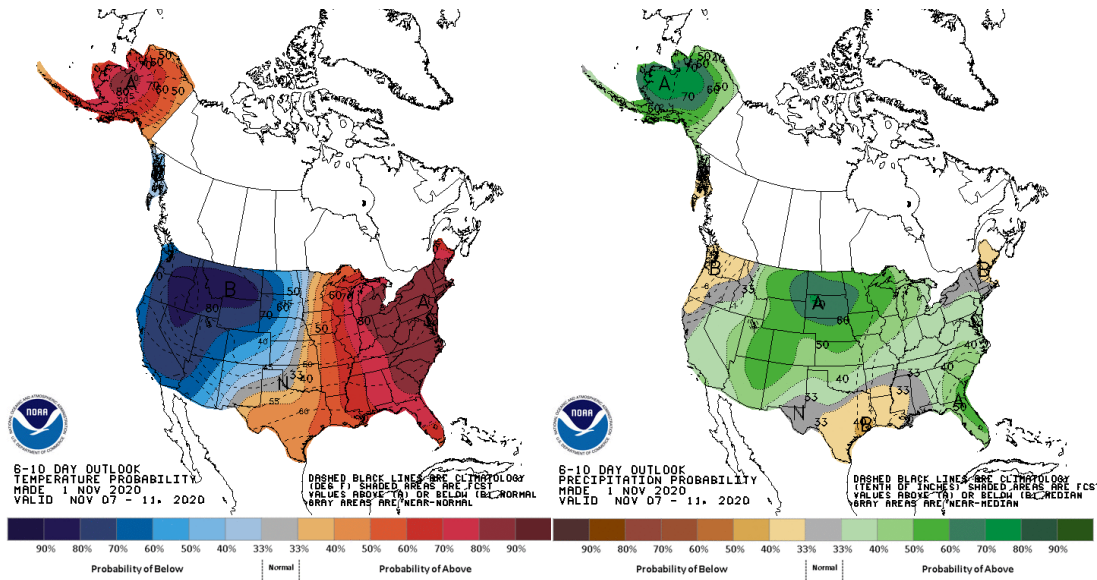


Figure 9. CPC 6-10 Day temperature and precipitation outlooks through November 11, 2020.

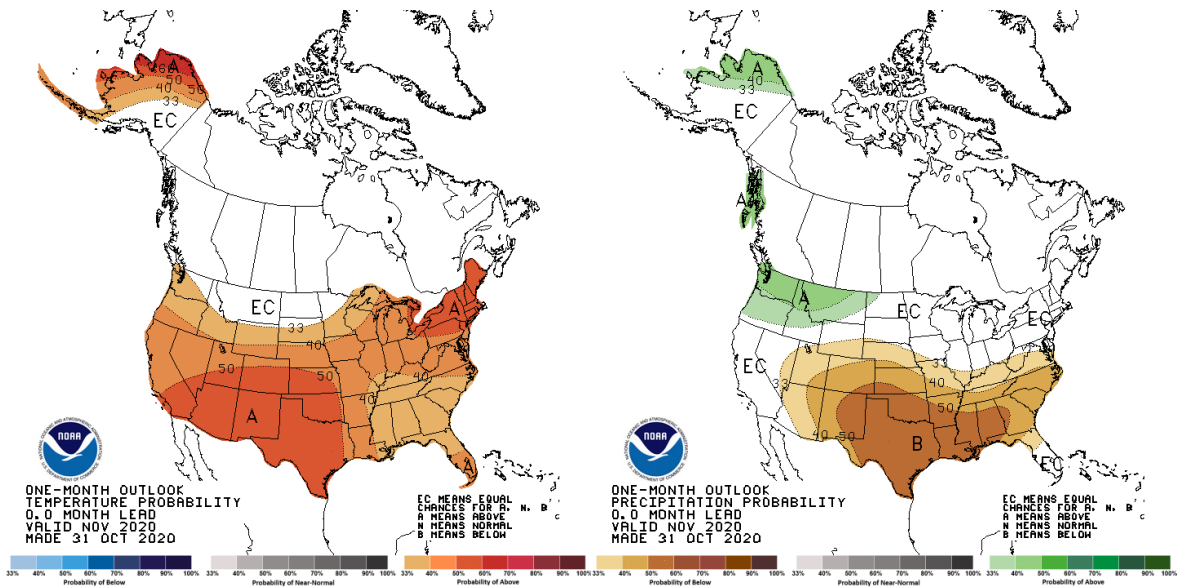


Figure 10. CPC November 2020 temperature and precipitation outlooks.

Three-month temperature and precipitation outlooks for the three-month periods from December 2020 through February 2021 are shown below in **Figure 11**. During November-December 2020-January 2021, the CPC indicates increased chances for above-normal temperatures across the entire Basin. Regarding precipitation, there are increased chances for above-normal precipitation in Montana, North Dakota, and South Dakota, with equal chances over the remainder of the Basin.

