INTERMOUNTAIN WEST CLIMATE SUMMARY

A product of the Western Water Assessment

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March 2012 Summary

Temperature & Precipitation — *February temperatures were near-average across most of the region. Nearly all of Colorado and Wyoming saw near-average to above-average precipitation, while most of Utah was much drier than average during February.*

Hydrological Conditions — *Despite substantial accumulations in February in most mountain areas, basin snowpacks across the region were still below average on March 1, except in central and northern Wyoming. Accordingly, the March 1 forecasts call for below-average spring–summer streamflow for nearly all basins. Reservoir storage was generally above average as of the end of February due to the high inflows last year.*

ENSO —*The current La Niña event continues to weaken, and is expected to transition to ENSO-neutral conditions by the end of April. The ensemble of ENSO model forecasts is split between continued neutral conditions and the emergence of an El Niño event by late summer.*

Climate Forecasts — *While La Niña conditions are weakening, they are expected to continue to influence the weather in our region through the spring. The climate outlooks from NOAA CPC call for enhanced odds of warmer and drier conditions for portions of the Intermountain West in April and subsequent periods.*

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Announcements & News

Joint Front Range Climate Change Vulnerability Study released

The Joint Front Range Climate Change Vulnerability Study ('Joint Front Range Study') was a unique collaborative effort between eight water providers along Colorado's Front Range, the Colorado Water Conservation Board, the National Center for Atmospheric Research, Riverside Technology, Inc., the Western Water Assessment, and the Water Research Foundation (primary funding). Its objective was to assess changes in the timing and volume of runoff that might be expected under several climate change scenarios for the years 2040 and 2070 for 18 gage locations across north-central Colorado, by combining the latest climate science with the best available hydrologic simulation capabilities.

The final report for the Joint Front Range Study, published by the Water Research Foundation, provides details of the methodology, the technical findings, and recommendations for application and further research. While streamflows generally declined under most future climate scenarios, there was considerable variation among the scenarios and between the basins represented by the 18 gages. The PDF of the final report is available from the

CWCB's Joint Front Range Study webpage.

Gunnison Basin Climate Change Vulnerability Assessment released

Since 2009, the Gunnison Climate Working Group--a broad partnership of public agencies and private organizations with interests in the resilience of species and ecosystems in Colorado's Gunnison Basin--has worked to develop a climate change vulnerability assessment as one of four landscape-level climate adaptation projects under the Southwest Climate Change Initiative (SWCCI), led by The Nature Conservancy with support from the Western Water Assessment and others. The Working Group used a consensus process to evaluate and rank the vulnerability of 24 ecosystems and 73 species in the Gunison Basin under future climate scenarios for the mid-21st century. Joe Barsugli of WWA helped develop the climate scenarios, and was an author of the final assessment report. Imtiaz Rangwala, then a PACE postdoctoral associate affiliated with WWA, also assisted the Working Group in effectively incorporating climate science into the vulnerability assessment.

The Gunnison Basin Climate Change Vulnerability Assessment Final Report is available as a PDF from the Colorado Natural Heritage Program here, under "2011 Reports".

National Climate Assessment report on climate change in the Southwest open to public comment March 28

The most comprehensive assessment on climate changes, impacts, and adaption strategies for the Southwest will be ready for public review on March 28. In the report, "Assessment of Climate Change in the Southwest United States: A Technical Report Prepared for the U.S. National Climate Assessment," 100 experts—including ten WWA team members—focused on the links between climate, environment, and people in the Southwest, which includes Utah, Colorado, Arizona, New Mexico, Nevada, and California. (See the IWCS Feature Article for October 2011 for more information about the National Climate Assessment.) This report conforms to the Global Change Research Act of 1990, a federal mandate to synthesize climate-related information every four years. The Southwest report will be incorporated into the National Climate Assessment report, to be published in 2013.

Public comments on the report's content can be made online beginning at noon (PDT) Wednesday, March 28, and ending at midnight (PDT) Wednesday, April 11. Learn more at http://swcarr.arizona.edu.

