Upper Missouri River Basin
October 2015 Calendar Year Runoff Forecast
October 2, 2015

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.

2015 Calendar Year Forecast Synopsis

The September calendar year runoff forecast for the Missouri Basin above Sioux City is **24.9 MAF** (98% of average). September runoff was **1.0 MAF** (84**%** of average). Observed September runoff was higher than normal in the lower four reaches - Oahe, Fort Randall, Gavins Point, and Sioux City - due to above normal precipitation. Runoff in the upper two reaches – Fort Peck and Garrison – was well below normal due to below normal precipitation.

Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next 3 months, the range of expected inflow ranges from the 25.5 MAF (102% of average) upper basic forecast to the 24.4 MAF (96% of average) 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 wetter than average (upper basic) and lower than average (lower basic) is attributed to all 6 reaches for 3 months. The result is a 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

Drought Analysis

Drought conditions have continued to expand in the basin over the last few months. The drought conditions are shown in the National Drought Mitigation Center's drought monitor for September 29, 2015 (**Figure 1**) and August 25, 2015 (**Figure 2**). Extreme Drought (D3) and Severe Drought (D2) conditions expanded slightly in western Montana. Abnormally Dry (D0) conditions have persisted in eastern Montana and have now developed in eastern North Dakota, eastern Wyoming, western Nebraska and north-central Kansas. The U.S. Seasonal Drought Outlook in **Figure 3** indicates drought will persist and likely intensify in western Montana and develop in central Montana through the end of the calendar year. Conditions are not expected to change anywhere else in the Missouri Basin.

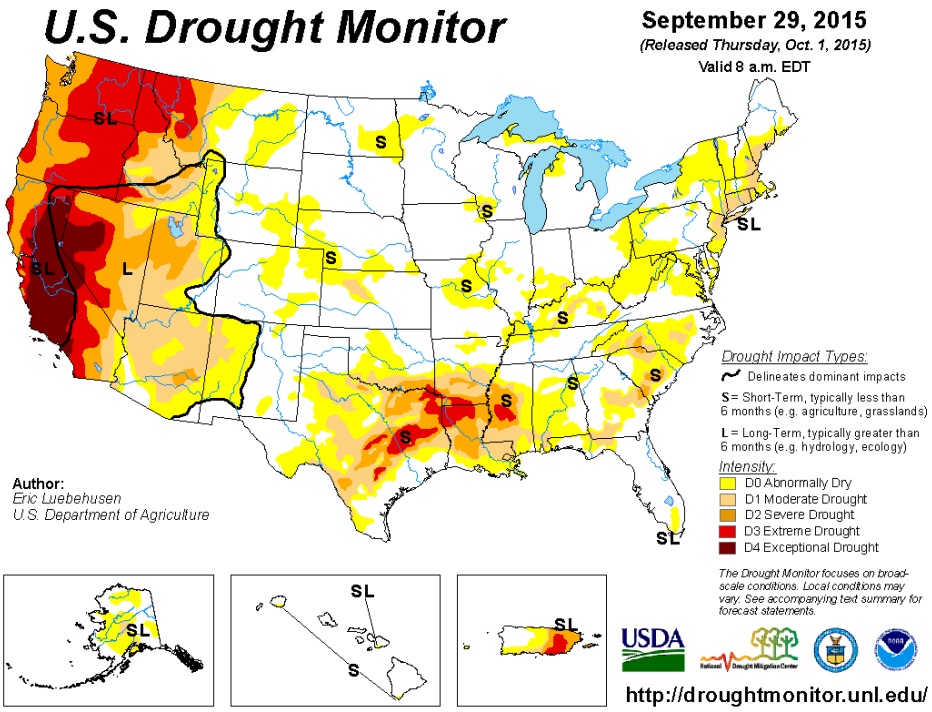


Figure 1. National Drought Mitigation Center U.S. Drought Monitor for September 29, 2015.