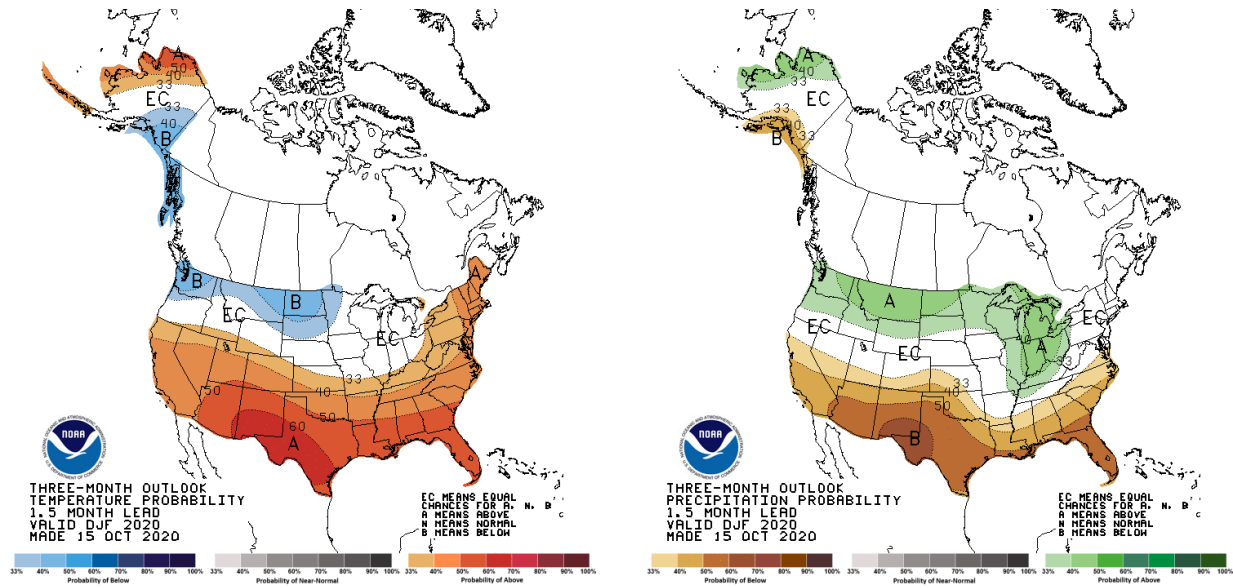


Figure 11. CPC November-December 2020-January 2021 temperature and precipitation outlooks.

## Summary

In summary, the 2020 calendar year runoff forecast is **30.2 MAF (117% of average)**. The November 1 calendar year runoff forecast is just below an upper quartile runoff volume.

**Upper Missouri River Basin  
December 2020 Calendar Year Runoff Forecast  
December 1, 2020**

**U.S. Army Corps of Engineers, Northwestern Division  
Missouri River Basin Water Management  
Omaha, NE**

**Calendar Year Runoff Forecast**

**Explanation and Purpose of Forecast**

The long-range runoff forecast is presented as the Calendar Year Runoff Forecast. The Calendar Year Runoff Forecast is available at <http://www.nwd-mr.usace.army.mil/rcc/reports/runoff.pdf>. This forecast is developed shortly after the beginning of each calendar year and is updated at the beginning of each month to show the actual runoff for historic months of that year and the updated forecast for the remaining months of the year. This forecast presents monthly inflows in million acre-feet (MAF) from five incremental drainage areas, as defined by the individual System projects, plus the incremental drainage area between Gavins Point Dam and Sioux City. Due to their close proximity, the Big Bend and Fort Randall drainage areas are combined. Summations are provided for the total Missouri River reach above Gavins Point Dam and for the total Missouri Basin above Sioux City (upper Basin). The Calendar Year Runoff Forecast is used in the Monthly Study simulation model to plan future system regulation in order to meet the authorized project purposes throughout the calendar year.

**Observed Runoff**

November precipitation was generally drier than normal across much of the Basin, with 25 to 50% of normal precipitation or drier conditions observed in areas of every state in the Basin. The exceptions were northern Montana and eastern Nebraska, Kansas, and South Dakota, where portions of the states received 200% of normal or more precipitation. November runoff was 1.2 MAF (116% of average) in the upper Basin above Sioux City, and 1.2 MAF (123% of average) for the upper Basin above Gavins Point Dam. November runoff for the Basin above Sioux City was 0.4 MAF more than the November 1 forecast. November runoff was above average in the Fort Peck, Garrison, and Gavins Point reaches, and below average in the Oahe, Fort Randall, and Sioux City reaches.

**2020 Calendar Year Forecast Synopsis**

The 2020 calendar year runoff forecast for the upper Missouri Basin above Sioux City, IA is **30.6 MAF, 119% of average**. The 2020 calendar year runoff forecast for the Missouri Basin above Gavins Point is **25.0 MAF, 107% of average**. Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next month, expected inflow could range from the 30.8 MAF upper basic forecast to the 30.5 MAF lower basic forecast. The upper and

lower basic forecasts are used in long-term regulation planning models to “bracket” the range of expected runoff given much wetter or drier conditions, respectively.

## Current Conditions

### Drought Analysis

The National Drought Mitigation Center’s drought monitor for November 24, 2020 is shown in **Figure 1**. The drought monitor is available at <http://droughtmonitor.unl.edu/>. The U.S. Drought Monitor shows D3 “extreme drought” conditions are present in Colorado and areas of Wyoming and Nebraska. Larger areas of D2 “severe drought” are also present in those states, and in western Iowa, southwestern South Dakota, northern North Dakota, and eastern Montana. There are areas of D1 “moderate drought” and D0 “abnormally dry” conditions present in every state in the Basin. The National Weather Service (NWS) Climate Prediction Center’s (CPC) Seasonal Drought Outlook in **Figure 2**, which extends through the end of February, shows the drought persisting in most states, with some improvement forecasted in Montana and worsening conditions forecasted in Kansas.

