Upper Missouri River Basin
Calendar Year Runoff Forecast
February 1, 2013

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 and Sioux City, IA. 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.

2013 Calendar Year Forecast Synopsis

The annual runoff forecast as of February 1, 2013 is 19.9 MAF (80% of normal) above Sioux City, IA. Above Gavins Point, the runoff forecast is 18.6 MAF (82% of normal). For both, this is a decrease of 0.6 MAF from the January forecast. January runoff was 0.9 MAF (114% of normal) in the upper Missouri River Basin (basin) above Sioux City, IA and 0.8 MAF (116% of normal) above Gavins Point. While last month's runoff was greater than both forecasted and normal, the annual forecast total was decreased due to decreasing mountain snowpack.

Due to the amount of variability in precipitation and other hydrologic factors that can occur over the next 11 months, the range of expected inflow is quite large and ranges from the 27.0 MAF upper basic forecast to the 13.6 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. 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

ENSO (La Nina)

ENSO-neutral conditions continue in the equatorial Pacific, and equatorial sea surface temperatures are near average across most of the Pacific Ocean. ENSO-neutral conditions are favored in the Northern Hemisphere through the winter of 2012-2013 and into spring 2013; therefore, there is not a strong indication of future winter temperature and precipitation conditions in the basin based on ENSO conditions.

Drought Analysis

According to the National Drought Mitigation Center (Figure 1), drought conditions impacted a large majority of the upper basin with the exception of the northern half of Montana. Abnormally Dry (D0) conditions transitioned to Severe (D2) and Extreme (D3) drought conditions in southern Montana and the Dakotas. Exceptional (D4) drought, which is the worst classification of drought according to the drought monitor, is present in southern South Dakota, eastern Wyoming and a very large portion of Nebraska. These conditions developed as a result of the record warmest calendar year and very low precipitation accumulations as indicated in Figures 2 and 3.

The U.S. Seasonal Drought Outlook shown in Figure 4 indicates drought conditions impacting the basin will persist through winter and early spring 2013. Areas that will experience drought persistence include most of Wyoming, Nebraska and western Iowa. There is potential for some improvement in eastern North Dakota, northern South Dakota, southern Montana, and northern Wyoming, where one-category improvement could occur. The Drought Outlook, though, does forecast likely improvement in eastern and southern North Dakota and some improvement in southern Montana and northern South Dakota.

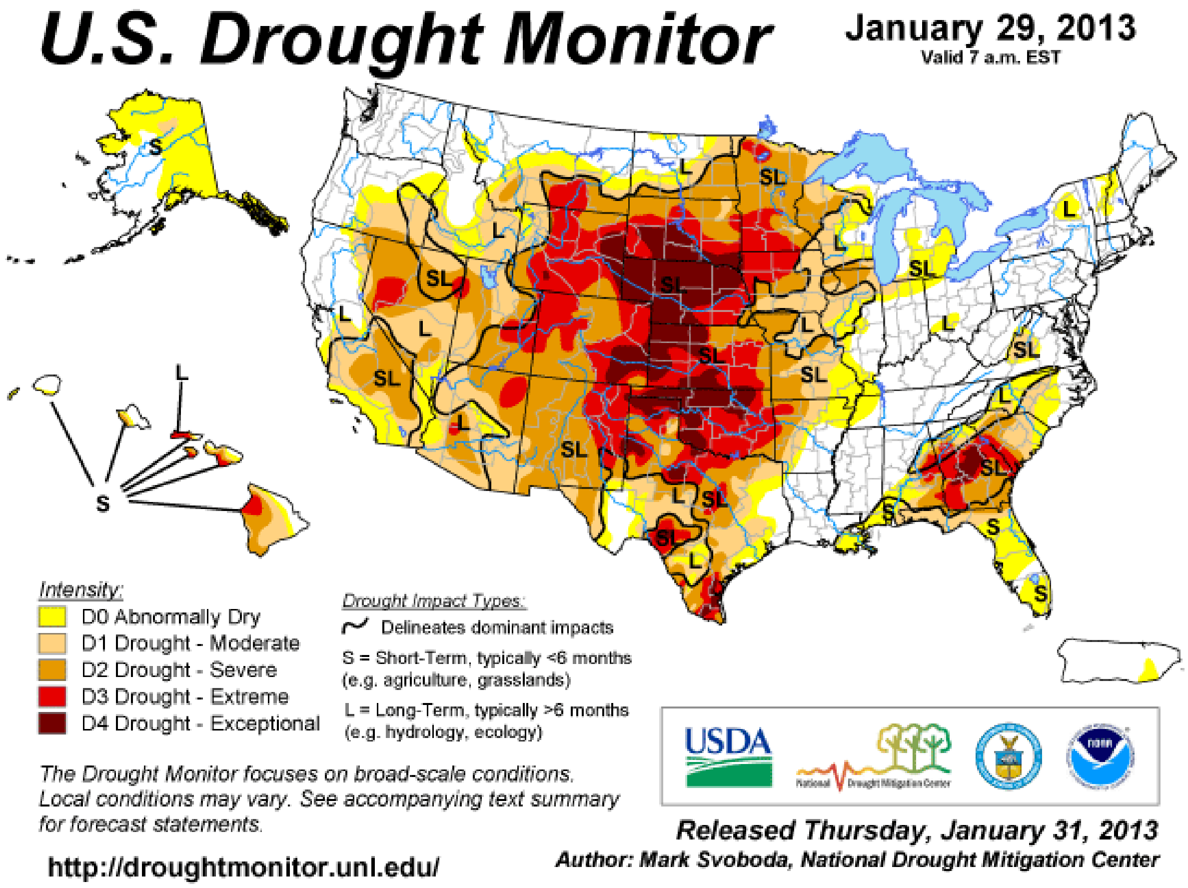

Figure 1. National Drought Mitigation Center U.S. Drought Monitors for December 25, 2012.

