Upper Missouri River Basin
August 2012 Calendar Year Runoff Forecast
August 1, 2012

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. 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 River reach above Sioux City. 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.

July 2012 Runoff

July 2012 Missouri River runoff was 2,169 KAF (68% of normal) above Sioux City, and 2,079 KAF (70% of normal) above Gavins Point. Runoff in all reaches was below normal with the exception of the Gavins Point reach, which received 111% of normal runoff.

2012 Calendar Year Forecast Synopsis

The August 1 runoff forecast is **21.0 MAF** (85% of normal) above Sioux City, IA, and **18.8 MAF** (83% of normal) above Gavins Point Dam. This is a decrease from the July 1 forecast due to much drier and warmer than normal conditions in the upper Missouri River basin. Due to the amount of variability in precipitation that can occur over the next 5 months, the expected inflow ranges from the 21.9 MAF upper basic forecast to the 20.1 MAF lower basic forecast. The upper and lower basic forecasts provide a likely range of runoff scenarios that could occur given wetter or drier conditions. Given that 5 months are being forecasted on August 1 (7 months observed/5 months forecast), the range of greater than normal (upper basic) and lower than normal (lower basic) runoff is attributed to all 6 reaches for all 5 months. The result is a large range or "bracket" for each reach, and thus, for the total runoff forecast. As the year progresses, the range will lessen as the number of observed months increases and number of forecast months decreases.

Current Conditions

Precipitation

Overall precipitation accumulations during the month of July were well below normal (Figures 1 and 2). All of the lower Missouri River basin received less than 50% of normal precipitation, though a majority of this area received less than 25% of normal precipitation and some areas less than 10% of normal precipitation. A majority of the upper Missouri River basin received below normal precipitation; however, several areas received greater than normal precipitation. Those areas included western and northwest South Dakota, northeast Wyoming, western North Dakota and extreme eastern Nebraska (Figure 2). In these areas precipitation ranged from 150 to 300% of normal.

A similar pattern with departures not as severe has occurred over the 90-day period (May-June-July) shown in Figure 3. A majority of the Missouri River basin has received less than 75% of normal, especially in the lower basin where accumulations are less than 50% of normal. Departures in northern Montana and western North Dakota have been primarily above normal.

Please refer to the January – July Calendar Year Forecast narratives for information on the amounts of precipitation that occurred in previous months as well as a comparison to 2011 precipitation amounts in the Missouri River basin.

Temperature

Much warmer than normal temperatures have also been a major factor in calendar year runoff forecast. Warm temperatures have accelerated water consumption by plants and dried surfaces soils much more rapidly. Thirty day temperature departures have ranged from 2 to 7 degrees Fahrenheit above normal in all parts of the Missouri River basin. The hottest temperatures have occurred in South Dakota, Iowa, Nebraska and Missouri where temperature have ranged from 6 to 7 degrees Fahrenheit above normal. (Figure 4).

Ninety-day (90-day) temperature departures ending on July 31, 2012 are shown in Figure 5. During this time period including the months of May, June and July, average daily temperatures ranged from -1 to 4 degrees F above normal throughout the Missouri River basin. Temperatures in Montana have ranged from 0 to 2 degrees F above normal.

Soil Moisture Conditions

Two independent assessments of soil moisture are provided below which include the calculated Climate Prediction Center soil moisture anomaly (Figure 6) and percentile ranking (Figure 7) and the Variable Infiltration Capacity (VIC) soil moisture percentile ranking (Figure 8). The CPC calculated soil moisture anomaly (Figure 6) indicates very dry soils in the lower Missouri River basin and moderately dry soils in the upper basin. Soil moisture conditions in central Montana are near normal with slightly wet soils in northwest Montana. According to the calculated soil moisture ranking percentile (Figure 7), soil moisture conditions over a majority of the lower basin rank in the 10^{th} percentile or less. In the upper

basin soil moisture conditions rank in the 10th to 30th percentile with normal to above normal soil moisture conditions in much of Montana. The VIC model soil moisture percentiles show similarly dry soils in the Missouri River basin (Figure 8).

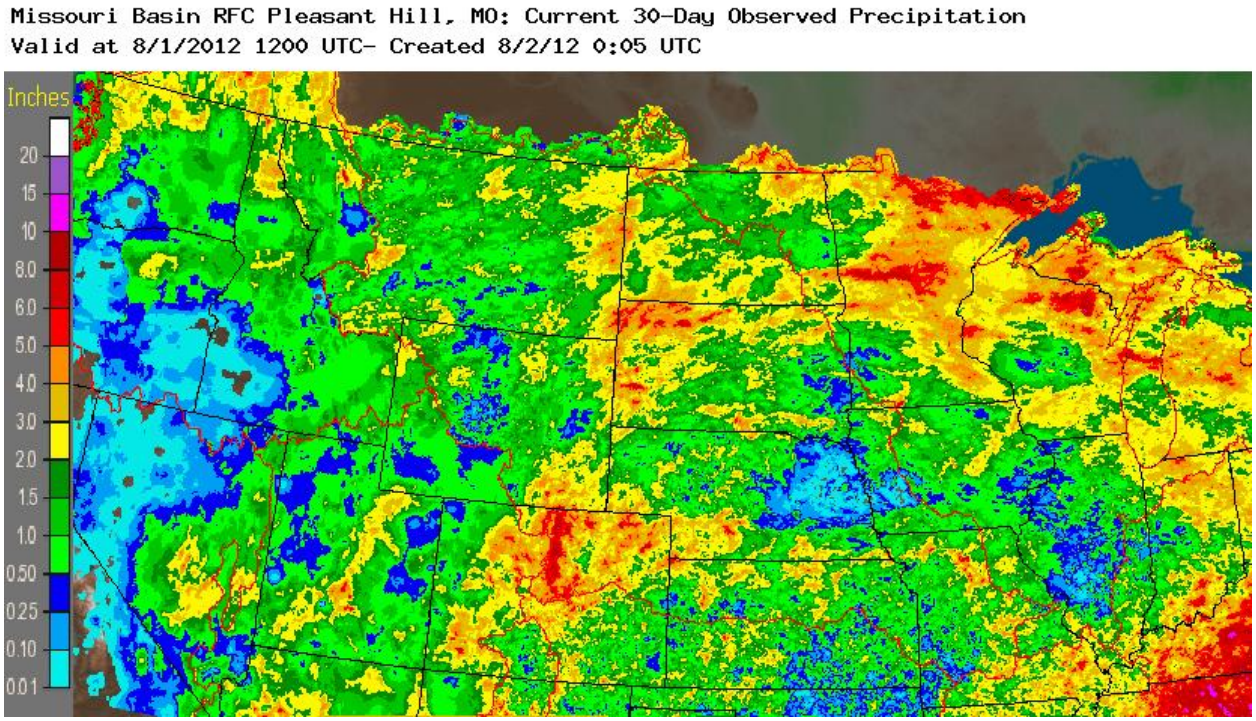

Figure 1. July 2012 Precipitation (inches). Source: National Weather Service.