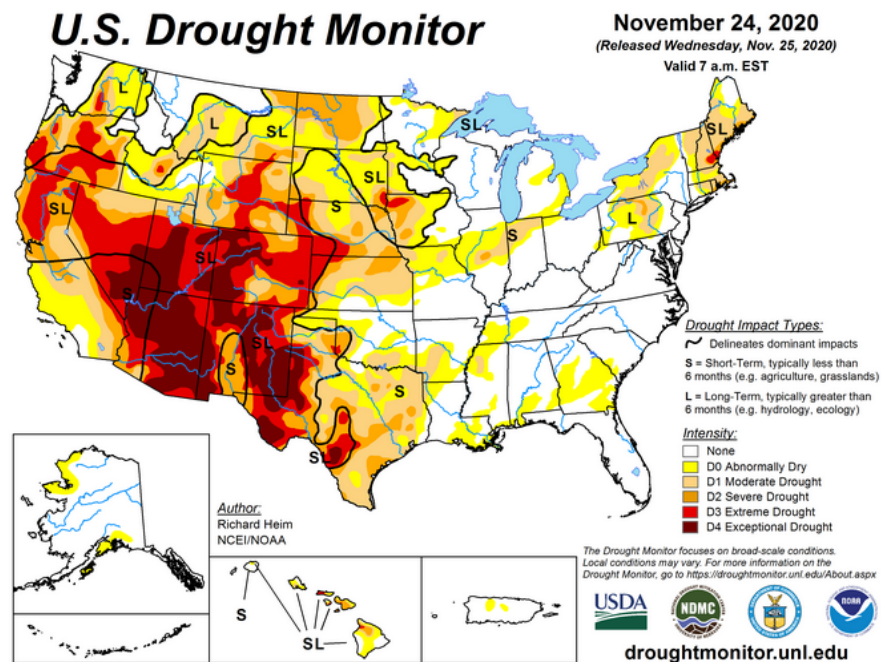


Figure 1. National Drought Mitigation Center U.S. Drought Monitor for November 24, 2020.

**U.S. Seasonal Drought Outlook** Valid for November 19, 2020 - February 28, 2021  
 Drought Tendency During the Valid Period Released November 19, 2020

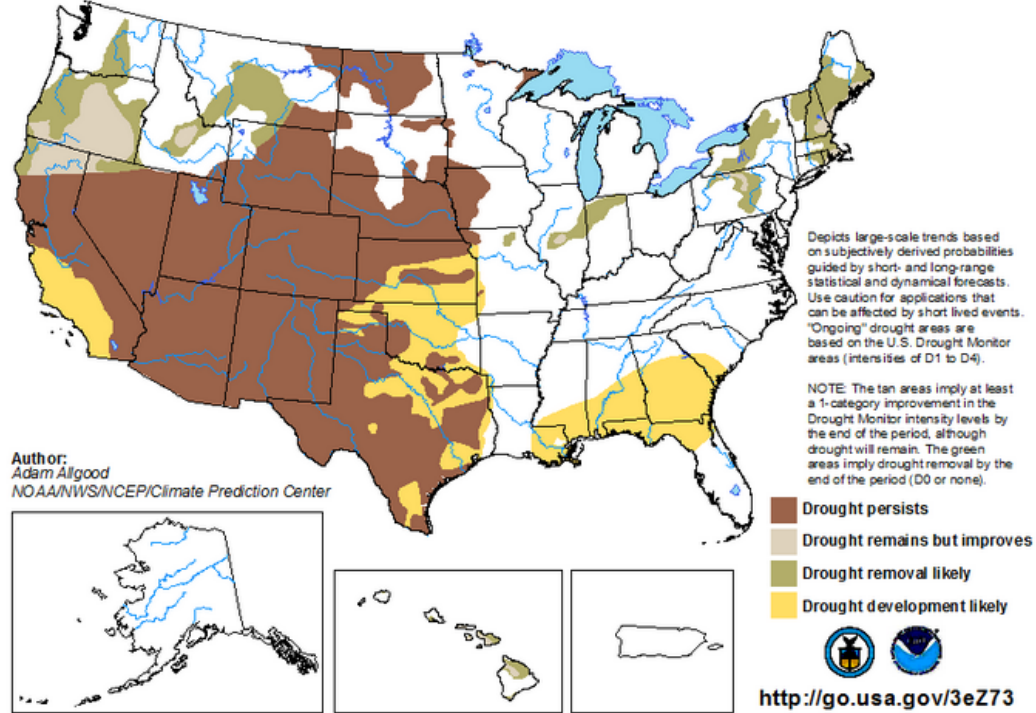


Figure 2. NWS CPC Seasonal Drought Outlook.

## Precipitation

Monthly precipitation accumulations are shown using High Plains Regional Climate Center images available at <http://www.hprcc.unl.edu/>. The November precipitation accumulation map is shown in **Figure 3** as a percent of normal precipitation. November precipitation was generally drier than normal across much of the Basin, with 25 to 50% of normal precipitation or drier conditions observed. The exceptions were northern Montana and eastern Nebraska, Kansas, and South Dakota, where portions of the states received 200% of normal or more precipitation.