Utah State urban water-use researchers supported by WWA receive top GIS award

Utah State University reseachers Fayek Farag, Christopher Neale, Roger Kjelgren and Joanna Endter-Wada are recipients of the 2012 ESRI Award for Best Scientific Paper in Geographic Information Systems. The team's paper, "Quantifying Urban Landscape Water Conservation Potential Using High Resolution Remote Sensing and GIS," was published in the November 2011 issue of *Photogrammetric Engineering and Remote Sensing*. The research described in the paper was funded primarily by the USDA and also by the Utah Agricultural Experiment Station. The team's research approach uses airborne multispectral imagery of irrigated landscaped areas that, when combined with local reference evapotranspiration data, yielded estimates of water demand. Those estimates were compared in a GIS environment with actual landscape water use by parcel data, obtained from the cities of Layton, West Jordan, and Logan, Utah, to identify specific parcels with higher-than-expected water usage where conservation programs could be targeted.

The USU researchers have continued to refine their approach and have worked with other Utah municipalities and water conservancy districts, with funding from the USDA, the Bureau of Reclamation and the Western Water Assessment. For a PDF of the winning paper or more information about the USU project, please contact Christopher Neale.

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Feature Article

Freshwater use by U.S. power plants: Initial insights into the energy-water nexus

Kristen Averyt, Western Water Assessment

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Focus Article

There is no Focus Article this month.

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Recent Climate Conditions

In February, much of the region experienced near-average temperatures. An area of unusually warm temperatures, up to 8°F above average, centered on northeastern **Utah** and far northwestern **Colorado**, while unusually cold temperatures gripped a portion of northeastern **Colorado** and parts of central **Wyoming**. (Figures RC-1 and RC-2).

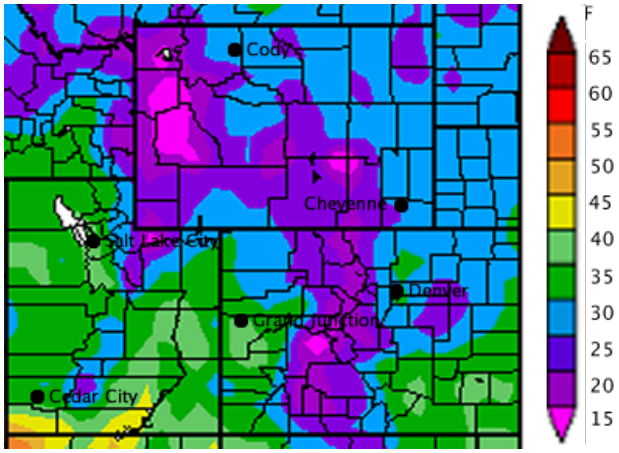

Figure RC-1. Average temperature for the month of February 2012 in °F. (Source: High Plains Regional Climate Center)

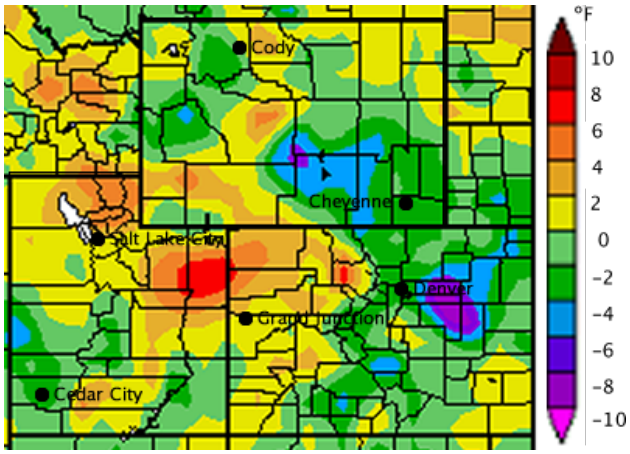

Figure RC-2. Departure from average temperature for the month of February 2012 in °F. (Source: High Plains Regional Climate Center)

February precipitation was ample across most of **Colorado** and **Wyoming**, with more than 3" of snow-water-equivalent falling in many mountain areas. While the total amounts were lower, much of eastern **Colorado** and southern and eastern **Wyoming** received 150% or more of average precipitation, largely due to a record-breaking snowstorm early in the month. **Utah**, however, did not benefit as much from these systems in February, seeing less than 60 percent of average precipitation across large swaths of the state, especially in the northwest and southwest. (Figures RC-3 and RC-4). For the water-year-to-date, well-above-average precipitation has occurred just east of the mountain front in **Colorado**, in portions of southwest **Colorado**, in far southeastern **Wyoming**, and in the basins of western **Wyoming**. Conversely, nearly all of **Utah**, western **Colorado**, and far eastern **Colorado** has been much drier than average since last October (Figure RC-4b).