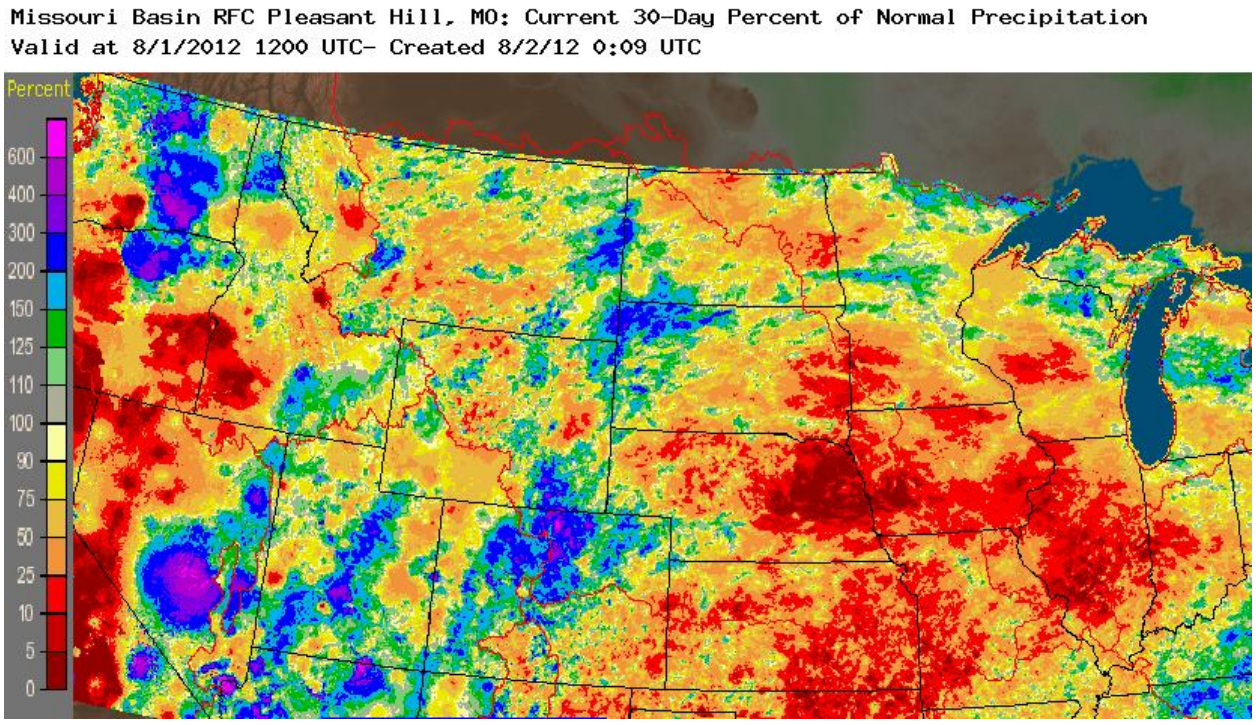

Figure 2. July 2012 Percent of Normal Precipitation. Source: National Weather Service.

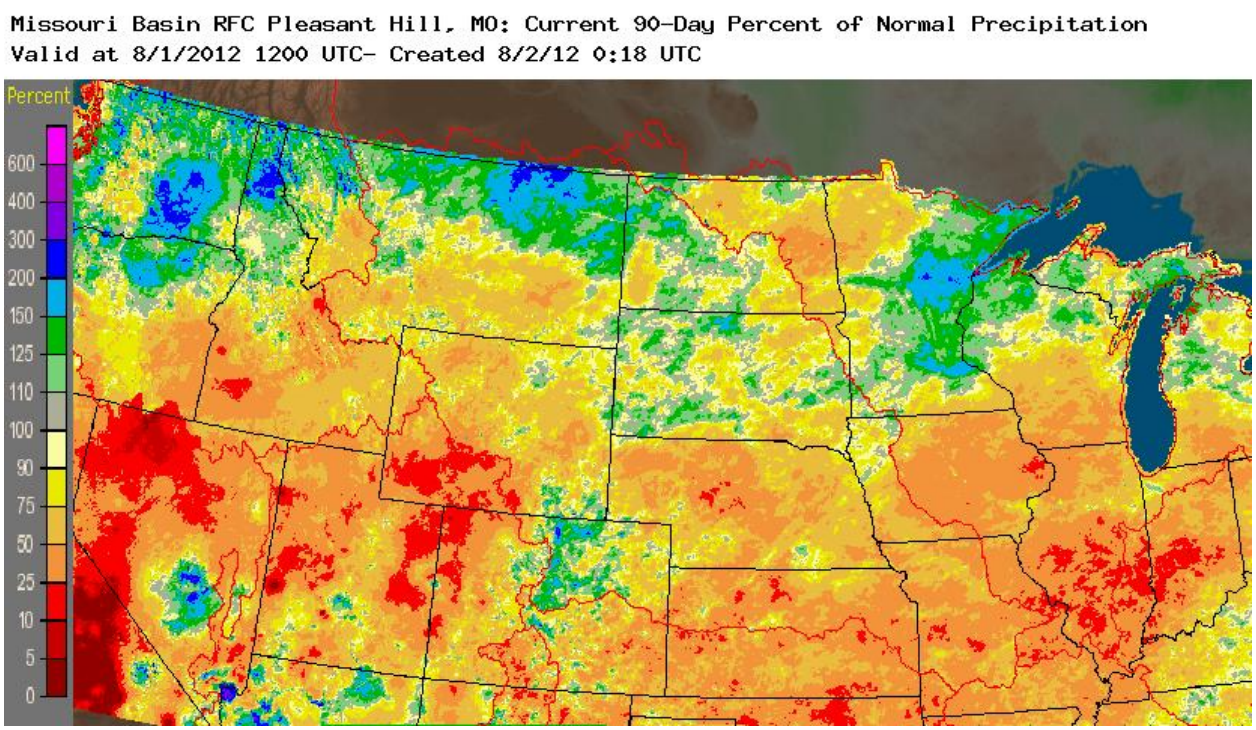

Figure 3. May-June-July 2012 Percent of Normal Precipitation. Source: National Weather Service.