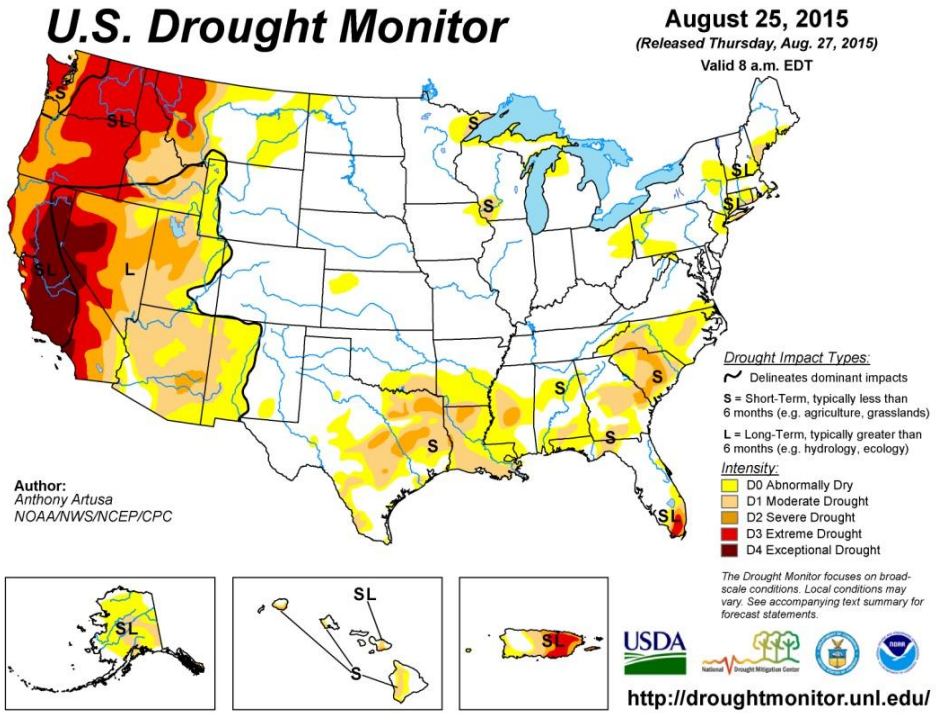


Figure 2. National Drought Mitigation Center U.S. Drought Monitor for August 25, 2015.

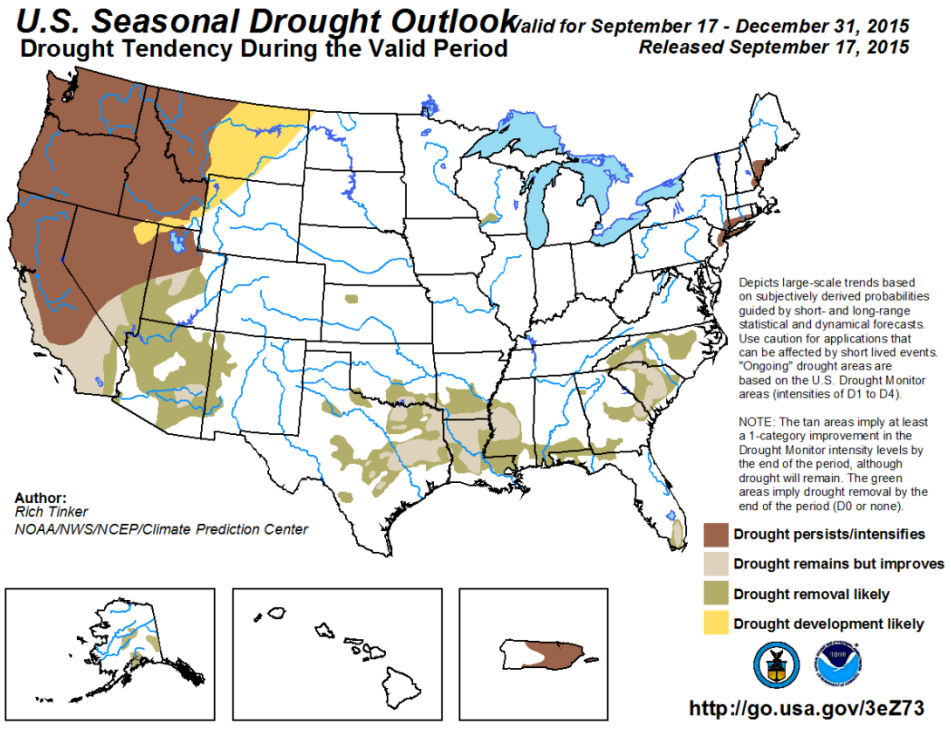


Figure 3. National Drought Mitigation Center U.S. Seasonal Drought Outlook, released September 17, 2015.