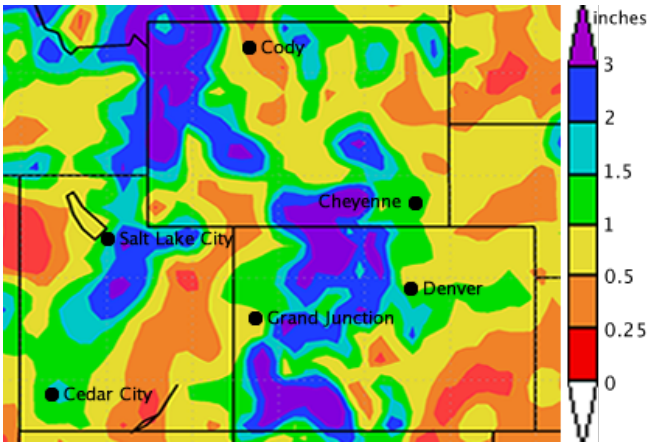

Figure RC-3. Precipitation for the month of February 2012 (inches). (Source: Gary Bates, NOAA ESRL Physical Science Division)

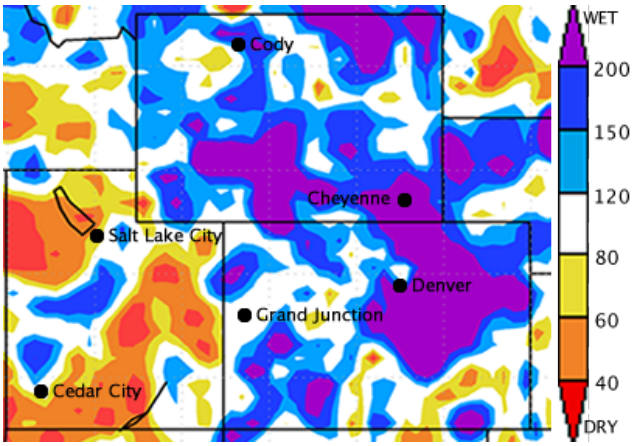

Figure RC-4. Precipitation for the month of February 2012 as percent of average precipitation for February. (Source: Gary Bates, NOAA ESRL Physical Science Division)

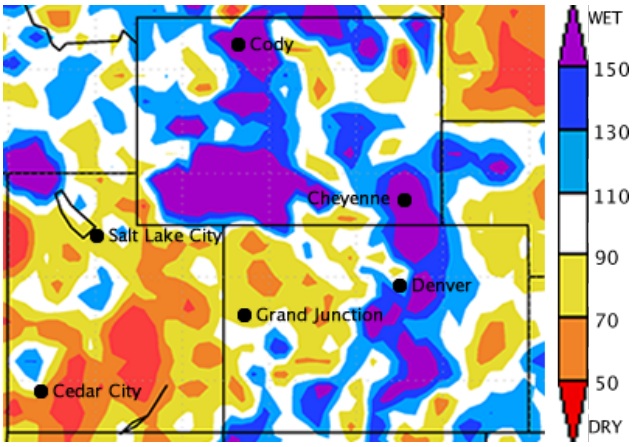

Figure RC-4b. Precipitation for water year 2012 to-date (October–February 2012) as percent of average precipitation for October–February. (Source: Gary Bates, NOAA ESRL Physical Science Division)

The 3-month SPI (Figure RC-5) reflects that many parts of the region received relatively low precipitation from December through February. Western **Colorado** and southwestern **Wyoming** are moderately dry, while northern and western **Utah** are very dry. On the other hand, the Platte River basins in north-central **Colorado** are very wet, as are portions of northeastern **Wyoming**.