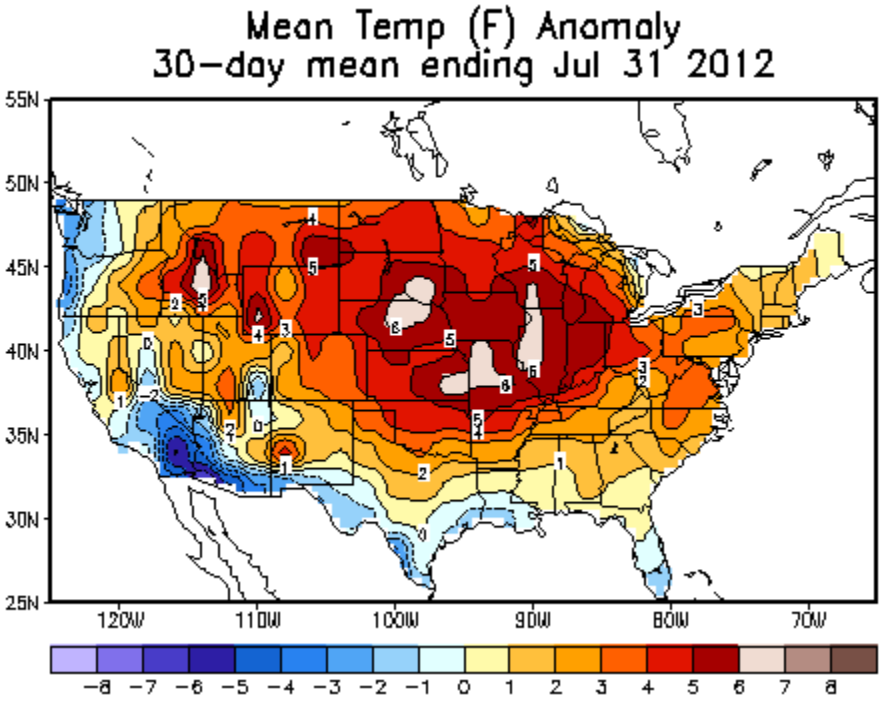

Figure 4. 30-day temperature anomaly (deg F) ending on July 31, 2012.

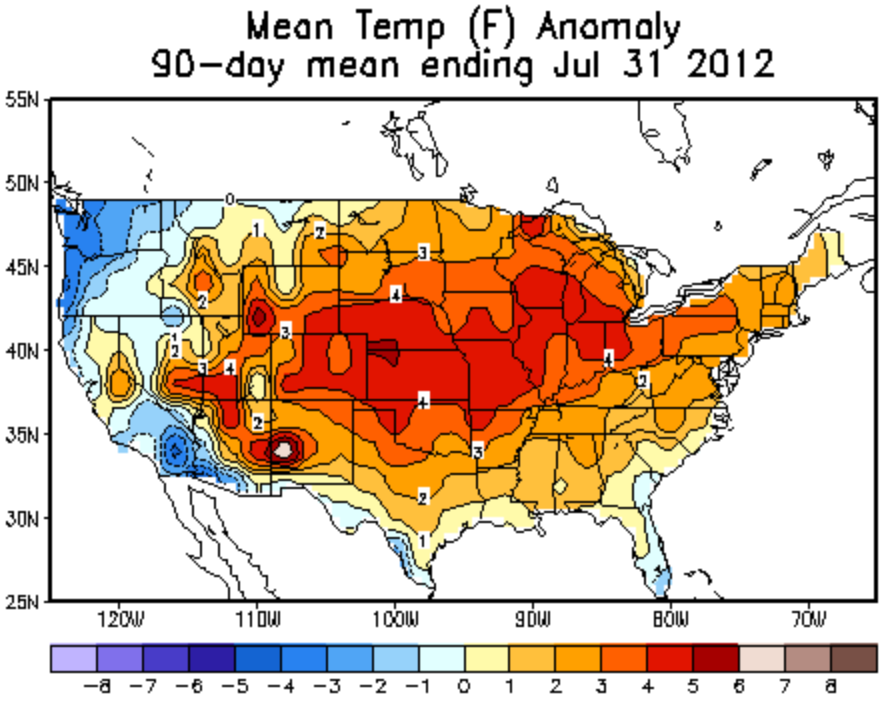

Figure 5. 90-day temperature anomaly (deg F) ending on July 31, 2012.

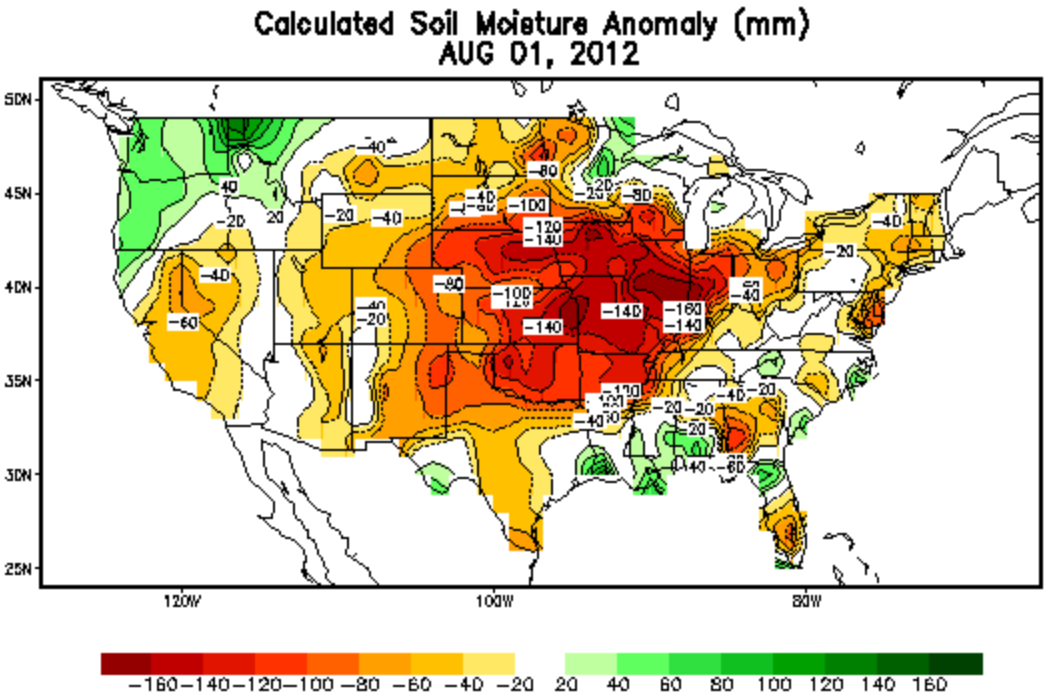

Figure 6. Calculated Soil Moisture Anomaly as of August 1, 2012. Source: Climate Prediction Center. http://www.cpc.ncep.noaa.gov/cgi-bin/US_Soil-Moisture-Monthly.sh#