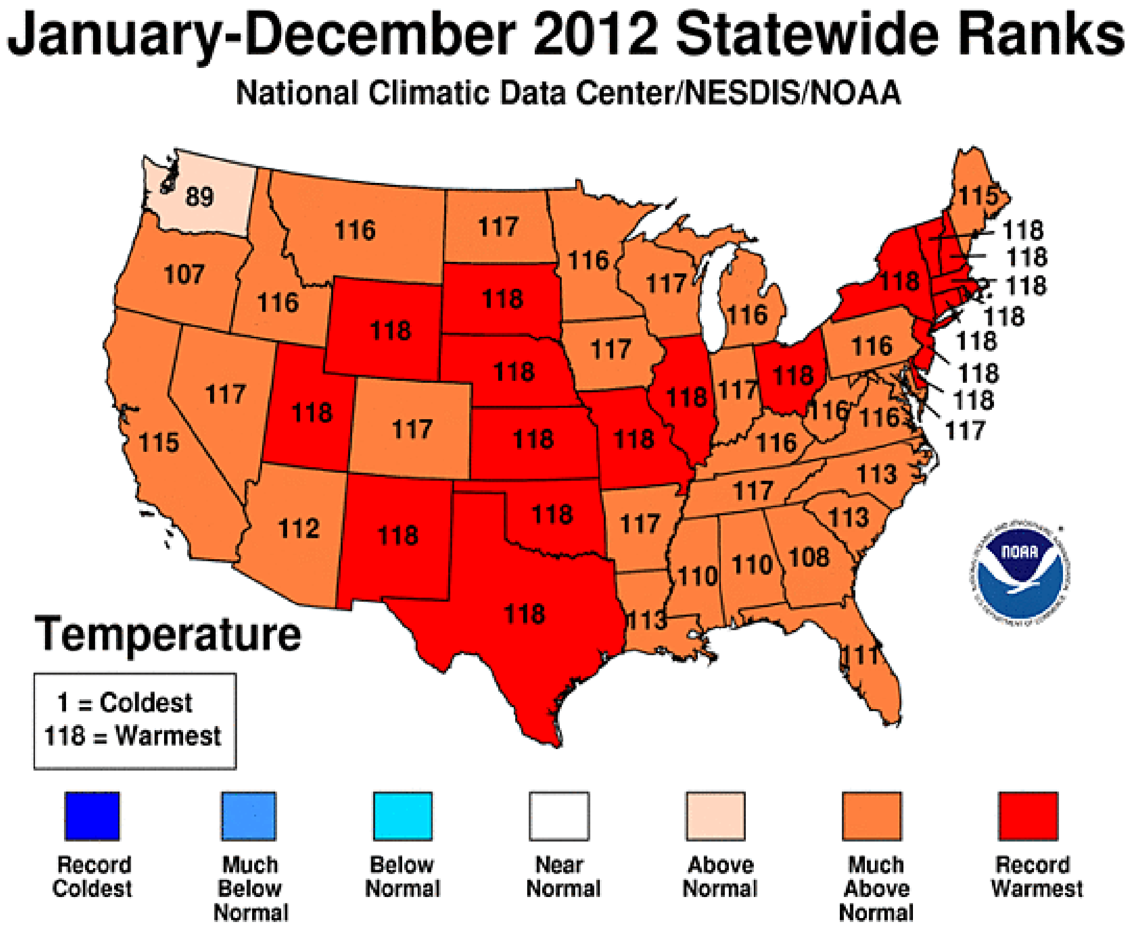

Figure 2. 2012 Temperature – Statewide Ranks

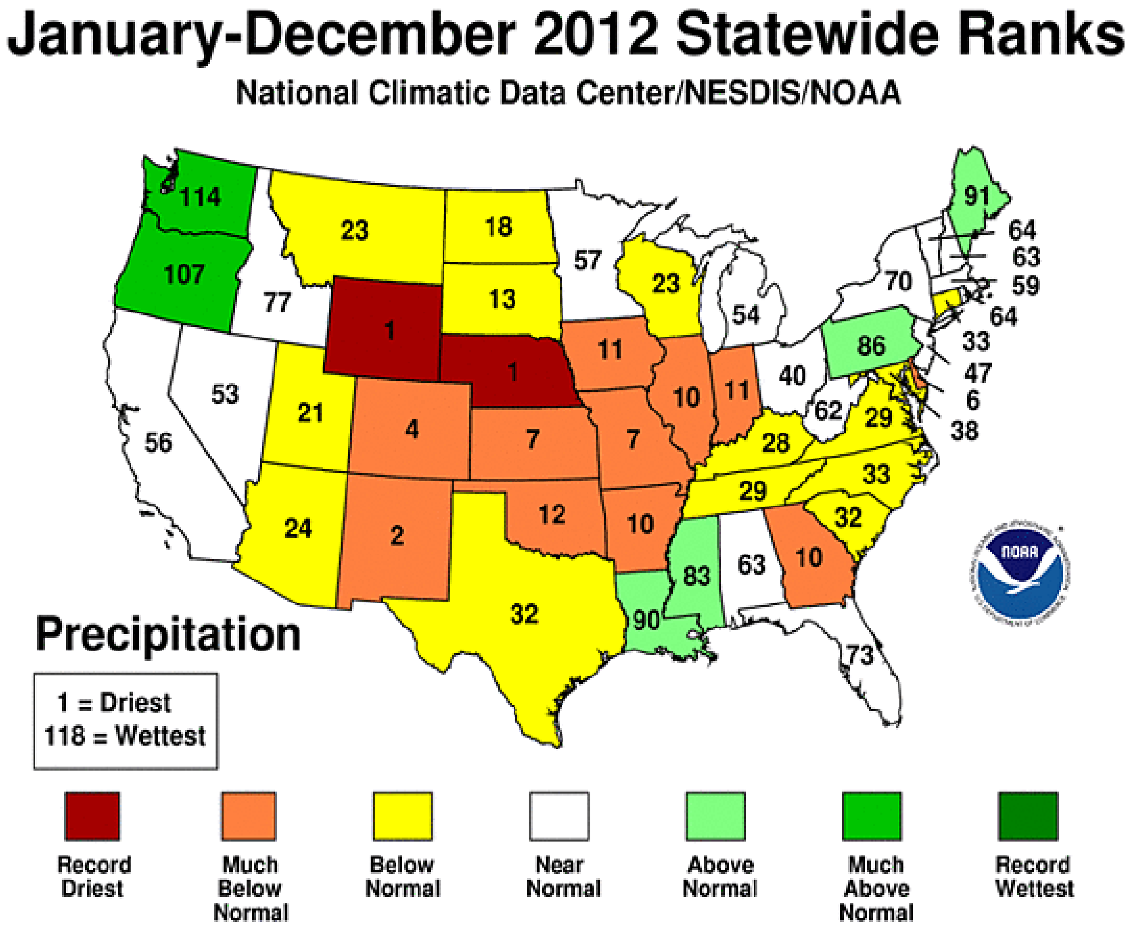

Figure 3. 2012 Precipitation – Statewide Ranks.

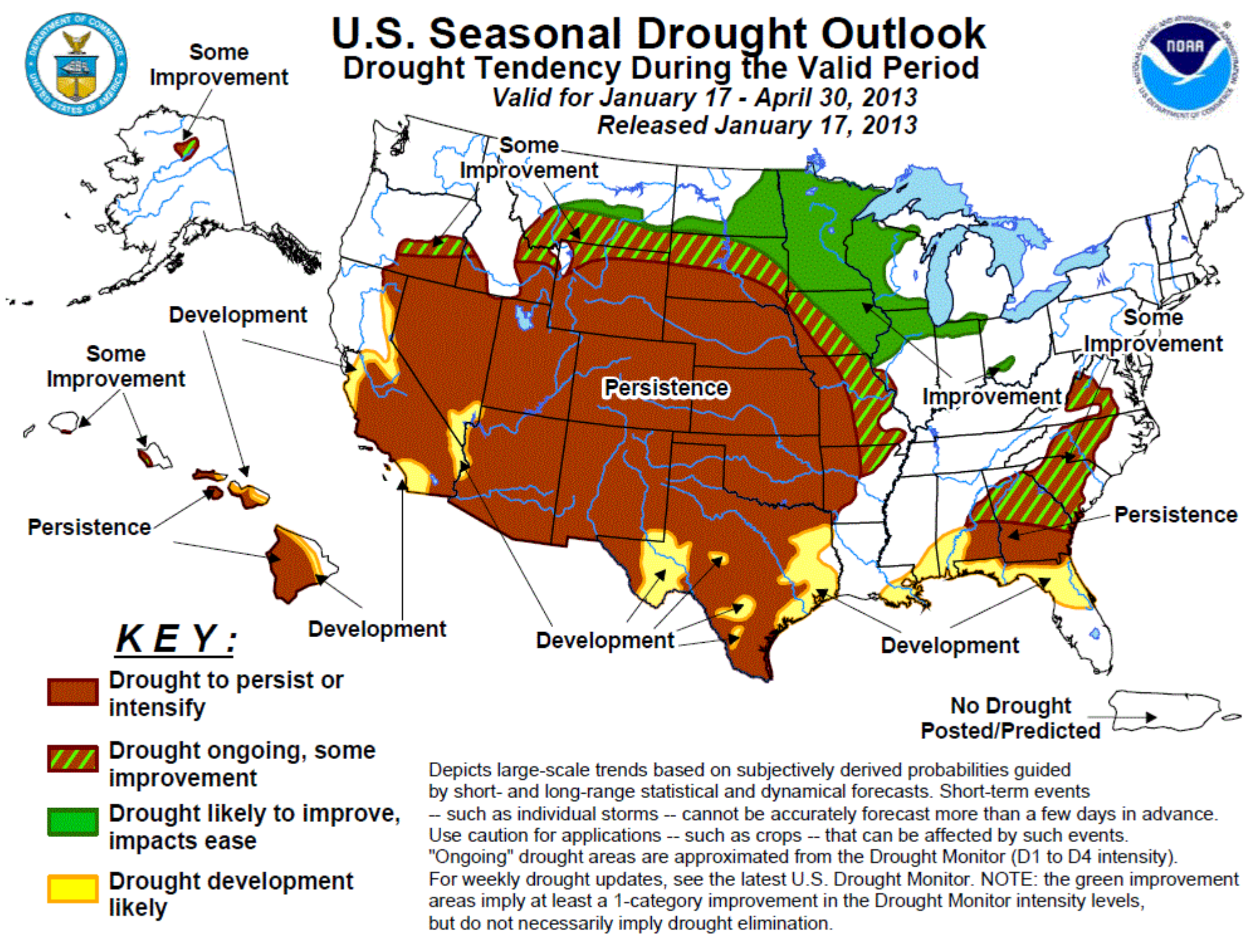

Figure 4. National Drought Mitigation Center U.S. Drought Seasonal Drought Outlook.