The 36-month SPI (Figure RC-6) shows that longer-term precipitation trends have been more favorable to the

three-state region. Near-normal conditions appear across much of **Colorado**, **Wyoming**, and **Utah**. Northeastern **Colorado**, northern **Utah**, and much of central **Wyoming** are all moderately wet over the past 36 months, while southeastern **Wyoming** is very wet. On the other hand, the Rio Grande basin in south-central **Colorado** is moderately dry for the same time period.

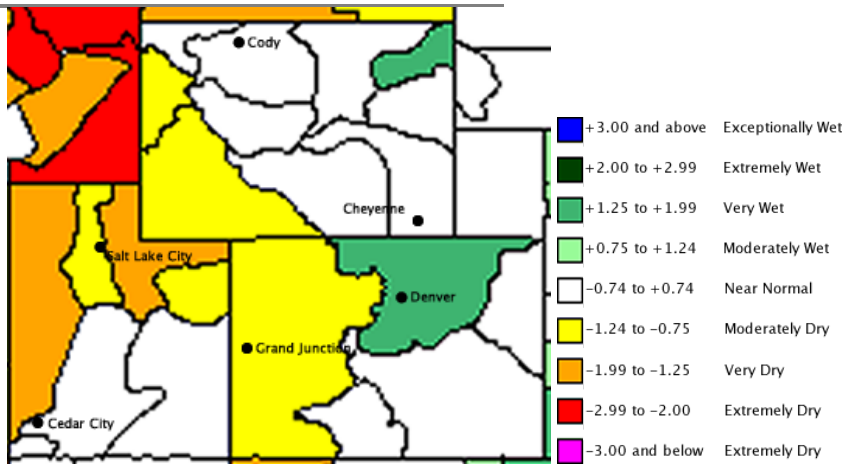

Figure RC-5. 3-month Intermountain West regional Standardized Precipitation Index as of the end of February 2012 (data from 12/01/11–2/28/12). (Source: Western Regional Climate Center)

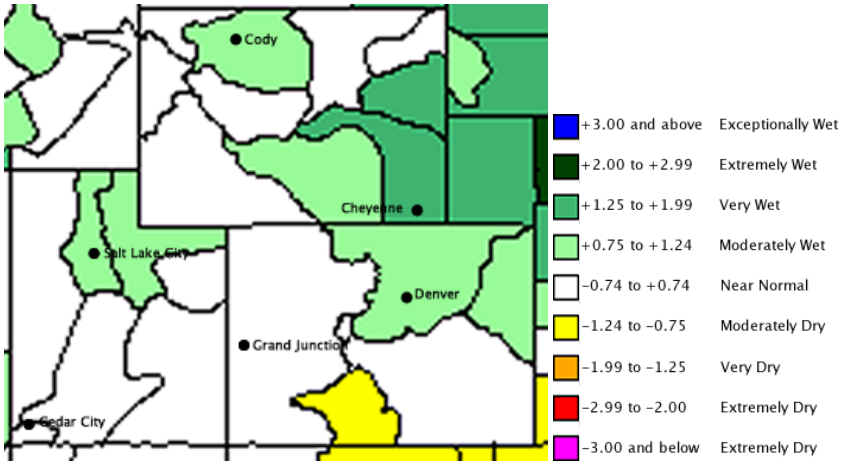

Figure RC-6. 36-month Intermountain West regional Standardized Precipitation Index as of the end of February 2012 (data from 3/01/09–2/28/12). (Source: Western Regional Climate Center)

The U.S. Drought Monitor issued March 13 (Figure RC-7) indicates continued abnormal dryness and drought across much of **Colorado** and **Utah**. Moderate (D1) and severe (D2) drought persists across much of northwestern and southeastern **Colorado,** and central **Utah**. Drought in the southern portion of **Utah's** Wasatch Front has worsened since the end of January, now showing D2 conditions. Only small portions of southwestern **Wyoming** show abnormally dry (D0) conditions, while the rest of the state is free of dry conditions.