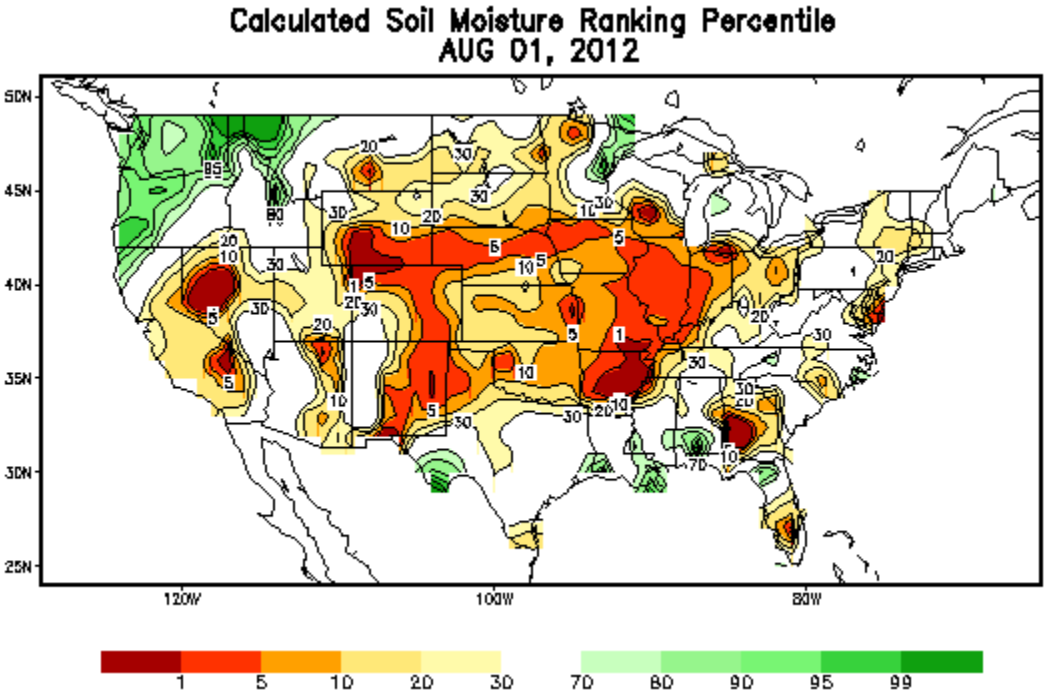

Figure 7. Calculated Soil Moisture Ranking Percentile as of August 1, 2012. Source: Climate Prediction Center. http://www.cpc.ncep.noaa.gov/cgi-bin/US_Soil-Moisture-Monthly.sh#

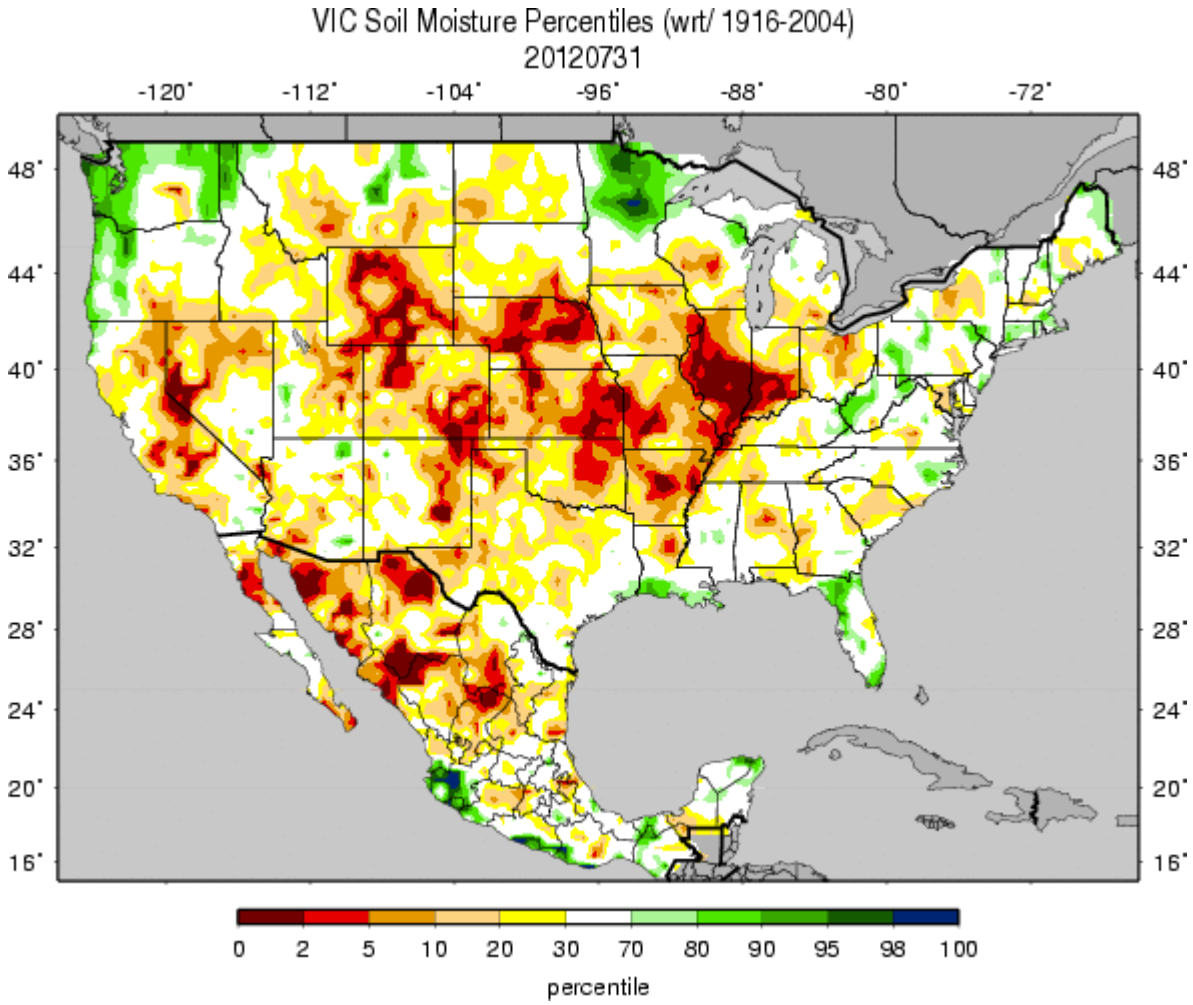

Figure 8. VIC modeled soil moisture percentiles as of July 31, 2012. Source: University of Washington. http://www.hydro.washington.edu/forecast/monitor/curr/conus.mexico/main_sm.multimodel.shtml

Mountain Snowpack

Mountain snowpack is the primary factor used to predict May-June-July runoff volumes in the Fort Peck and Fort Peck to Garrison mainstem reaches. During the 3-month runoff period, about 50% of the annual runoff enters the mainstem system as a result of mountain snowmelt and rainfall runoff. Greater than average mountain snow accumulations are usually associated with greater than average May-June-July runoff volumes, especially when mountain soil moisture conditions have been wetter than normal as in the past three years.