Precipitation

September precipitation accumulations are shown in **Figure 4** as both inches of precipitation and percent of normal monthly precipitation. Precipitation was either much above or much below normal in the basin. Because normal September precipitation in the upper basin historically is quite low, one storm could result in above normal totals. While the percent of normal graphic (**Figure 4, right**) shows that above normal precipitation fell in western Montana, western North Dakota, southeastern South Dakota, eastern Nebraska and western Iowa, the precipitation total graphic (**Figure 4, left**) indicates that, other than in the eastern Nebraska/western Iowa area where some monthly totals exceeded 7 inches, monthly totals in the rest of the basin were generally less than 3 inches. July-August-September precipitation accumulations are shown in **Figure 5**. The three-month accumulations reflect a wide array of above normal, normal and below normal precipitation across the basin, highlighted by the eastern Nebraska/western Iowa area recording much above normal precipitation.

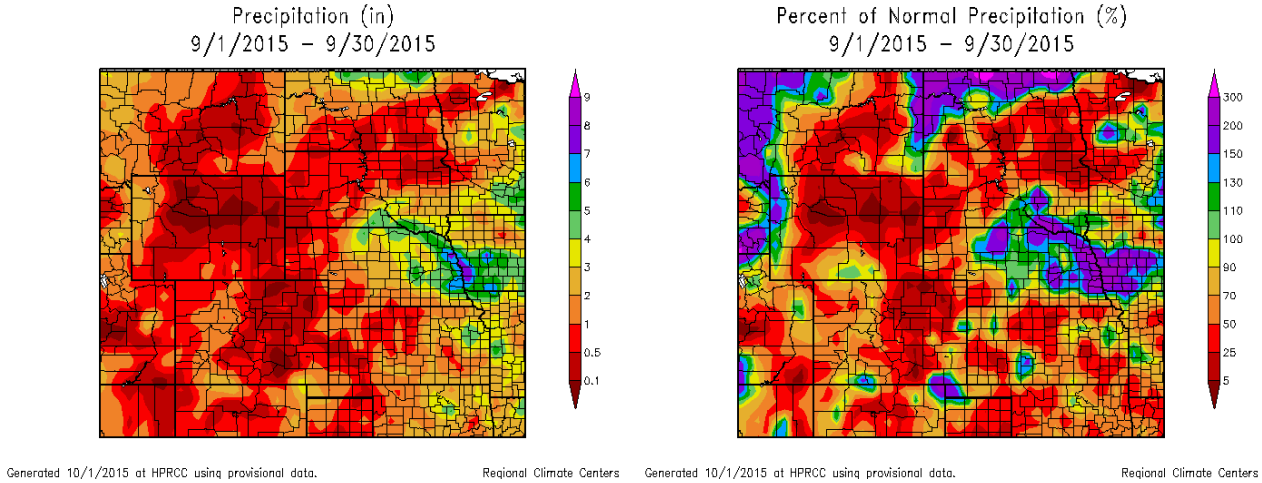


Figure 4. September 2015 Precipitation (inches) and Percent of Normal Precipitation. Source: High Plains Regional Climate Center, http://www.hprcc.unl.edu/.