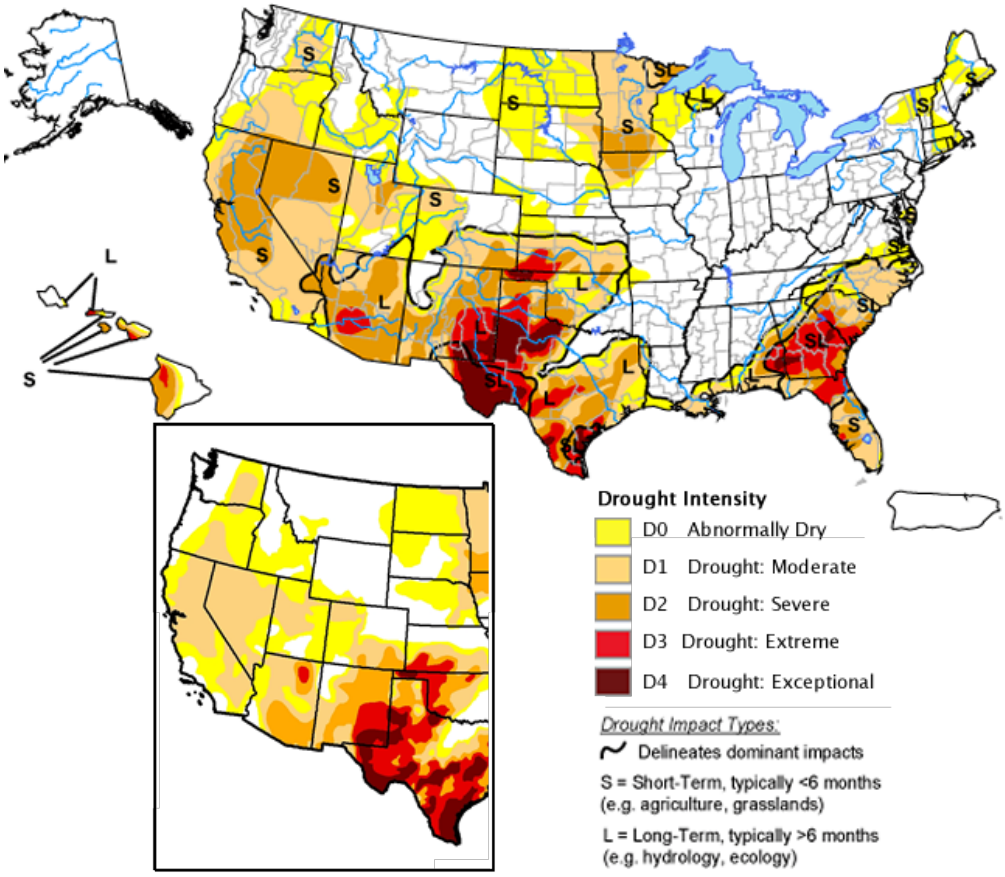

Figure RC-7. U.S. Drought Monitor from March 13, 2012 (full size) and January 31, 2012 (inset, lower left) for comparison. (Source: National Drought Mitigation Center)

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Intermountain West Snowpack

March 1 snowpacks (as measured by snow-water equivalent) in the three-state region were below to much below the long-term average in almost all basins in the region, with the only exception being above-average conditions in portions of northern and eastern **Wyoming** (Figure SP-1).