Precipitation

Accumulated precipitation during the month of January is shown in Figure 5. While January precipitation generally has limited impact on January runoff since it generally falls as snow and does not result in immediate runoff, it was above normal in many parts of Montana and the Dakotas. In Wyoming, Nebraska and Iowa, it was mostly below normal except for a few isolated areas. Precipitation in Montana was greater than 150% of normal across the Rocky Mountain front, in northern and northeast Montana with some areas receiving up to 200% of normal. Similar amounts occurred in southern North Dakota and across South Dakota. Eastern South Dakota received over 200% of normal precipitation in January. Some areas received much less than normal precipitation in January including central and eastern Wyoming and Nebraska where precipitation was as little as 25% of normal.

Accumulated precipitation over the 90-day period ending on December 31, 2012, is shown in Figure 6. Precipitation was well below normal in all states except for Montana and localized areas of Wyoming. Most areas including South Dakota, Nebraska, western Iowa and parts of Wyoming received less than 50% of normal precipitation over the past three months, with some accumulations ranging from 10 to 25% of normal. In contrast large portions of Montana and North Dakota received greater than 150% of normal precipitation. Accumulations in excess of 200% of normal occurred in northern portions of these states.

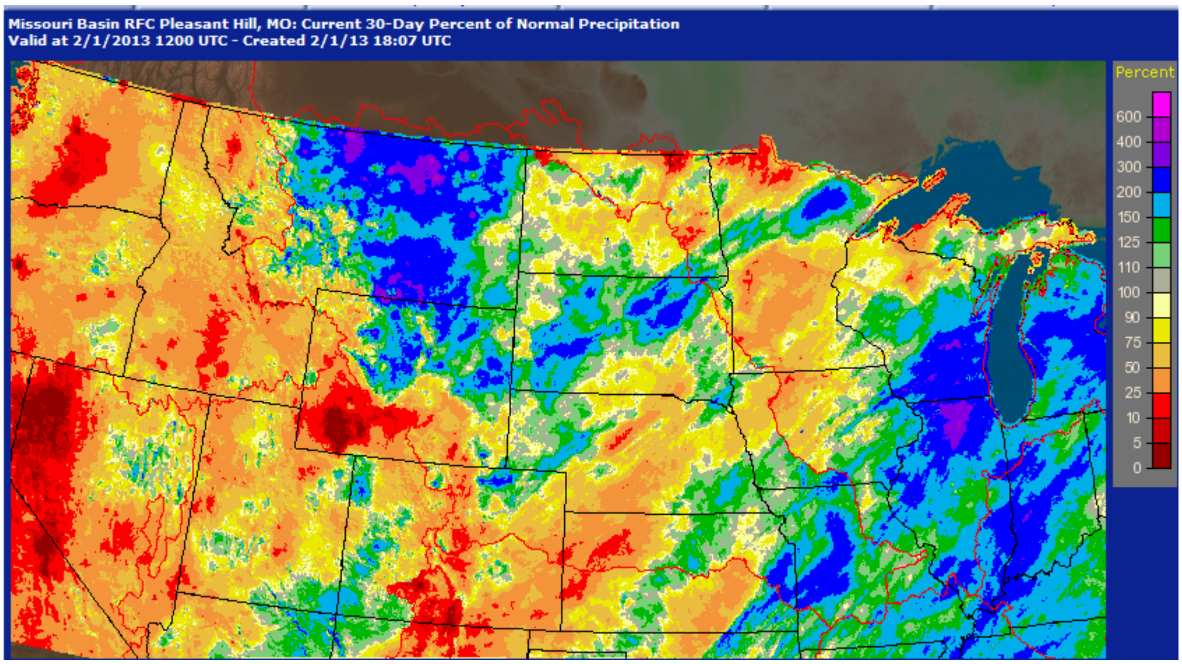

Figure 5. January 2013 Percent of Normal Precipitation.

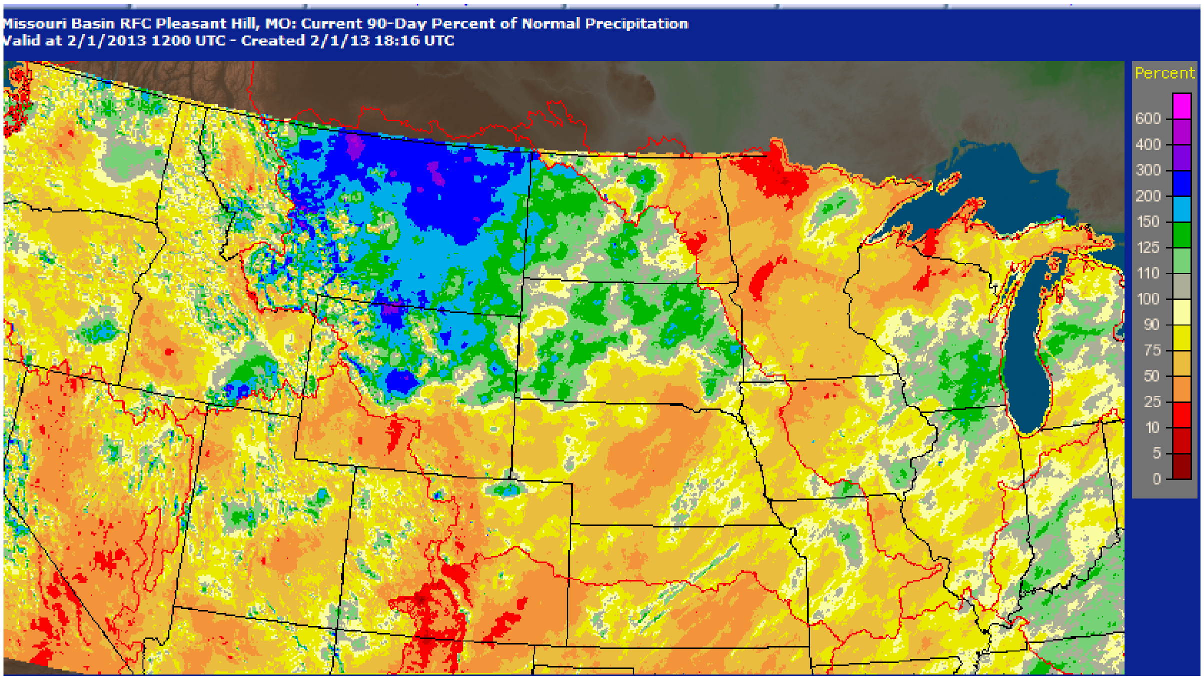

Figure 6. 90-day Percent of Normal Precipitation ending on January 31, 2013.

Temperature

Average temperatures throughout the basin above Sioux City, IA during the month of January 2013 generally ranged from 2 to 3 degrees F above normal (Figure 7).