Percent of Normal Precipitation (%)  
11/1/2020 – 11/30/2020

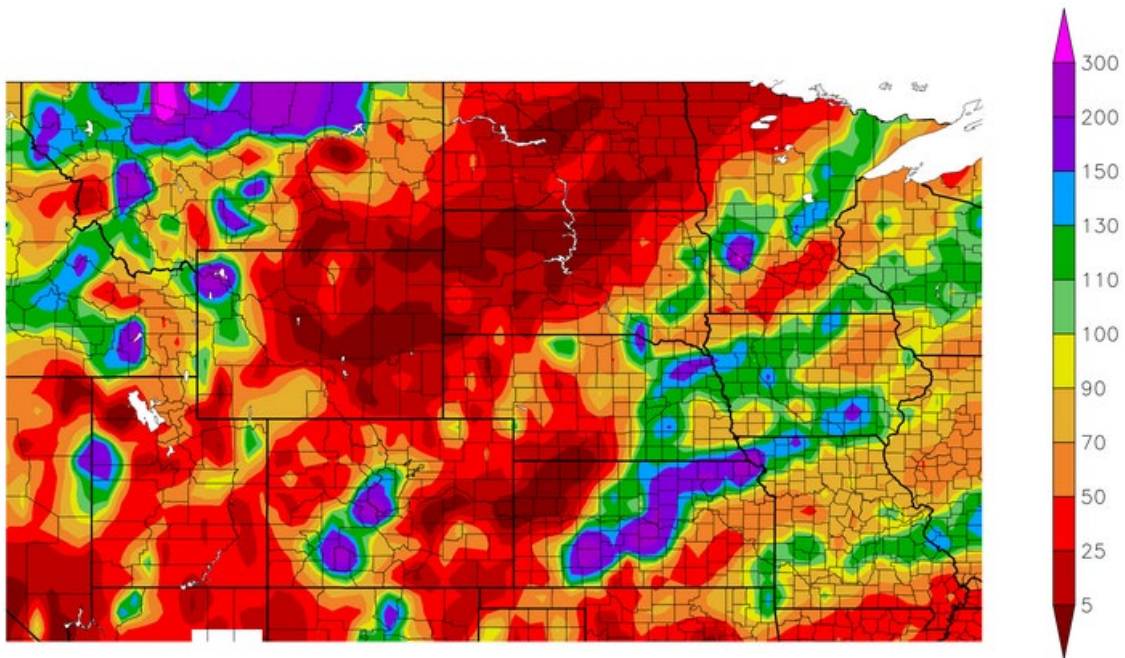


Figure 3. November 2020 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Since September 1, most of the Basin has received below-normal precipitation (see **Figure 4**), with only areas in Montana receiving above-normal precipitation. Larger areas of 5-25 and 25-50 percent of normal precipitation have developed in Wyoming, Colorado, North Dakota, Nebraska, and Kansas.

Percent of Normal Precipitation (%)  
9/1/2020 – 11/30/2020

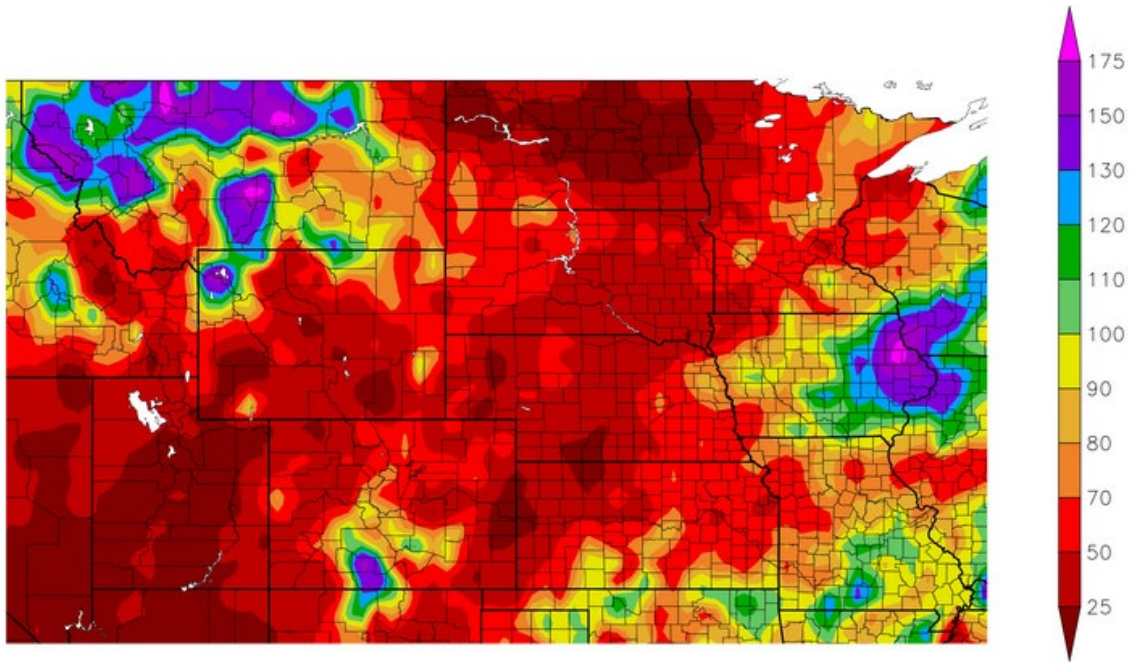


Figure 4. September 1 – November 30 Percent of Normal Precipitation. Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

### Temperature

November temperature departures in degrees Fahrenheit (deg F) in **Figure 5** were warmer than normal across the entire Basin, with areas of up to 10 degrees above normal in the central plains.

September-October-November temperature departures are shown in **Figure 6**. The past three month's temperature departures were generally near normal for the entire Basin with slightly warmer departures from normal temperatures in the western portion of the Basin compared to the eastern portion of the Basin.