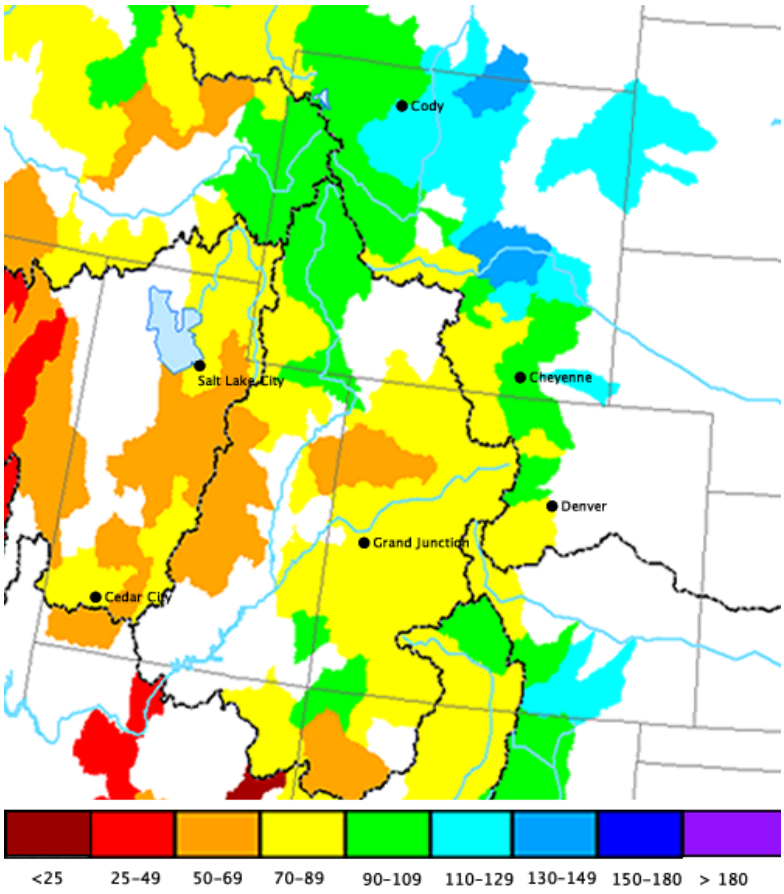

Figure SP-1. Snow water equivalent (SWE) as a percent of average for available SNOTEL and snow course sites, averaged across each basin, in the Intermountain West as of March 1, 2012. (Source: Natural Resources Conservation Service)

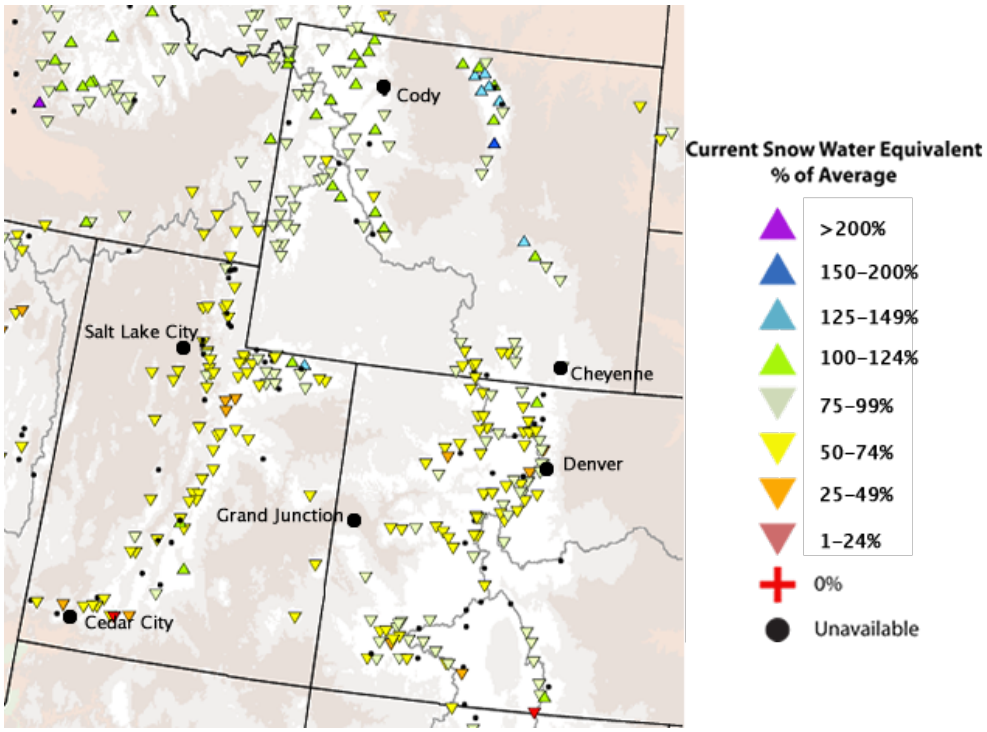

Figure SP-2. Current snow water equivalent (SWE) as a percent of average for individual SNOTEL sites as of March 19, 2012. (Source: Natural Resources Conservation Service)

In **Colorado**, March 1 snowpacks were below average in all basins. February's wetter weather helped improve conditions in most basins, bringing the statewide total from 72% of average on February 1st to 81% on March 1st. February precipitation was 111% of average statewide, with only the Arkansas and Colorado basins reporting slightly below-average accumulation. Basinwide snowpack percentages ranged from a high of 89% on the South Platte to 74% in the Yampa and White.