Ninety-day (90-day) temperature departures ending on February 1, 2013 are shown in Figure 8. The map in this figure indicates that temperatures in Montana and North Dakota have generally ranged from 1 degree F below normal to 2 degrees F above normal for the basin.

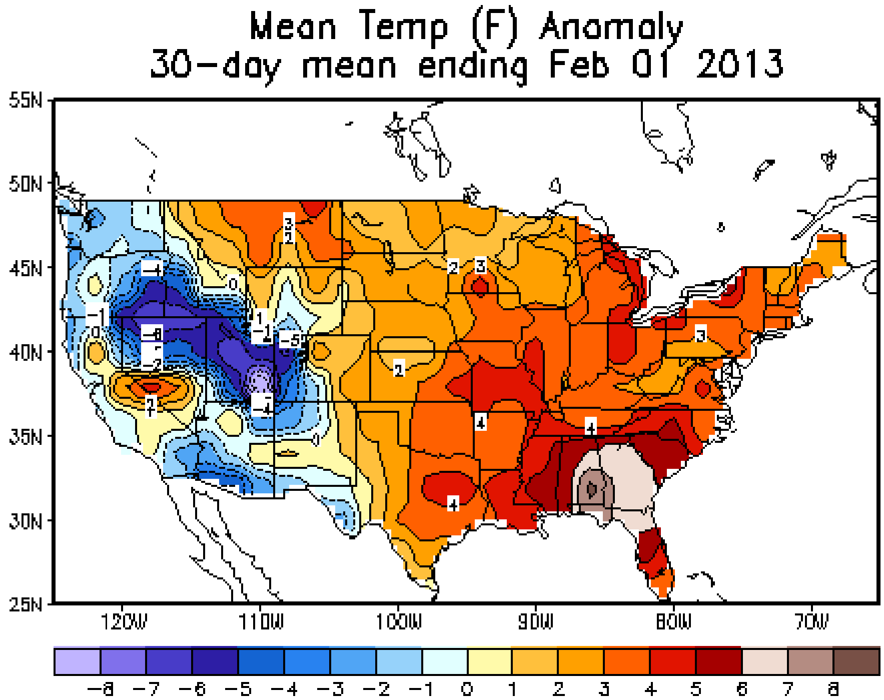

Figure 5. 30-day temperature anomaly (deg F) ending January 31, 2013.

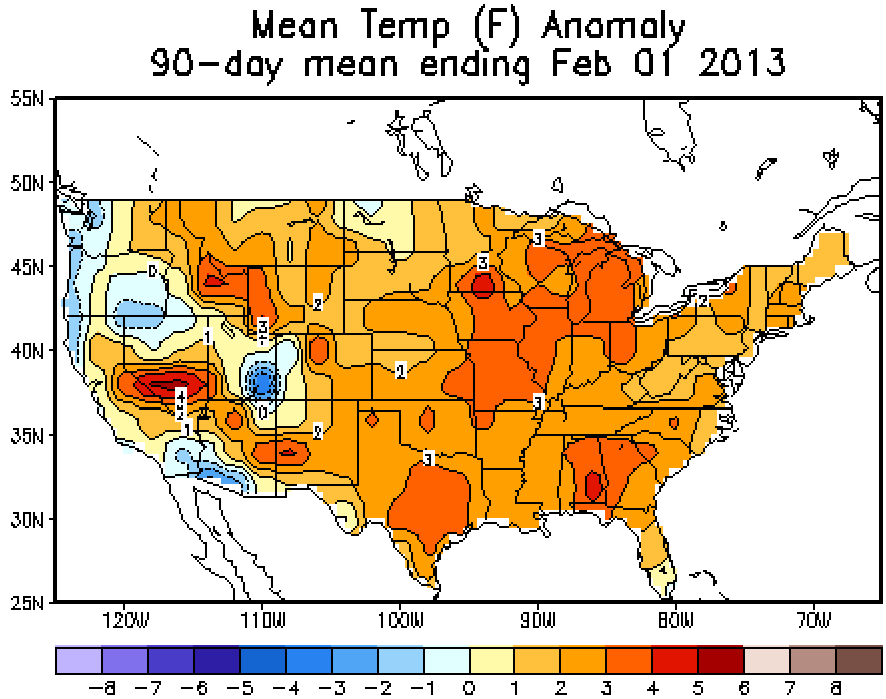

Figure 8. 90-day temperature anomaly (deg F) ending February 1, 2013.

Soil Moisture and Frost Conditions

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 (e.g. baseflow).

Two independent estimates of soil moisture are presented in this report. Figure 9 shows the NOAA Climate Prediction Center's (CPC) calculated soil moisture ranking percentiles for the end of November 2012. Figure 10 shows the University of Washington's Variable Infiltration Capacity (VIC) model soil moisture percentiles.

Both soil moisture rankings depict very dry soil moisture conditions throughout the upper basin, especially in South Dakota, Nebraska, Wyoming and southern Montana. CPC soil moisture conditions in these areas rank from the 5th to the 1st percentile, which are exceptionally dry. In North Dakota and northern Montana, soil moisture ranges from near normal conditions down to the 10th percentile. In comparison, the VIC model depicts very dry soils in the same areas with soil moisture percentiles ranking from the 5th to below the 2nd percentile. In our analysis of the influence of soil moisture on forecast runoff, neither model takes preference over the other. As an indicator of future monthly runoff, soil moisture conditions suggest runoff will be well-below average when considered along with the temperature and precipitation outlooks, which were discussed previously in this forecast discussion.

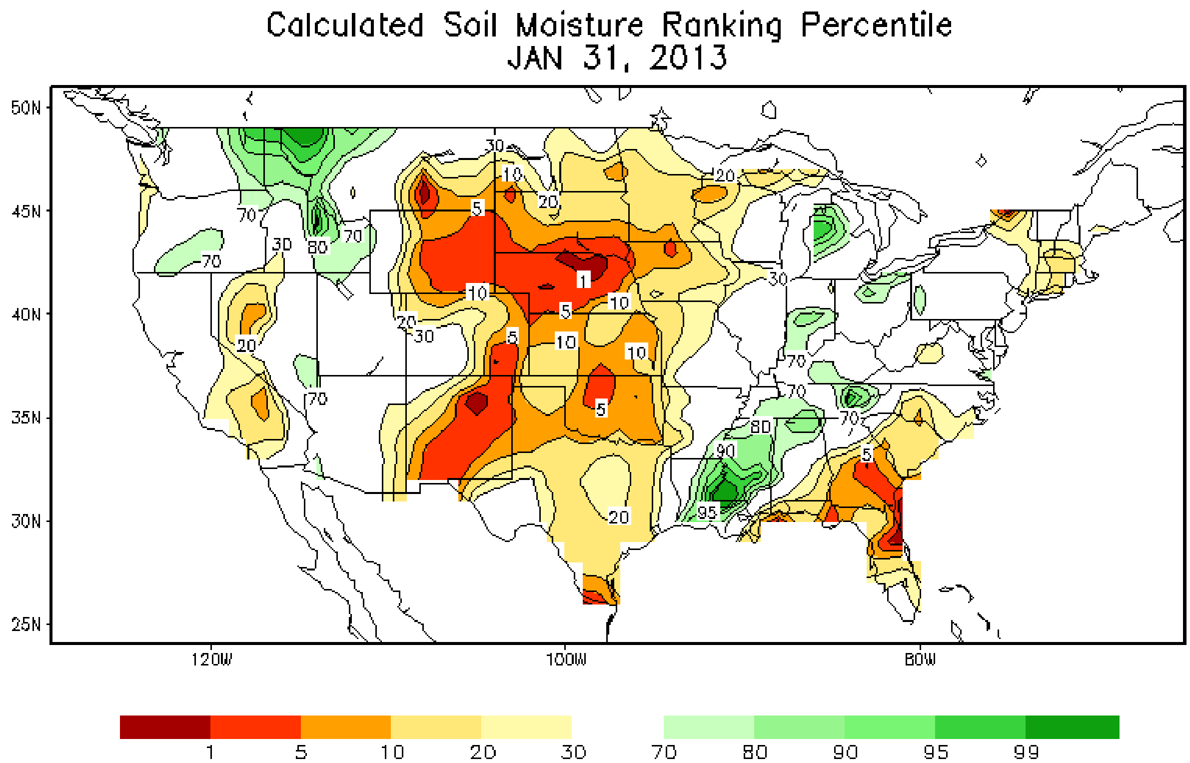

Figure 9. Calculated Soil Moisture Ranking Percentile on January 31, 2013. Source: Climate Prediction Center. http://www.cpc.ncep.noaa.gov/cgi-bin/US_Soil-Moisture-Monthly.sh#