Departure from Normal Temperature (F)  
11/1/2020 – 11/30/2020

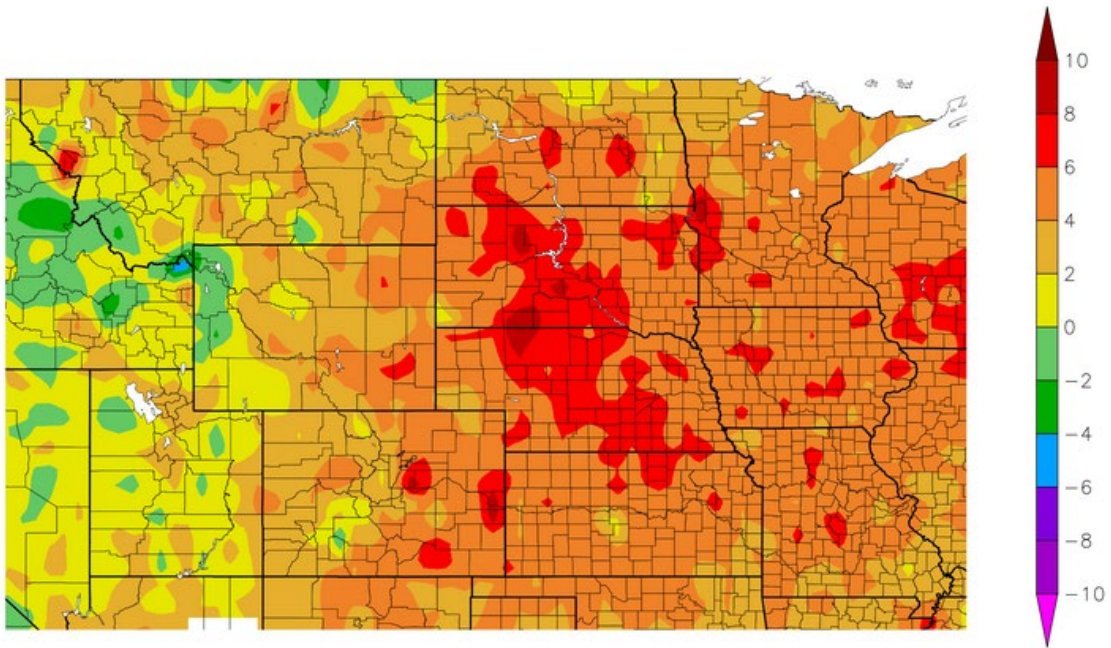


Figure 5. November 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

Departure from Normal Temperature (F)  
9/1/2020 – 11/30/2020

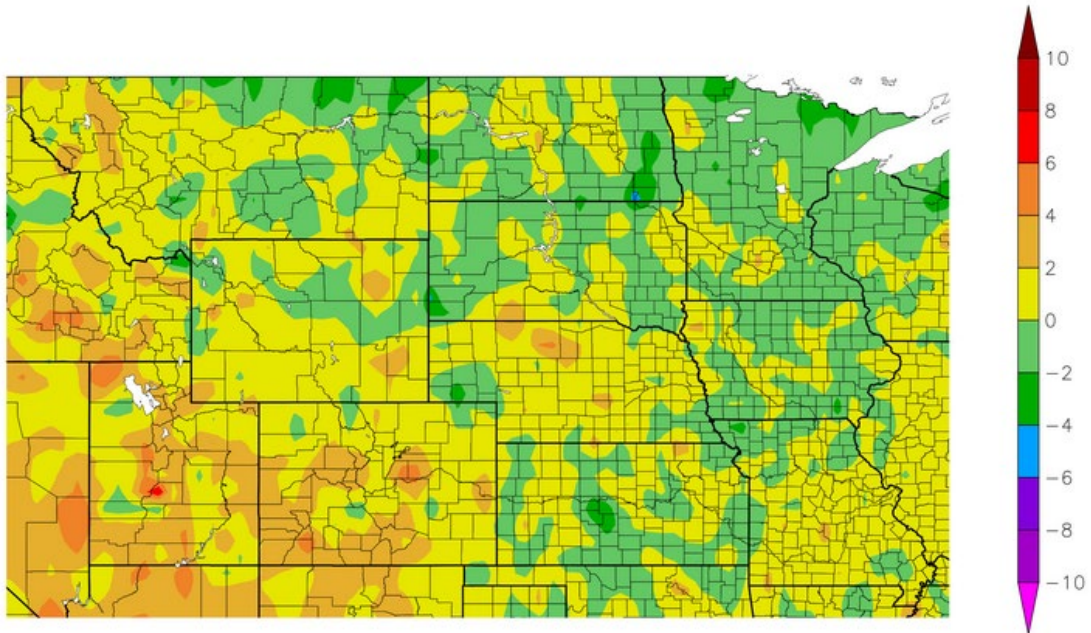
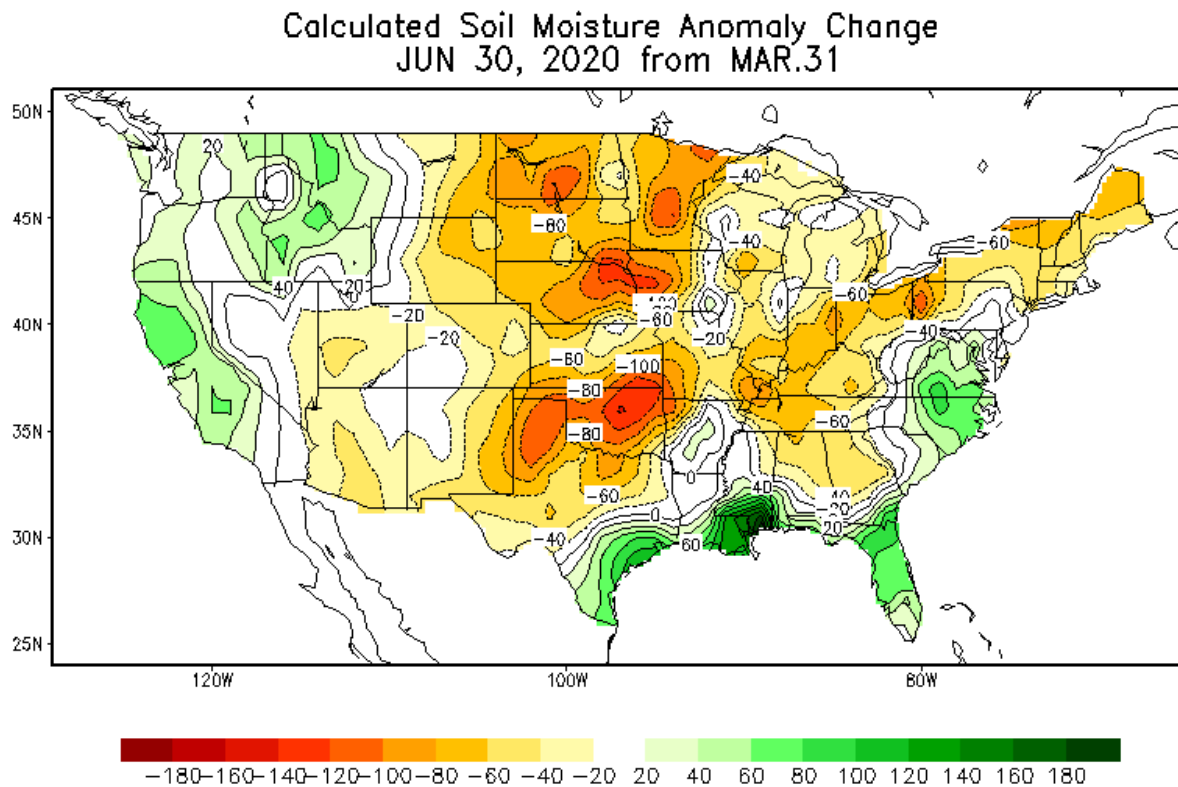