Utah statewide snowpack on March 1, in sharp contrast to last year, was the lowest of the three-state region, at 72% of average. Major basins ranged from 62% in southeast Utah to 78% in the Uintas. Conditions improved somewhat over January and February, with statewide monthly precipitation still below average at 92% and 86%, respectively, but not nearly as dry as December. Unlike on January 1st, no sites reported record low snowpack on March 1st.

Wyoming snowpacks were slightly above average for March 1st, at 107% statewide. January precipitation was somewhat below average, but highly variable across the state, and February precipitation was above average in most of the state and much above average in northeastern basins. As a result, the northeastern basins reported March 1 snowpack of 127% of average, while the southwest basins were at 86% of average.

Snowpack update, March 19. Thus far in March, nearly all basin snowpacks in the region have lost ground relative to average conditions, reversing the gains made in February. The first two weeks of the month were very dry across the region, except for southwestern **Utah**. A potent storm finally brought significant moisture, at least to the southern part of the region, on March 18th and 19th. As of March 19th, the majority of SNOTEL sites in **Colorado** and **Utah** were in the 50-74% of average category, with only a few sites above average, while sites in **Wyoming** were generally closer to average, or above-average (Figure SP-2).

[Much of the text in this section comes from the NRCS State Basin Outlook Reports: http://www.wcc.nrcs.usda.gov/cgibin/bor.pl.]

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Spring and Summer Streamflow Forecasts for the 2011 Runoff Season

The spring and summer streamflow forecasts issued on March 1 call for below-average to much-below-average April-July runoff for most of the region including southern **Wyoming**, most of **Colorado**, and all of **Utah**. Forecasts for northern **Wyoming**, and portions of the South Platte and Upper Rio Grande in **Colorado** are for near-average runoff conditions (Figure STRM-1). The inflow to Lake Powell is forecasted to be 67% of average (based on 1971–2000; see below). Since the initial WY 2012 streamflow forecasts were released in January, the streamflow outlook has remained fairly consistent, or improved slightly, in most of the region.

Important note about "percent of average": The coordinated streamflow forecasts provided in the IWCS are taken from NRCS State Basin Outlook Reports and use the 1971–2000 period for calculating the percent of average, while the NOAA NWS Colorado Basin River Forecast Center (CBRFC) this year has switched to the 1981–2010 period for calculating the percent of average for the same coordinated forecasts. Since the 1970s were wetter than the 2000s, the NRCS baseline is generally higher than CBRFC's for a given gage, and thus the NRCS-reported % of average will generally be *lower* than the CBRFC-reported % of average for the same volume forecast. For example, the coordinated March 1 forecast for April–July Lake Powell inflow is for 5300 KAF, which NRCS calculates as 67% of average (1971–2000), while CBRFC calculates it as 74% of average (1981–2000).