The average mountain snow accumulation in the basin above Fort Peck Dam peaked on April 9, 2012 at 97% of the normal peak mountain snow accumulation that would normally occur on April 15. The peak SWE on April 9, 2012 was 17.4 inches compared to an average peak of 18.0 inches. The average mountain snow accumulation in the reach from Fort Peck Dam to Garrison Dam peaked on March 22, 2012 at 88% of the normal peak that would normally occur on April 15. The peak SWE on March 22, 2012 was 13.8 inches compared to an average peak of 15.6 inches. As of July 19, 2012, mountain

snowpack had melted at all monitoring locations throughout the Fort Peck and Garrison reaches. Mountain snowpack is illustrated in Figure 9.

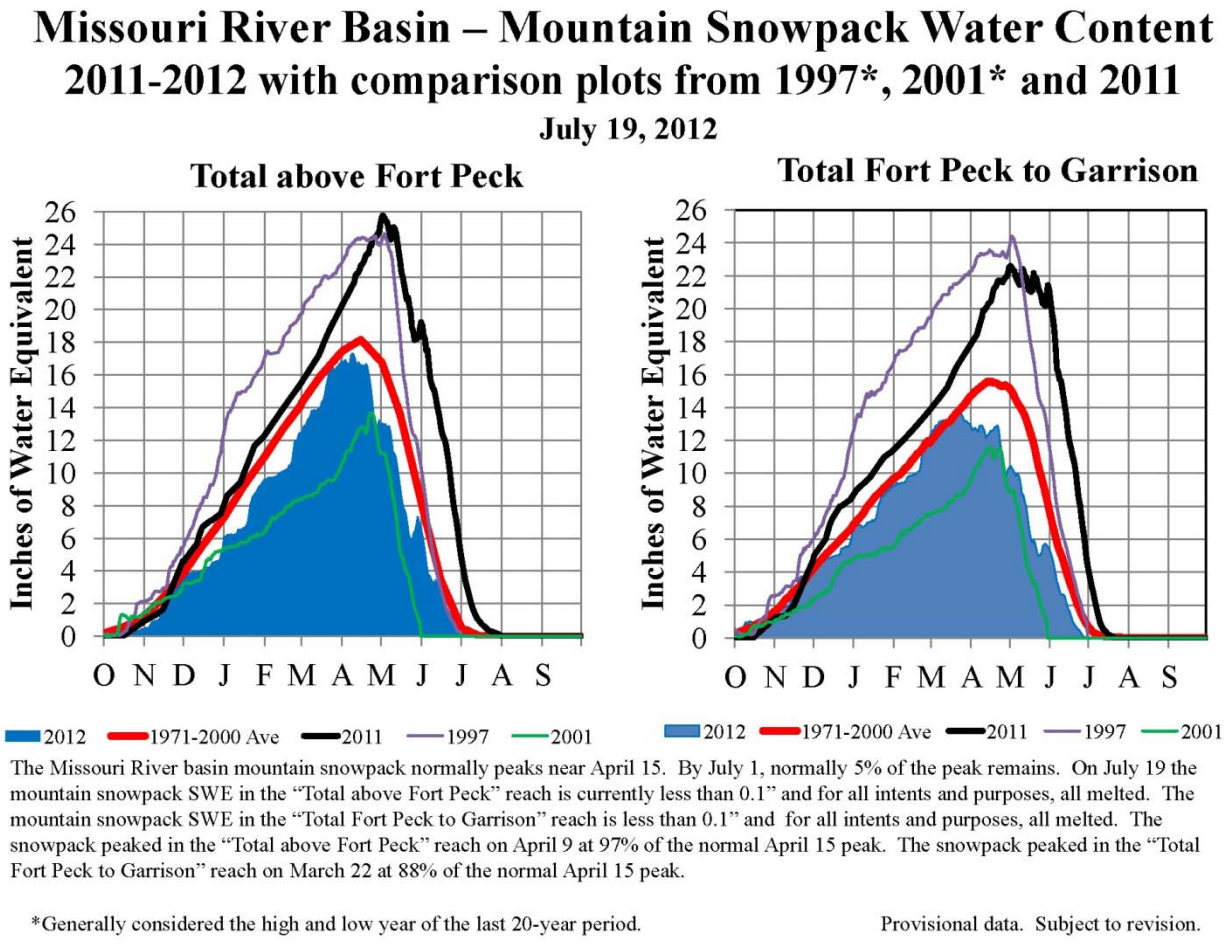

Figure 9. Missouri River mountain snowpack in the headwater basin above Fort Peck and the Fort Peck to Garrison reach..

Drought Analysis

Drought conditions grew worse over the month of July with many areas in the Missouri River basin moving one category to more severe conditions. According to the National Drought Mitigation Center's (NDMC) Drought Monitor, Moderate Drought (D1) and Severe Drought (D2) conditions are now impacting significant portions of the upper and lower Missouri River basin (Figure 10). In addition areas of Extreme Drought (D3) are impacting much of Nebraska, southern South Dakota, eastern Wyoming, Kansas and northern Missouri.

The U.S. Seasonal Drought Outlook is predicting persistent drought throughout most of the Missouri River basin (Figure 11) through October 31, 2012. Also the NDMC is predicting the development of drought in northern South Dakota and portions of North Dakota.