Figure 6. September-October-November 2020 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, <http://www.hprcc.unl.edu/>.

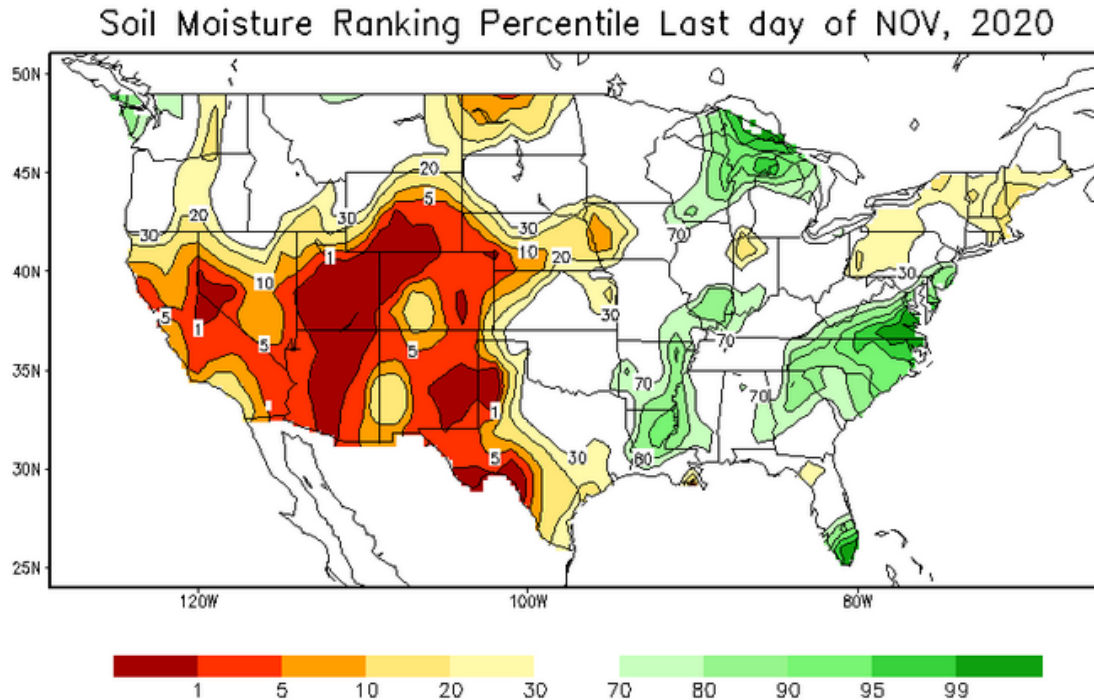
## Soil Moisture

Soil moisture is factored into the forecast as an indicator of wet or dry hydrologic basin conditions. Typically, when soil moisture conditions are wet or greater than normal, rainfall and snowmelt runoff is greater than when soil moisture is dry or less than normal. Not only is soil moisture a physical parameter that influences runoff, it can be used as an indicator of future runoff.

Soil moisture percentiles on March 31 based on the CPC's soil moisture model ranged from the 70<sup>th</sup> to 99<sup>th</sup> percentile ranking. Much of eastern Montana, North Dakota, South Dakota and Nebraska soils ranked above the 95<sup>th</sup> percentile, indicating soil conditions were very wet. Since March 31, soils have dried out considerably (see **Figure 7**). Based on the CPC's soil moisture model, the soil moisture anomaly had decreased by 60 to 140 mm over most of the Basin by the end of June. Soil moisture rebounded some during July. Since the end of June, soil moisture has continued to dry over parts of the basin of the Basin. Currently, 1-5 percent ranking covers areas of Colorado, Wyoming, and Nebraska (see **Figure 8**). Larger areas with 5-10 and 10-30 soil moisture percentiles are present in Wyoming, Colorado, North Dakota, Nebraska, and Iowa.