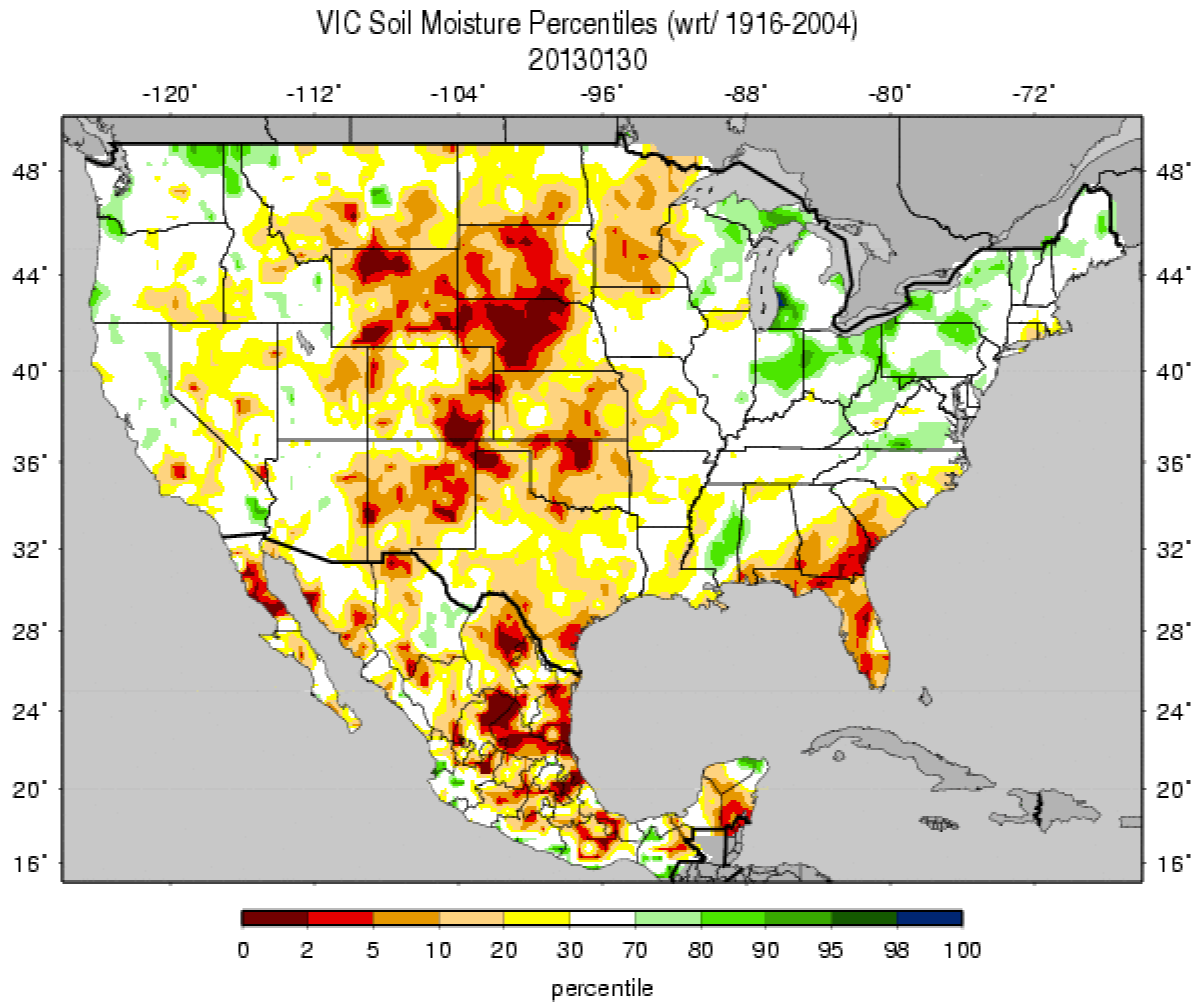

Figure 10. VIC modeled soil moisture percentiles as of December 31, 2012. Source: University of Washington. http://www.hydro.washington.edu/forecast/monitor/curr/conus.mexico/main_sm.multimodel.shtml

The CPC calculated soil moisture anomaly for the contiguous U.S. on January 31, 2013 is shown in Figure 11. According to the analysis, there are widespread negative soil moisture anomalies in the basin; however some areas in Montana and North Dakota have positive anomalies or are normal. Negative anomalies would indicate a soil moisture deficit or negative departure from normal. Negative anomalies range from -20 mm (about 1.0 inch) to –120 mm (about 5 inches) in the upper basin.

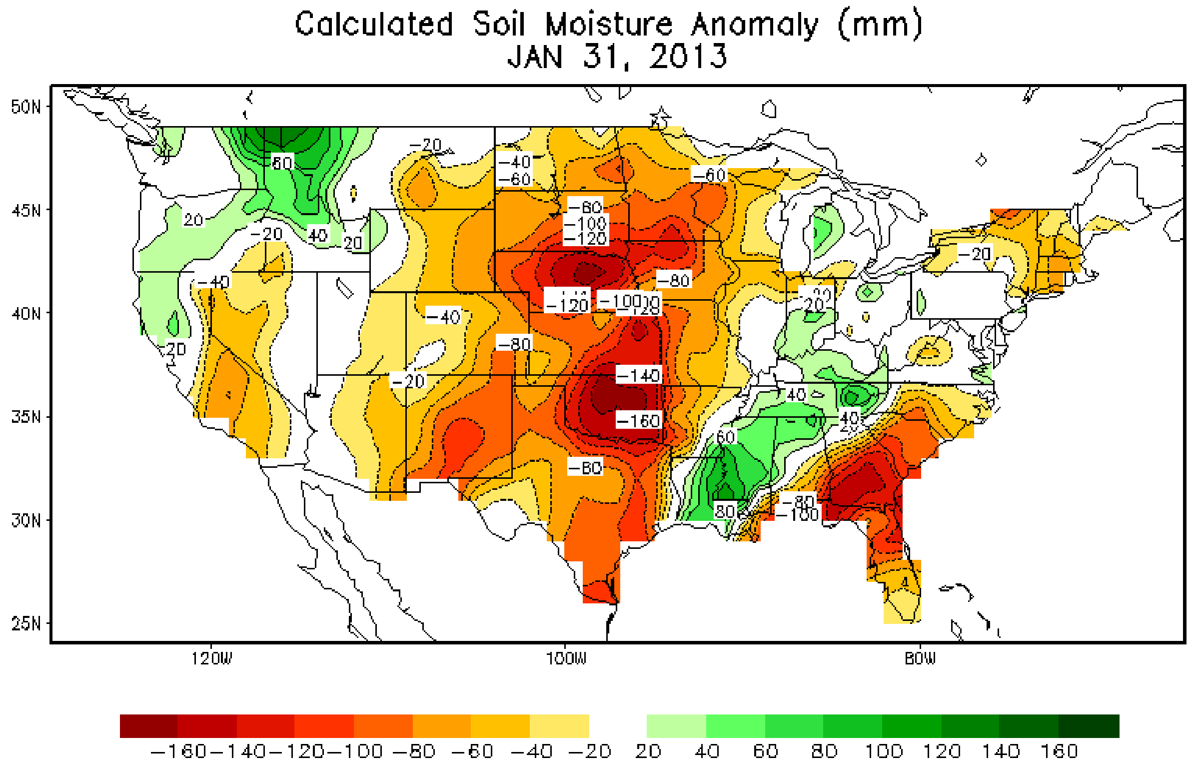

Figure 11. Calculated Soil Moisture Anomaly (bottom) in on 1 January 2013. Source: Climate Prediction Center. http://www.cpc.ncep.noaa.gov/cgi-bin/US_Soil-Moisture-Monthly.sh#

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.