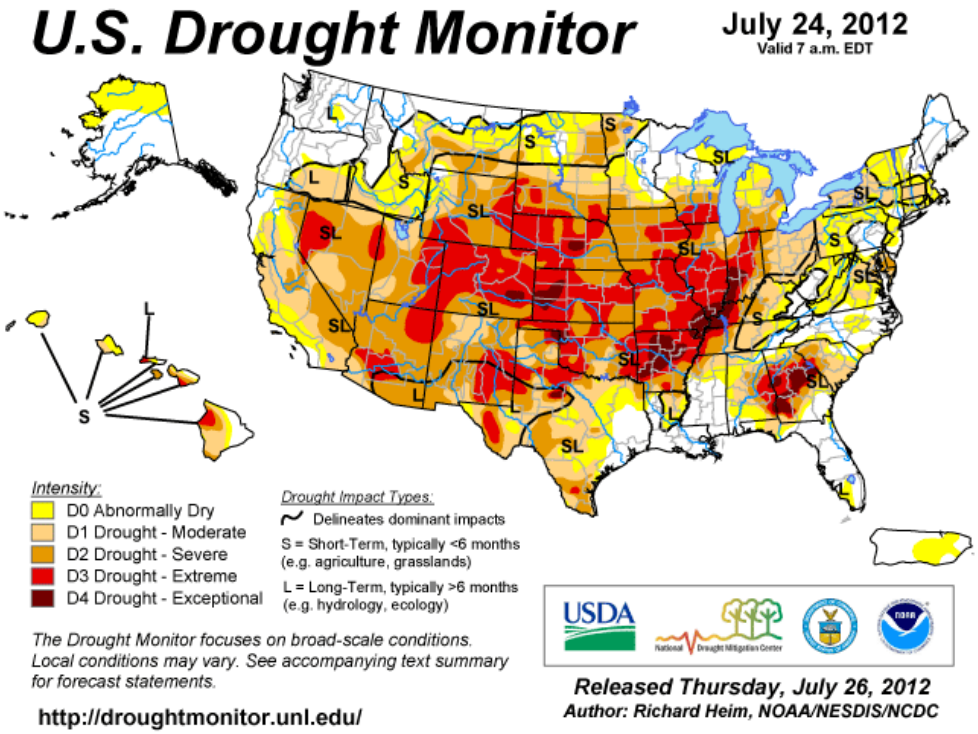

Figure 10. **National Drought Mitigation Center U.S. Drought Monitors for July 24, 2012.**

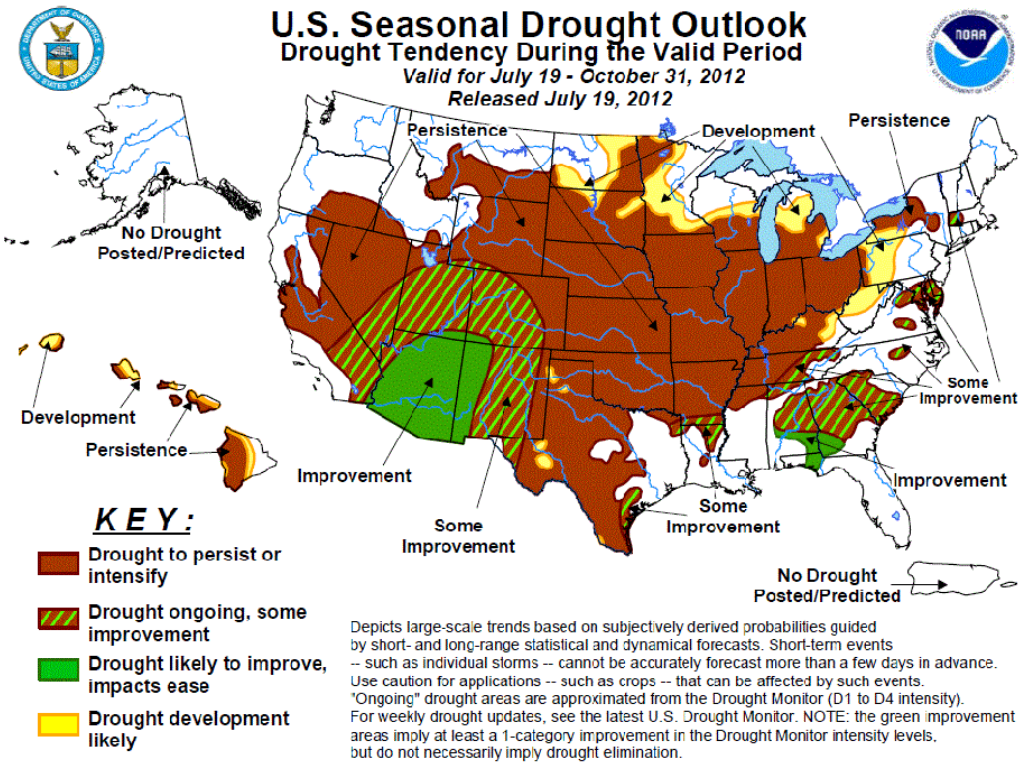

Figure 11. **National Drought Mitigation Center U.S. Drought Seasonal Drought Outlook for 19 July to 31 October 2012.v**

Climate Outlook

ENSO-neutral conditions continue in the equatorial Pacific, although equatorial sea surface temperatures are 0.5 degrees C above average across the eastern Pacific Ocean. According to the CPC, there is a 50% chance that El Nino conditions will develop during the second half of 2012, and about a 50% chance sea surface temperatures will remain neutral. Chances for the development of El Nino increase through September 2012. The last time El Nino conditions persisted in the equatorial Pacific was during the fall and winter of 2009-2010. During El Nino (warm) episodes, winters in the Missouri River basin have a tendency to be warmer than normal.

The 6-10 Day (Figure 12) and 8-14 Day (Figure 13) Outlooks indicate that temperatures are very likely to be above normal in the Missouri River basin through August 14. Regarding precipitation, there are better chances for normal precipitation in central portions of the basin, while there are increased chances for below normal precipitation in the lower basin and the upper basin affecting the Fort Peck and Garrison reaches.

The CPC August outlook is forecasting increased chances for above normal temperatures throughout the entire Missouri River basin. With regard to precipitation the CPC is forecasting equal chances for above normal, normal, and below normal precipitation through central and western portions of the Missouri River basin; however, there is an increased chance for below normal precipitation in eastern portions of the Missouri River basin (Figure 14). The August-September-October outlook (Figure 15) is also forecasting increased chances for above normal temperatures in much of the basin. With regard to precipitation CPC is forecasting equal chances for precipitation in all areas of the basin with the exception of below normal chances in Iowa and Missouri. The October-November-December CPC Outlook (Figure 16) indicates a continuation of warmer than normal conditions in the Missouri River basin accompanied by equal chances for above normal, normal and below normal precipitation.