**Figure 7. NOAA CPC Soil Moisture Anomaly Change (mm) March 31 to June 30. Source:**  
[https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)



**Figure 8. Calculated soil moisture ranking percentile. Source:**  
[https://www.cpc.ncep.noaa.gov/products/Soilmst\\_Monitoring/US/Soilmst/Soilmst.shtml](https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

### **Mountain Snowpack**

Mountain snowpack is the primary factor used to predict May, June and July runoff volumes in the Fort Peck and Fort Peck to Garrison reaches. As the date of peak snowpack accumulation, usually around April 15, approaches, the correlation between the level of mountain snowpack and May, June and July runoff increases. Mountain snowpack becomes a better predictor of Fort Peck and Garrison reach runoff once it reaches its peak. In December, the mountain snowpack accumulation period has only begun and is not used in the remaining forecast months of 2020.

### **Climate Outlook**

MRBWM participates in the monthly North Central U.S. Climate/Drought Outlook Webinar coordinated through NOAA, the regional climate centers, and the American Association of State Climatologists (AASC). These webinars provide updates on near-term climate outlooks and impacts including the ENSO climate pattern and its implications on winter temperature and precipitation patterns in the Basin.

### **ENSO (El Niño Southern Oscillation)**

The latest ENSO Outlook indicates that La Niña conditions are present and are likely to continue through the Northern Hemisphere winter and spring. During La Niña winters, the probability for a colder-than-normal and slightly wetter-than-normal weather pattern in the Northern Rockies and Northern Plains is higher.

## Temperature and Precipitation Outlooks

The CPC outlooks provide the forecasted probability (or chance) of occurrence of future weather conditions during periods ranging from 1 to 12 months into the future. The CPC outlooks are available at <http://www.cpc.ncep.noaa.gov/>.

The CPC temperature outlook for the forecast period from December 6-10 is shown in **Figure 9**. The outlook is indicating an increase in the chances for above-normal temperatures and below-normal precipitation over the entire Basin. During the month of December (**Figure 10**), the outlook is indicating increased chances for above-normal temperatures and below-normal precipitation across the entire Basin, except for Montana, which has equal chances for above-, below-, and normal precipitation.

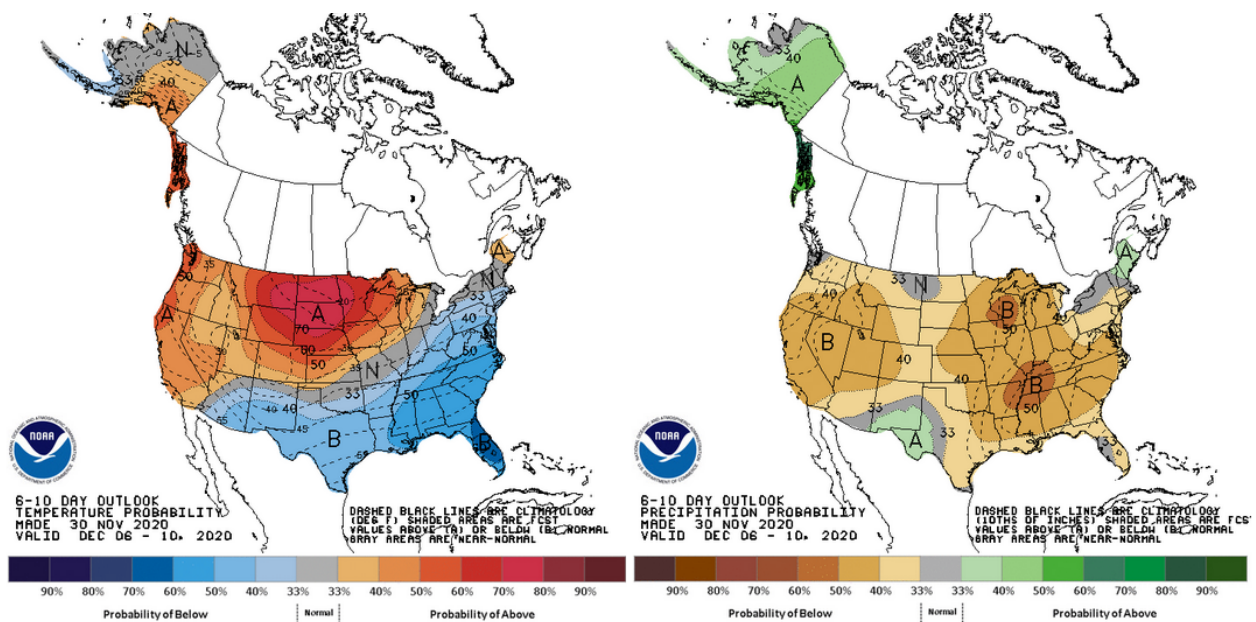


Figure 9. CPC 6-10 Day temperature and precipitation outlooks through December 10, 2020.