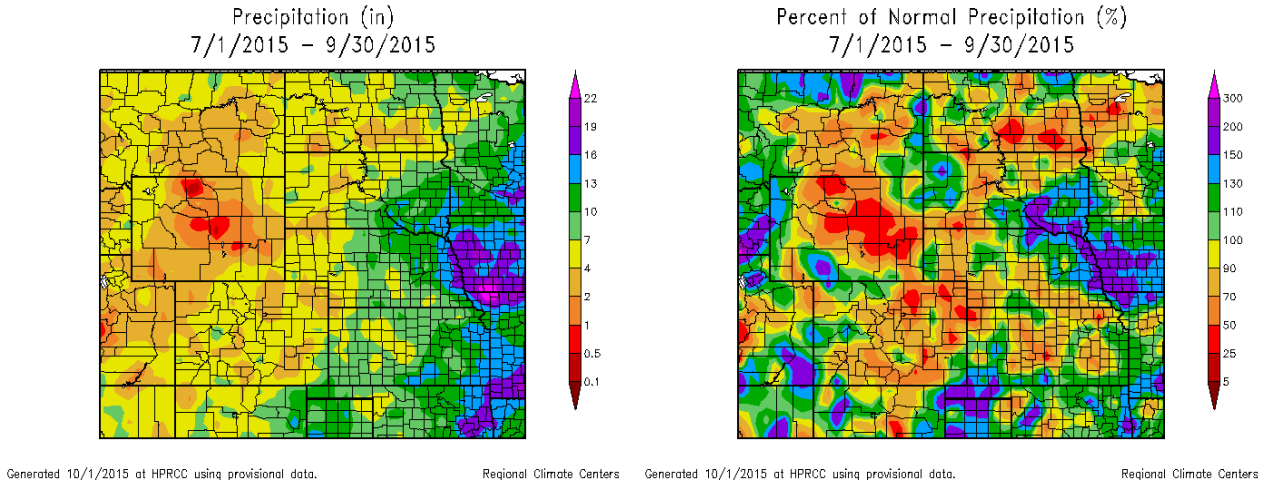


Figure 5. July-September 2015 Precipitation (inches) and Percent of Normal Precipitation. Source: High Plains Regional Climate Center, http://www.hprcc.unl.edu/.

Temperature

September temperatures were 2 to 6 degrees Fahrenheit (deg F) warmer than normal over much of the basin (**Figure 6, left)** and some of areas of basin experienced monthly temperatures 6 to 10 deg F warmer than normal. Three-month (July-August-September) temperature departures (**Figure 6, right**) show that most of the basin recorded temperatures within +/-2 deg F of normal temperatures. The western portion of the basin, as well as western Iowa and western Missouri, was slightly cooler than normal over the 3-month period and the rest of the basin was slightly warmer than normal.

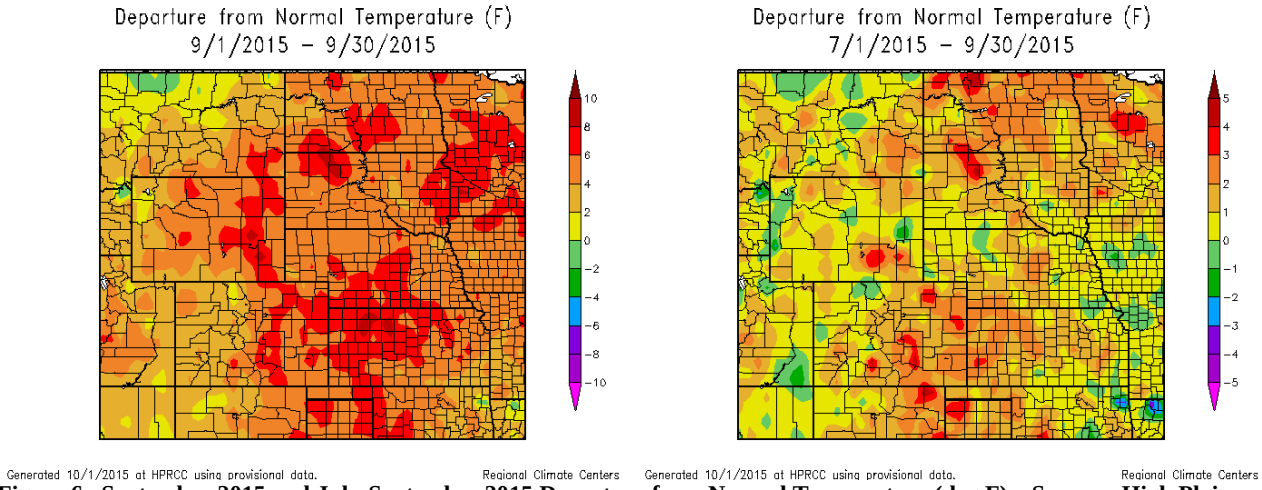


Figure 6. September 2015 and July-September 2015 Departure from Normal Temperature (deg F). Source: High Plains Regional Climate Center, http://www.hprcc.unl.edu/.

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 monthly runoff.

Figure 7 shows the NOAA NLDAS ensemble mean soil moisture percentiles on September 27, 2015 for the total modeled soil column, which is about 2 meters. Soil moisture percentiles on August 27, 2015 are shown in **Figure 8**. The NLDAS soil moisture depiction is an average value for the soil moisture column. **Figure 7** indicates above normal soil moisture conditions throughout much of the upper Basin, albeit drier than what was shown one month earlier (**Figure 8**) Soil moisture is normal and above normal throughout most the basin. Areas with below normal soil moisture are evident in western Montana (outside of the Missouri Basin) as well as eastern North Dakota and central Kansas.