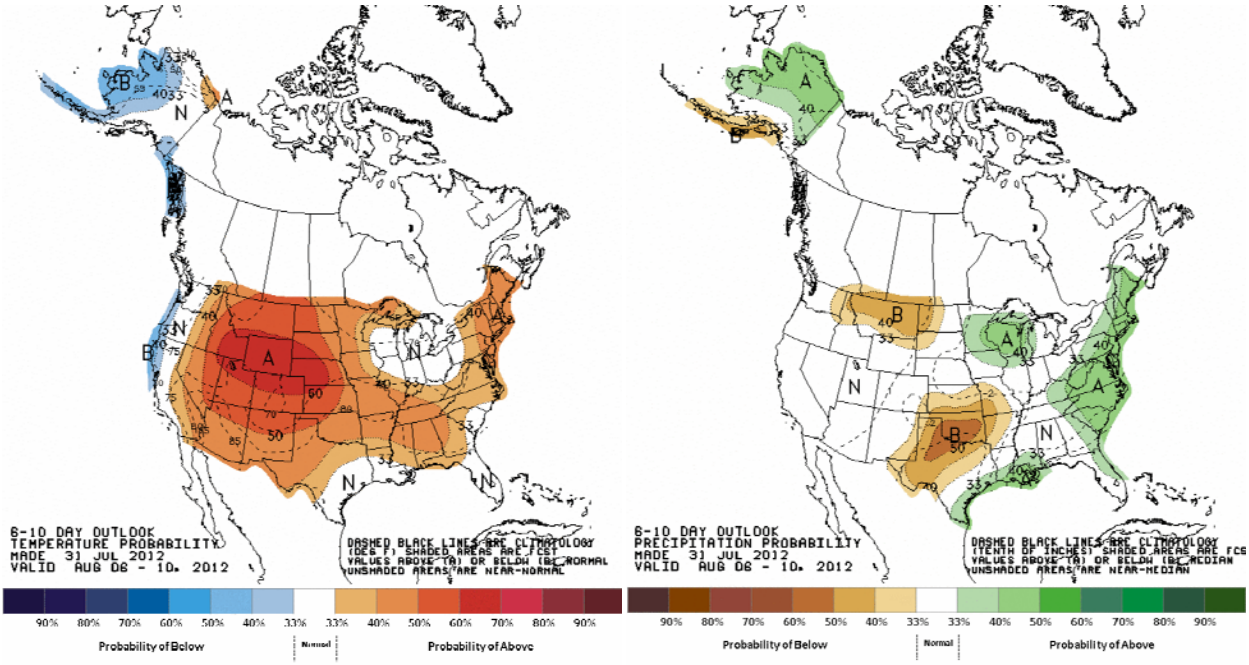

Figure 12. CPC 6-10 day temperature and precipitation outlooks.

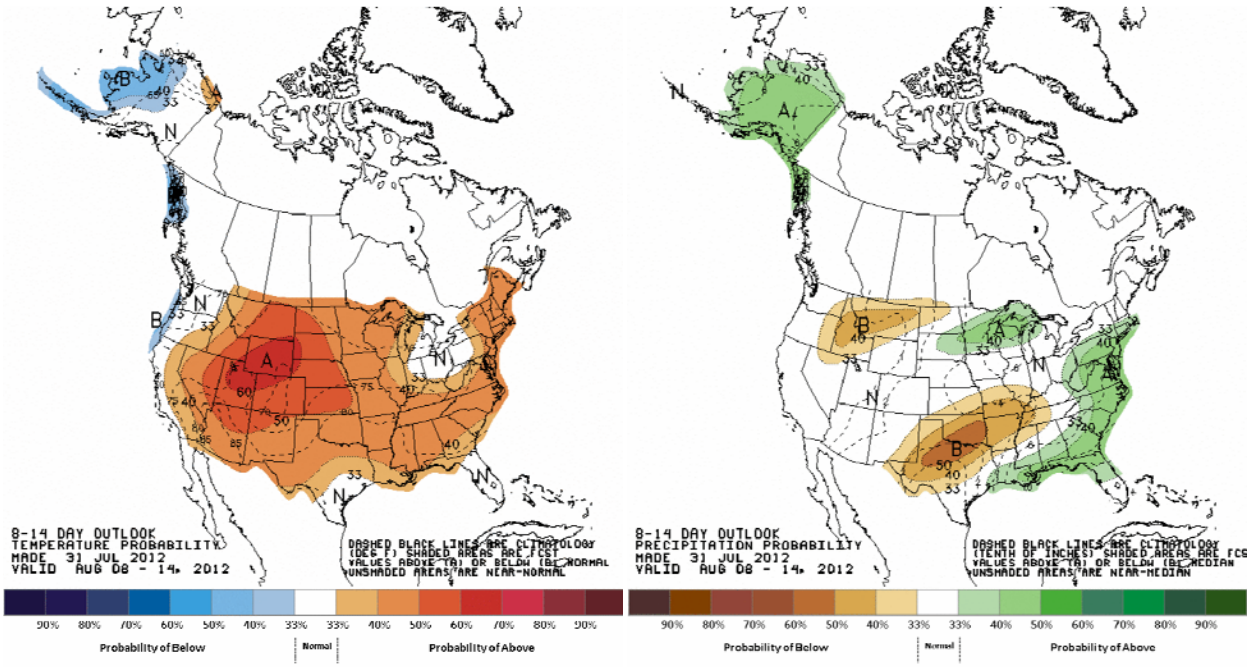

Figure 13. CPC 8-14 day temperature and precipitation outlooks.

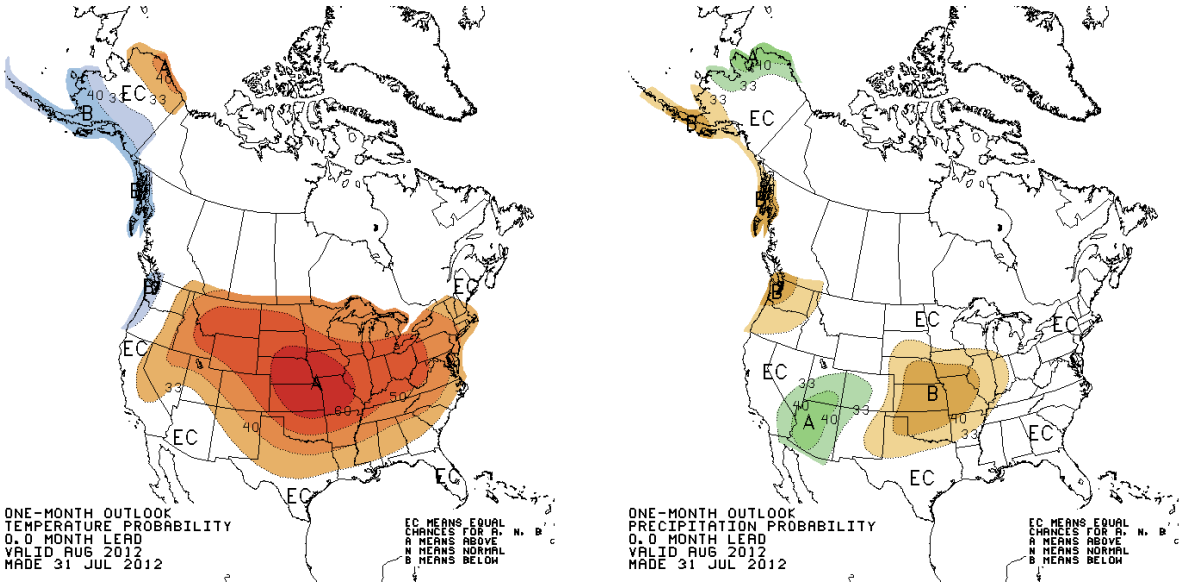

Figure 14. CPC August 2012 temperature and precipitation outlooks.