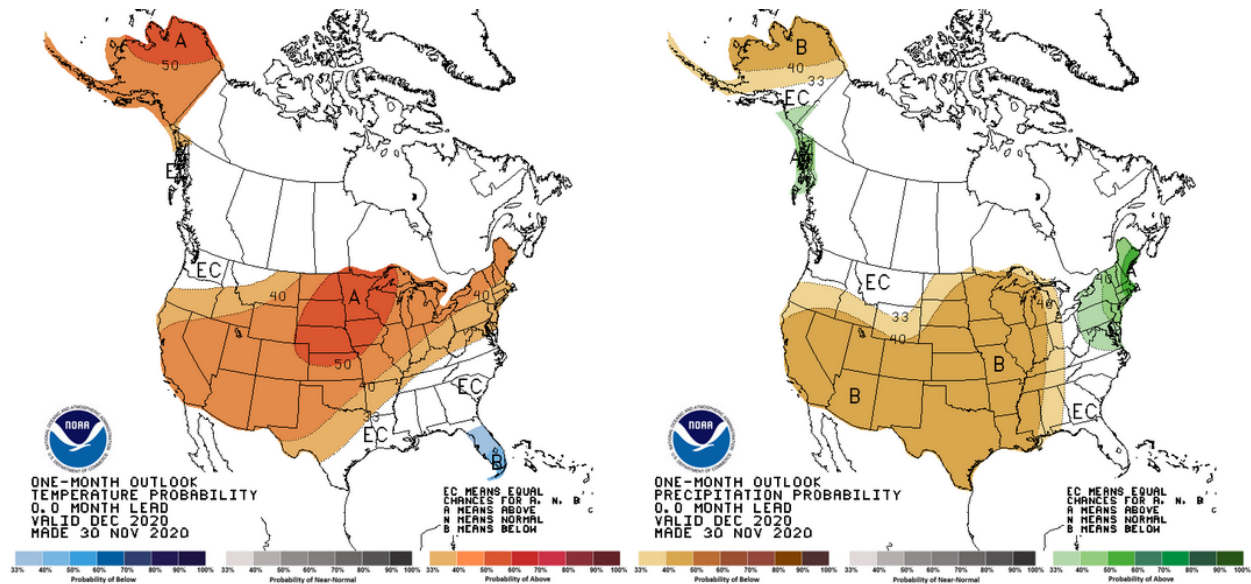


Figure 10. CPC December 2020 temperature and precipitation outlooks.

Three-month temperature and precipitation outlooks for the three-month periods from December 2020 through February 2021 are shown below in **Figure 11**. During December 2020-January 2021-February 2021, the CPC indicates increased chances for above-normal temperatures over southern portions of the Basin with equal chances in the middle portions and below-normal temperatures in the northern portions of the Basin. The CPC is also indicating a slight increase in chances for above-normal precipitation in Montana, North Dakota, and South Dakota and increased chances for below-normal precipitation in Colorado, Kansas, and southern Nebraska, with equal chances for precipitation elsewhere in the Basin.

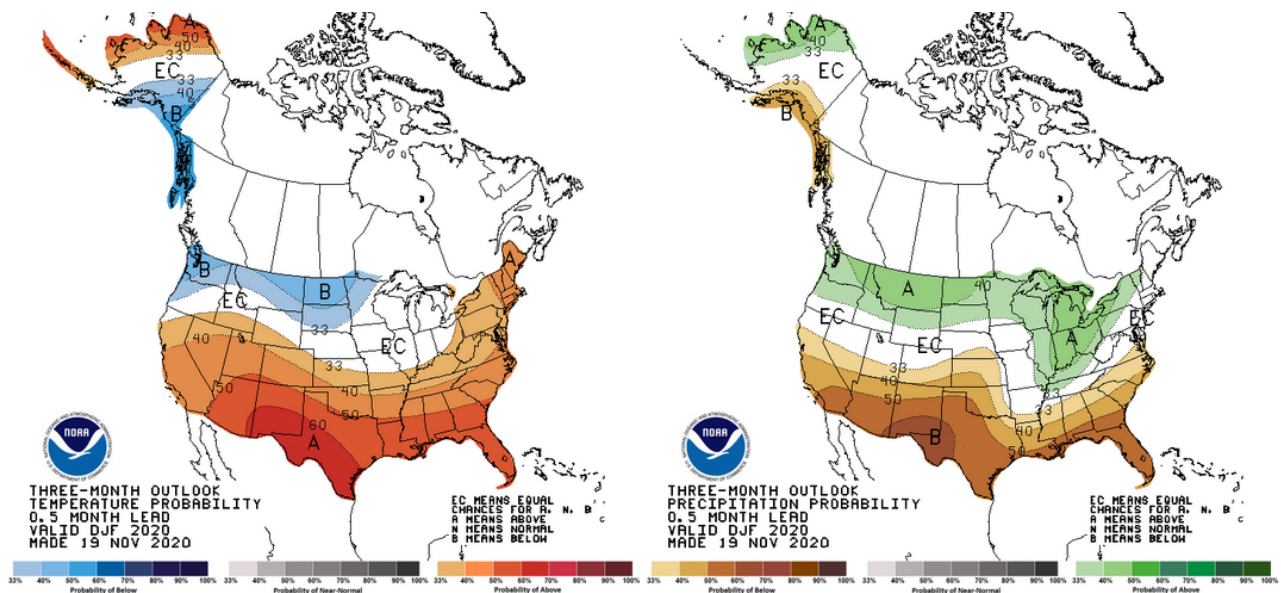


Figure 11. CPC December 2020-January 2021-February 2021 temperature and precipitation outlooks.

## **Summary**

In summary, the 2020 calendar year runoff forecast is **30.6 MAF (119% of average)**. The December 1 calendar year runoff forecast is just below an upper quartile runoff volume.