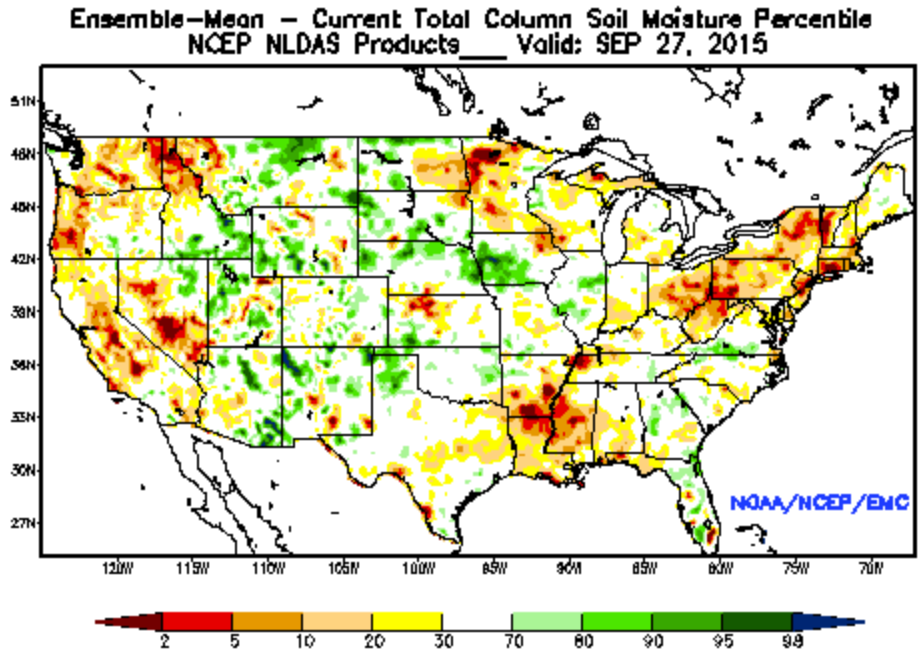


Figure 7. Total Column Soil Moisture Percentile on September 27, 2015. Source: NOAA NLDAS Drought Monitor Soil Moisture. http://www.emc.ncep.noaa.gov/mmb/nldas/drought/