According to the NOAA National Operational Hydrologic Remote Sensing Center (NOHRSC), most plains snow water equivalent (SWE) amounts ranged from trace to 4-inch amounts throughout the upper basin. Amounts ranging from 1 to 2 inches cover a majority of eastern

Montana, North Dakota, and less than half of South Dakota. Amounts less than 1 inch cover all remaining plains areas of the basin, as shown on Figure 12.

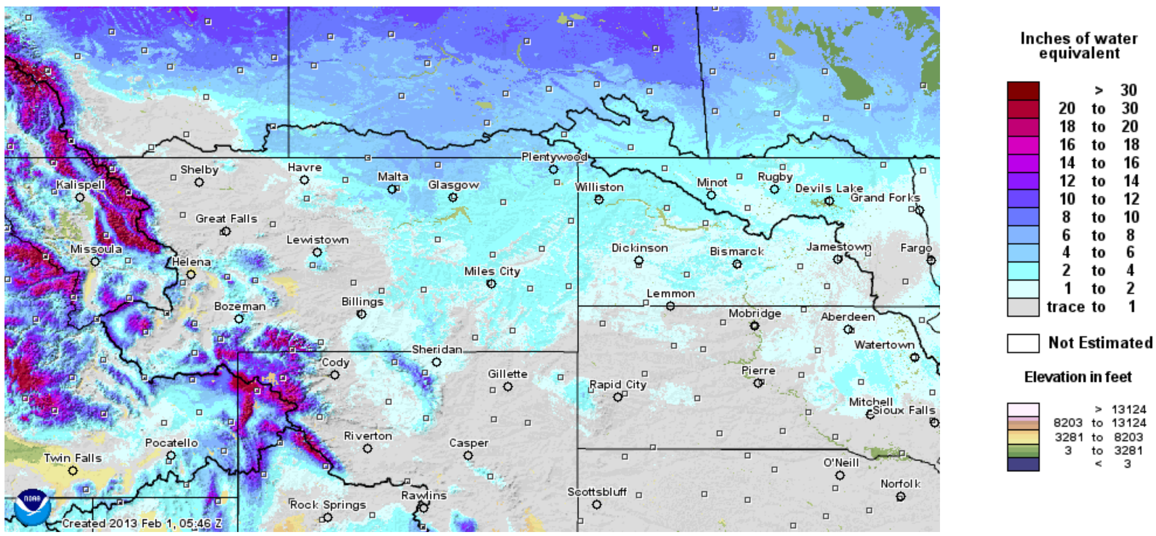

Figure 12 February 1, 2013, NOHRSC modeled plains snow water equivalent. Source: NOAA National Operational Hydrologic Remote Sensing Center. http://www.nohrsc.nws.gov/interactive/html/map.html

Plains snowpack as of February 1, 2013 was classified as predominantly Light across the upper Missouri River basin according to the Corps of Engineers classification methods (Table 1). This classification includes plains snowpack accumulations that fall between the range of 0 to 1 inch of snow water equivalent (SWE) in the Fort Peck, Oahe, Fort Randall and Gavins Point subbasins. In the Garrison and Sioux City subbasins, this includes accumulations ranging from 0 to 2 inches of SWE.

Table 1. January 1, 2012 plains snowpack classification for runoff forecasting.

Reservoir Reach	Plains Snowpack Classification
Above Fort Peck	Light (0 – 1 inch SWE)
Fort Peck to Garrison	Light (0 – 2 inch SWE)
Garrison to Oahe	Light (0 – 1 inch SWE)
Oahe to Fort Randall	Light (0 – 1 inch SWE)
Fort Randall to Gavins Point	Light (0 – 1 inch SWE)
Gavins Point to Sioux City	Light (0 – 2 inch SWE)

Mountain Snow Pack

Mountain snowpack is the primary factor used to predict May-July runoff volumes in the Fort Peck and Fort Peck to Garrison reaches. During the 3-month May-July runoff period, about 50% of the annual runoff enters the mainstem system as a result of mountain snowmelt and rainfall runoff. As of February 1, 2013, (see Figure 13) the Corps of Engineers computed an average mountain SWE in the headwater basin above Fort Peck Dam of 9.4 inches, which is 92% of normal based on the 1981-2010 average SWE for the Fort Peck basin. In the subbasin between Fort Peck Dam and Garrison Dam, the Corps computed an average mountain SWE of 7.3 inches, which is 84% of normal based on the 1981-2010 average SWE for the Fort Peck to Garrison subbasin. Normally by February 1, 64% of the peak snow accumulation has occurred in the mountains.

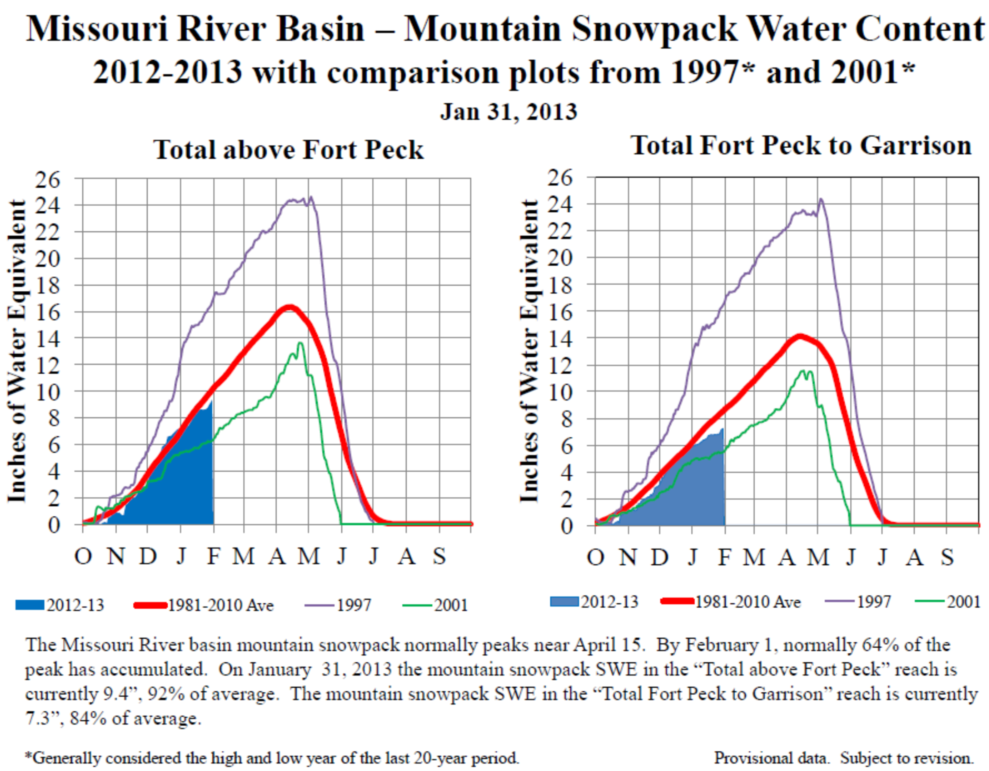

Figure 12. Mountain snowpack water content snow accumulation compared to normal and historic conditions. Corps of Engineers - Missouri River Basin Water Management.