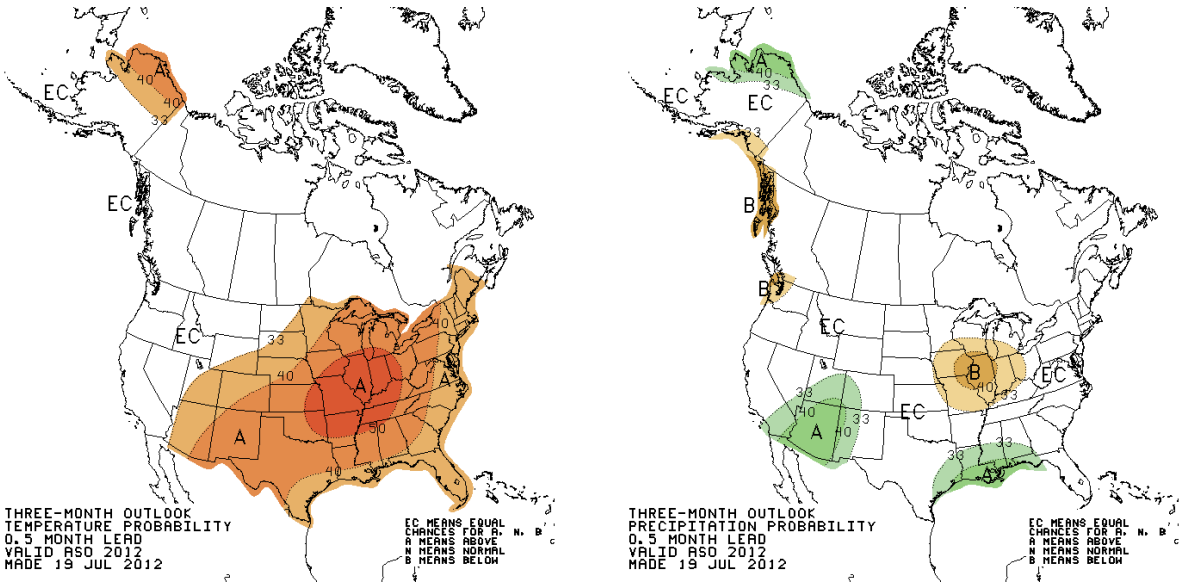

Figure 15. CPC August-September-October 2012 temperature and precipitation outlooks.

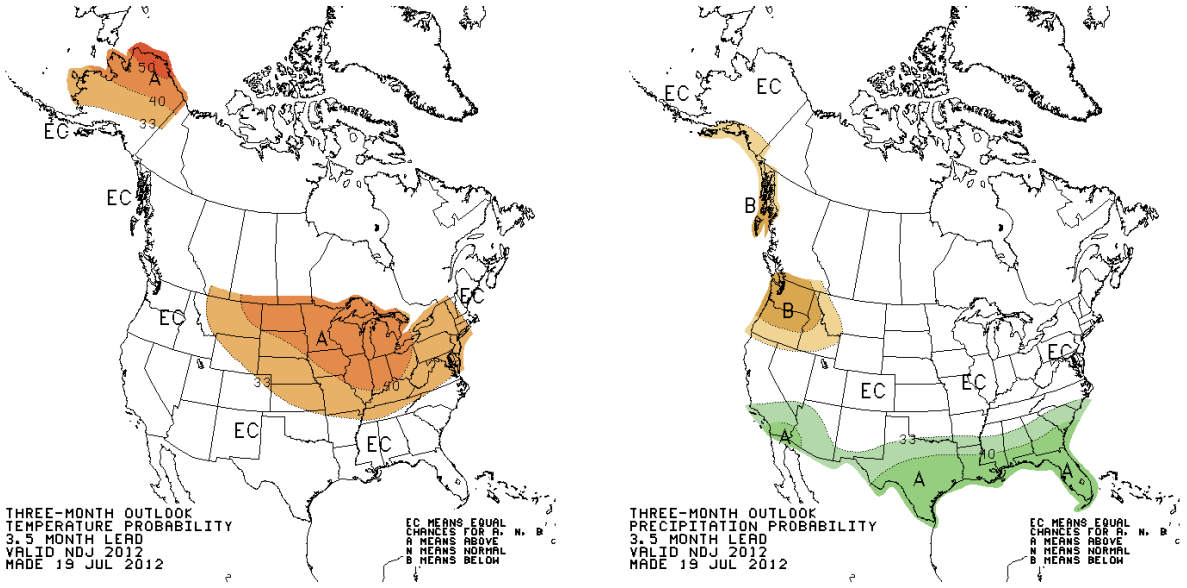

Figure 16. CPC November-December 2012-January 2013 temperature and precipitation outlooks.

August 2012 Calendar Year Runoff Forecast

The August 1 runoff forecast above Sioux City, IA is **21.0 MAF** (85% of normal) and **18.8 MAF** (83% of normal) above Gavins Point Dam. Actual July 2012 Missouri River runoff was 2.2 MAF (68% of normal) above Sioux City, and 2.1 MAF (70% of normal) above Gavins Point. The end of July calendar year accumulation above Sioux City is 85% of normal or 16.4 MAF. Due to the amount of variability in precipitation that can occur over the next 5 months, the expected inflow ranges from the 21.9 MAF upper basic forecast to the 20.1 MAF lower basic forecast.

The August runoff forecasts for all reaches were determined by first establishing a likely range of runoff volumes that could occur by reach given the observed 2012 reach and system runoff. Secondly the August volumes were adjusted to a likely historic ratio of July to August runoff. Finally, August runoff volumes converted to a monthly inflow were compared to current rates of inflow in order to verify that the volumes were reasonable. The resulting forecast August inflow volume above Gavins was 925 kaf (79% of normal) while above Sioux City it was 985 kaf (75% of normal).

Given the warm temperature outlook with a possible slight improvement to the precipitation outlook through October, September runoff is forecast to be 83% of normal above Sioux City with continued improvement in October. The November-December time period also shows some improvement; however, runoff is still projected to be 92% and 94% of normal, respectively. The November-December forecast is a reflection of existing dry conditions, limited recovery in accumulated precipitation, and the expectation of warmer than normal temperatures continuing into the winter of 2012-2013.