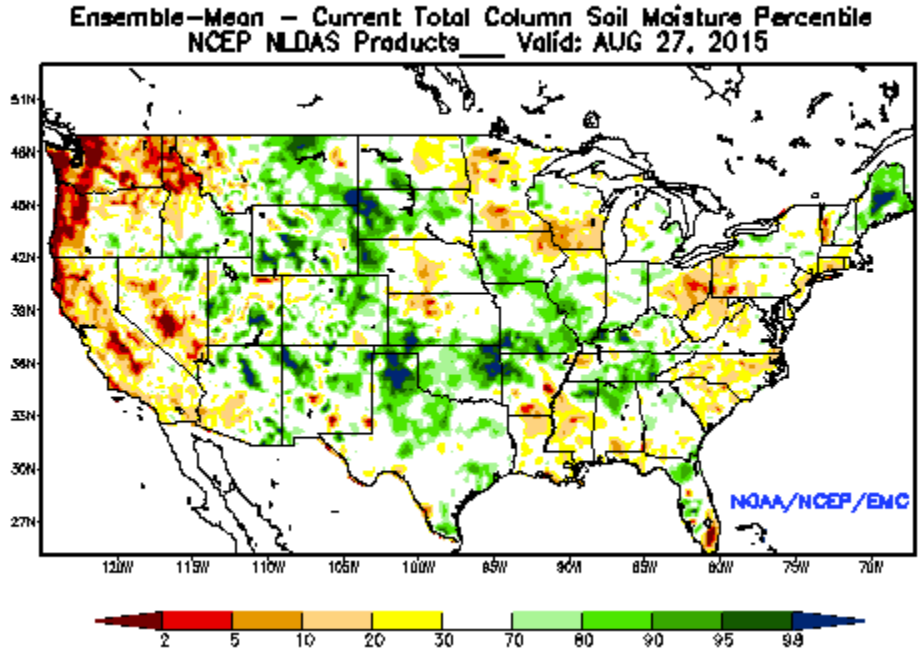
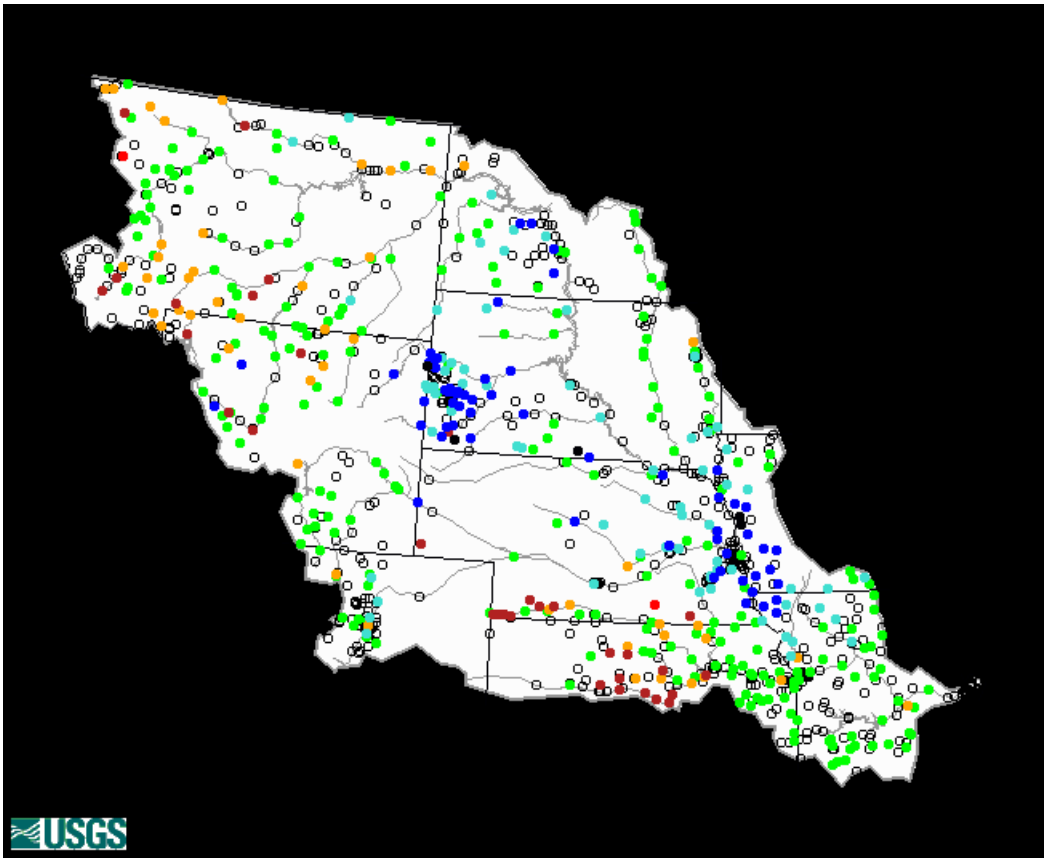


Figure 8. Total Column Soil Moisture Percentile on August 27, 2015. Source: NOAA NLDAS Drought Monitor Soil Moisture. http://www.emc.ncep.noaa.gov/mmb/nldas/drought/

Streamflow Conditions

Missouri Basin streamflow conditions represented as percentile classes on October 1, 2015 are shown in **Figure 9**. These conditions are based on the ranking of the October 1, 2015 daily streamflow versus the historical record of streamflow for that date. Streamflow conditions have been much above normal (exceeding the 90th percentile) in western South Dakota, central North Dakota, eastern Nebraska, western Iowa and north-west Missouri. In contrast, streamflow is much below normal in central Kansas (below the 10th percentile). Aside from those areas just mentioned, the rest of the basin streamflows are within the below-normal and above-normal range (25th to 75th percentile).



Explanation - Percentile classes						
Low	<10	10-24	25-75	76-90	>90	High
	Much below normal	Below normal	Normal	Above normal	Much above normal	

Figure 9. USGS Streamflow Conditions as a Percentile of Normal in the Missouri River Basin as of October 1, 2015. Source: USGS. http://waterwatch.usgs.gov/index.php

Climate Outlook

ENSO (El Niño Southern Oscillation)

According to the CPC's latest monthly update on September 10, 2015 (http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.pdf), "***there is an approximately 95% chance that El Niño will continue through Northern Hemisphere winter 2015-16, gradually weakening through spring 2016***". CPC studies are predicting a strong El Niño event at its peak. El Niño winters have a tendency to be warmer and drier than normal in the upper Missouri Basin, and the influence of El Niño has been factored into the CPC's climate outlooks.