Climate Outlook

The El Nino Southern Oscillation is currently in a neutral phase, which is expected to persist into the spring of 2013. During a neutral phase, there is not a strong indicator of winter weather conditions related to El Nino/La Nina.

The CPC's February outlook (Figure 14) is indicating are equal chances for above, below or normal temperatures warmer than normal throughout the upper basin. With regard to precipitation, there are above normal chances for above normal precipitation in much of North Dakota, and equal chances for above, below or normal precipitation in all other areas.

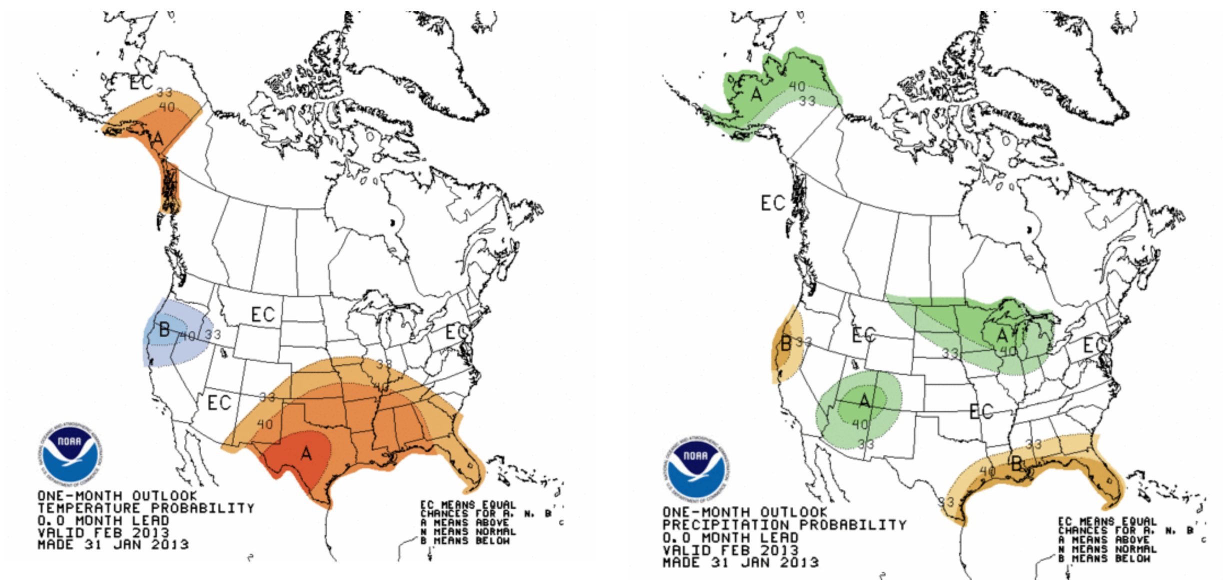

Figure 14. CPC February 2013 temperature and precipitation outlooks.

The CPC's 3-month outlooks (see Figure 15 and 16) are indicating below normal temperatures in eastern Montana and North Dakota and above chances of precipitation for the eastern two-thirds of the upper basin. For the remainder of 2013, the outlook indicates warmer temperatures throughout the basin combined with equal chances of above/below/normal precipitation.

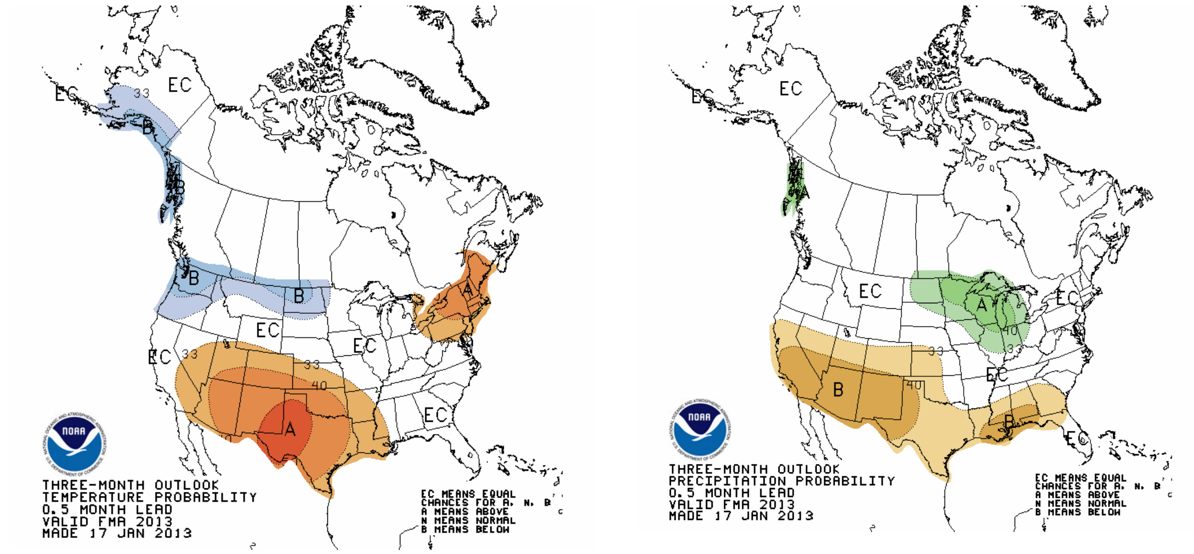

Figure 15. CPC February-March-April 2013 temperature and precipitation outlook.

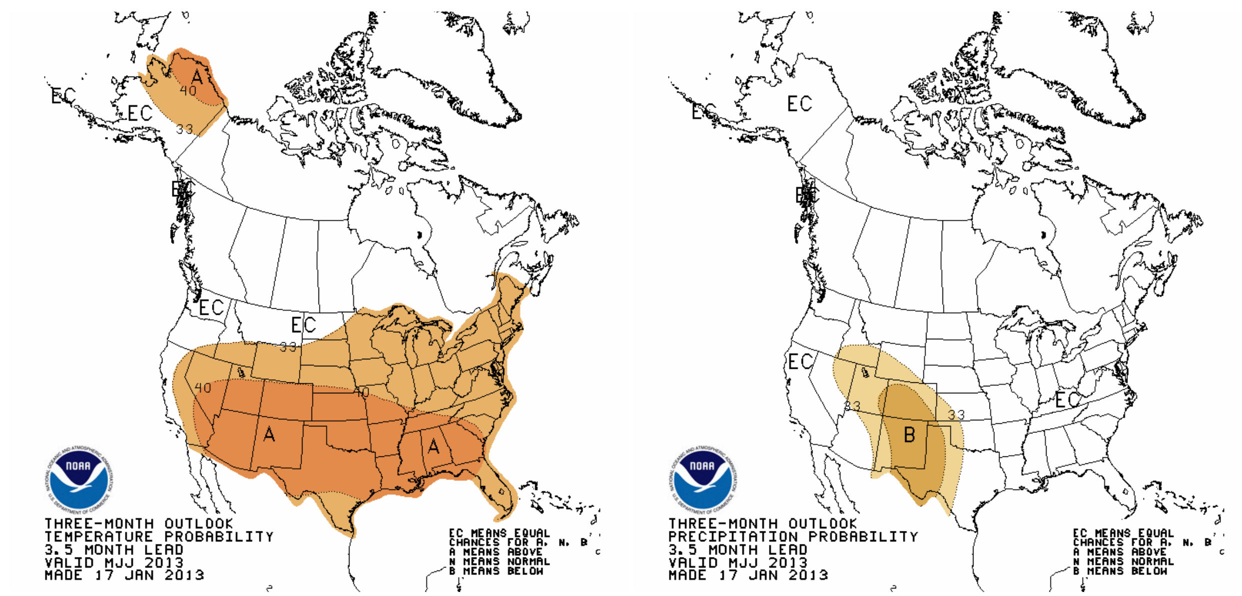

Figure 16. CPC May-June-July 2013 temperature and precipitation outlook.

February 2013 Calendar Year Runoff Forecast

The calendar year runoff forecast is 19.9 MAF (80% of average) above Sioux City and 18.6 MAF (82% of average) above Gavins Point. Due to the amount of variability in precipitation that can occur over the next 12 months, the range of expected inflow is quite large and ranges from the 27.0 MAF upper basic forecast to the 13.6 MAF lower basic forecast. The upper and lower basic forecasts provide a likely range of runoff scenarios that could occur given much wetter conditions or much drier conditions. The upper and lower basic forecasts are used in long-term regulation planning models to "bracket" the range of expected runoff. It should be noted, however, that it is possible, due to either much higher or much lower than forecasted precipitation occurring, that these ranges may be exceeded on either end.

Factors taken into consideration while preparing the 2013 forecast include continuing drought conditions in the upper Missouri River basin, soil moisture content, antecedent precipitation, antecedent temperature conditions, plains snowpack, mountain snowpack, and the CPC's monthly and seasonal temperature and precipitation outlooks.

USDA NRCS National Water & Climate Center

* - DATA CURRENT AS OF: February 04, 2013 07:46:24 PM

- Based on February 01, 2013 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	APR-JUL	97	100	112	103	91	82	97
	APR-SEP	114	102	129	120	108	99	112
St. Mary R at Int'l Boundary (2)	APR-JUL	440	101	540	480	400	340	435
	APR-SEP	500	99	600	540	460	400	505
Lima Reservoir Inflow (2)	APR-JUL	84	102	117	97	71	51	82
	APR-SEP	91	102	129	107	75	53	89
Clark Canyon Reservoir Inflow (2)	APR-JUL	101	100	188	136	66	13.7	101
	APR-SEP	121	101	215	159	83	26	120
Jefferson R nr Three Forks (2)	APR-JUL	650	88	1030	800	500	275	740
	APR-SEP	695	87	1120	865	525	275	800
Hebgen Reservoir Inflow (2)	APR-JUL	360	97	430	390	330	290	370
	APR-SEP	460	98	545	495	425	375	470
Ennis Reservoir Inflow (2)	APR-JUL	595	95	745	655	535	445	625
	APR-SEP	735	95	910	805	665	560	775
Missouri R at Toston (2)	APR-JUL	1690	94	2330	1950	1430	1050	1790
	APR-SEP	1940	94	2700	2250	1630	1180	2070
Smith R bl Eagle Ck (2)	APR-JUL	110	104	163	131	89	57	106
	APR-SEP	122	105	183	147	97	61	116
Gibson Reservoir Inflow (2)	APR-JUL	380	96	475	420	340	285	395
	APR-SEP	420	95	520	460	380	320	440
Marias R nr Shelby (2)	APR-JUL	340	99	520	410	270	161	345
	APR-SEP	345	96	535	420	270	156	360
Milk R at Western Crossing	MAR-JUL	38	103	63	48	28	13.3	37
	MAR-SEP	41	105	68	52	30	14.1	39
	APR-JUL	31	100	53	40	22	9.1	31
	APR-SEP	34	103	58	44	24	9.9	33
Milk R at Eastern Crossing	MAR-JUL	60	107	126	87	33	1.50	56
	MAR-SEP	69	110	141	98	40	1.50	63
	APR-JUL	47	104	101	69	25	1.50	45
	APR-SEP	59	107	120	84	34	1.50	55

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	53	90	61	56	50	45	59
	APR-SEP	68	92	79	72	64	57	74
Wind R ab Bull Lake Ck (2)	APR-JUL	360	90	495	415	305	225	400
	APR-SEP	440	90	580	495	385	300	490
Bull Lake Ck nr Lenore	APR-JUL	126	91	158	139	113	94	139
	APR-SEP	155	92	196	171	139	114	169
Boysen Reservoir Inflow (2)	APR-JUL	495	81	900	660	330	90	610
	APR-SEP	540	81	975	715	365	103	665
Greybull R nr Meeteetse	APR-JUL	122	93	157	136	108	87	131

	APR-SEP	167	94	210	184	150	124	177
Shell Ck nr Shell	APR-JUL	48	87	63	54	42	33	55
	APR-SEP	60	91	76	67	53	44	66
Bighorn R at Kane (2)	APR-JUL	685	82	1200	895	475	167	840
	APR-SEP	735	81	1290	960	510	179	905
NF Shoshone R at Wapiti	APR-JUL	445	97	530	480	410	360	460
	APR-SEP	495	96	585	530	460	405	515
SF Shoshone R nr Valley	APR-JUL	200	93	240	215	183	158	215
	APR-SEP	230	94	275	250	210	183	245
Buffalo Bill Reservoir Inflow (2)	APR-JUL	635	94	775	690	580	495	675
	APR-SEP	700	94	850	760	640	550	745
Bighorn R nr St. Xavier (2)	APR-JUL	1180	86	1790	1430	930	565	1380
	APR-SEP	1250	86	1930	1520	975	570	1460
Little Bighorn R nr Hardin	APR-JUL	65	66	113	84	46	17.1	98
	APR-SEP	73	66	126	94	52	20	111
Tongue R nr Dayton (2)	APR-JUL	65	76	96	78	52	34	86
	APR-SEP	74	76	107	87	61	41	98
Tongue River Reservoir Inflow (2)	APR-JUL	125	65	230	168	82	17.9	193
	APR-SEP	141	66	255	186	96	29	215
NF Powder R nr Hazelton	APR-JUL	10.0	110	12.5	11.0	9.0	7.5	9.1
	APR-SEP	10.9	110	13.5	12.0	9.8	8.3	9.9
Powder R at Moorhead	APR-JUL	152	86	250	193	111	52	177
	APR-SEP	174	89	275	215	132	71	196
Powder R nr Locate	APR-JUL	171	86	295	220	121	47	199
	APR-SEP	195	89	330	250	141	62	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	5.3	85	9.4	7.0	3.6	1.20	6.2
	APR-JUL	4.3	83	7.6	5.5	3.2	1.94	5.2
Pactola Reservoir Inflow (2)	MAR-JUL	21	84	40	29	13.4	2.2	25
	APR-JUL	17.1	78	35	24	11.6	5.5	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	APR-JUL	112	50	230	159	65	15.0	225
	APR-SEP	123	49	250	175	71	20	250
Encampment R nr Encampment	APR-JUL	97	75	143	116	78	51	129
	APR-SEP	103	75	151	122	84	55	138
Rock Ck nr Arlington	APR-JUL	35	71	52	42	28	18.2	49
	APR-SEP	37	71	55	44	30	18.9	52
Seminoe Reservoir Inflow (2)	APR-JUL	395	55	805	560	230	158	715
	APR-SEP	425	55	865	600	250	170	770
Sweetwater R nr Alcova	APR-JUL	31	53	67	46	16.3	2.5	59
	APR-SEP	36	56	75	52	20	4.2	64
North Platte R-Alcova to Orin Gain	APR-JUL	-4.0	-3	134	52	-23	-60	136
	APR-SEP	-1.00	-1	142	57	-23	-59	144
North Platte R bl Glendo Res (2)	APR-JUL	385	47	650	490	280	150	820
	APR-SEP	385	45	665	495	275	150	850
North Platte R bl Guernsey Res (2)	APR-JUL	375	46	705	510	240	150	820
	APR-SEP	390	46	730	530	250	150	850
Laramie R nr Woods	APR-JUL	80	70	119	96	64	41	115
	APR-SEP	88	70	130	105	71	46	126
Little Laramie R nr Filmore	APR-JUL	33	65	52	41	25	14.3	51

APR-SEP	36	65	57	44	28	15.2	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

Additional Figures