MRBWMD 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. These webinars provide updates on near-term climate outlooks and impacts including the El Niño climate pattern and its implications on late summer, fall and early winter temperature and precipitation patterns in the Missouri River Basin. The possible impacts of El Niño have been factored into the CPC climate outlooks described below.

Temperature and Precipitation Outlooks

For October (**Figure 10**), the CPC climate temperature outlook indicates increased chances for below normal temperatures in the upper basin and equal chances in the lower basin. With regard to precipitation, the CPC indicates that there are equal chances for above normal, below normal and normal precipitation in all of the Missouri Basin.

For October-November-December (**Figure 11**), the CPC is forecasting increased chances for above normal temperatures in the upper Basin and equal chances for the lower basin. For precipitation, the CPC is showing below normal precipitation in Montana, equal chances in the rest of the upper basin and above normal chances in the lower basin.

For January-February-March 2016 (**Figure 12**), the CPC temperature outlook indicates increased chances for above normal temperatures throughout the entire United States, including the upper Basin and a good portion of the lower basin. A "ribbon" of equal chances is indicated that includes most of Missouri-basin portions of Colorado and Kansas. Regarding precipitation, the CPC is indicating increased chances for below normal precipitation in the upper basin (except for South Dakota, which is equal chances) and equal chances or slightly above normal chances for the lower basin.

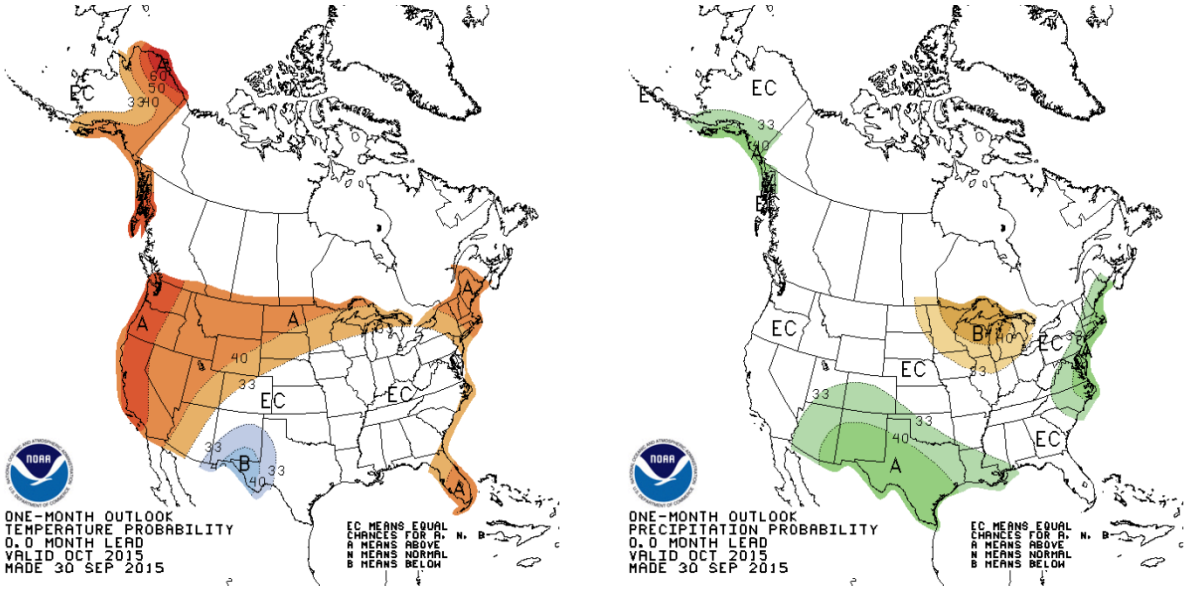


Figure 10. CPC October 2015 temperature and precipitation outlooks.

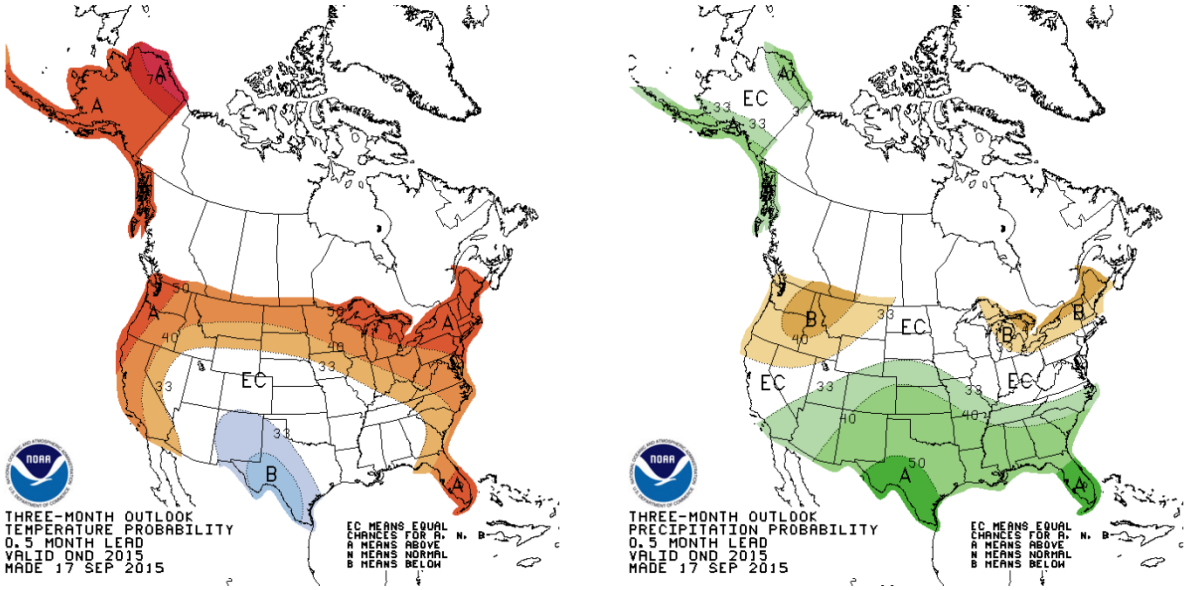


Figure 11. CPC October-November-December 2015 temperature and precipitation outlooks.

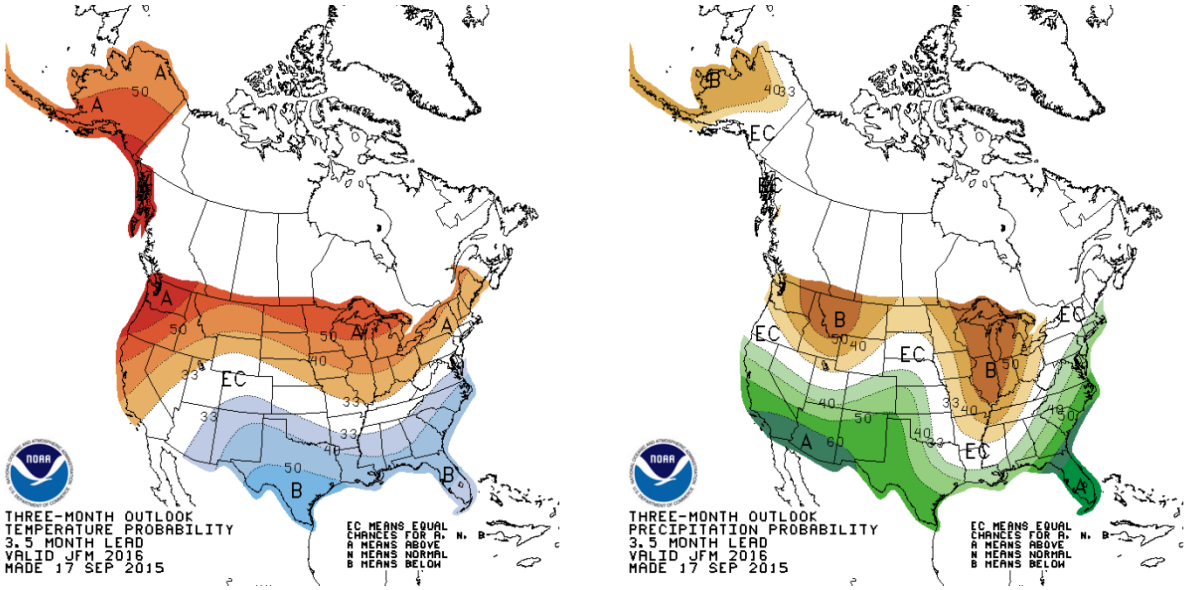


Figure 12. CPC January-February-March 2016 temperature and precipitation outlooks.

October 2015 Calendar Year Runoff Forecast

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