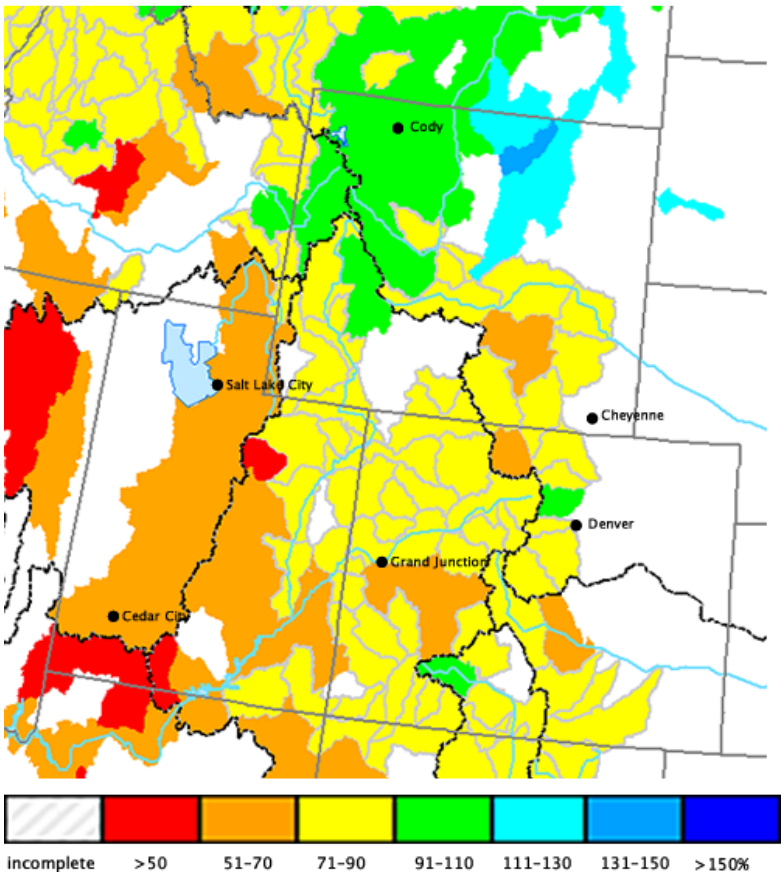

Figure STRM-1. NRCS outlook for natural streamflows for spring and summer in the Intermountain West region as a percent of average streamflows (data through March 1, 2012). (Source: Natural Resource Conservation Service)

In **Colorado**, March 1 streamflow forecasts are for below-average flow throughout the state. February saw significant increases in forecasts in the southwest and northwest portions of the state due to above-average precipitation in these areas. In most of the state, forecasted April–July runoff is in the range of 75 to 85% of average, with somewhat worse conditions in the headwater tributaries of the Gunnison and South Platte. The highest forecasted flows are for the northeastern portion of the Rio Grande and lower South Platte, though these flows are still expected to be slightly below average.

Utah streamflow March 1 forecasts are for below-average to much-below-average runoff throughout the state. Most forecasts are the 50% to 80% of average range, with the highest in the eastern Uinta Basin and the rest of the state closely competing for the "lowest" category. Soil moisture conditions have dried out significantly in the past few months, to near average in the southern half of the state and below average in the northern half.

Wyoming March 1 streamflow forecasted flows are considerably higher than in Colorado and Utah at 93% of average statewide. The forecasts range from over 120% of average flow on the Powder, Tongue, and Belle Fourche river basins to about 70% of average for the Upper North Platte and Upper Bear rivers. Overall, runoff conditions are more favorable to the north and east and less favorable to the south and west.

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Reservoir Supply

March is typically the last full month for snowpacks to receive a boost in accumulation before warmer temperatures commence the spring runoff, and reservoirs begin to fill. As of the end of February, levels in key reservoirs across the region were generally above-average for the date, and above their levels from last year (Figure RES-1). In particular, the high inflows last spring and summer in much of region led to large improvements

in storage in Lake Powell (from 53% to 64% full) and Bear Lake (from 33% full to 76% full), respectively, relative to one year ago.

	RESERVOIR	current storage (af)	capacity (af)	% full	% of average for 2/28
COLORADO	Dillon Reservoir	247,557	257,304	96%	113%
	Turquoise Lake	80,780	129,390	37%	59%
	Lake Granby	431,831	539,758	80%	144%
	Blue Mesa	533,005	829,500	64%	119%
	Pueblo	242,039	330,664	73%	123%
UTAH	Strawberry	974,800	1,106,500	88%	153%
	Utah Lake	895,000	870,900	103%	108%
	Bear Lake	993,600	1,302,000	76%	134%
	Lake Powell	15,452,603	24,322,000	64%	76%
WYOMING	Fontenelle	125,885	344,800	37%	81%
	Flaming Gorge	3,293,000	3,749,000	84%	113%
	Seminoe	845,778	1,017,273	73%	188%
	Boysen	648,184	741,594	81%	113%
	Buffalo Bill	442,035	644,126	68%	109%

Figure RES-1. End-of-month contents of selected large reservoirs in the Intermountain West Region."Current Storage" reflects contents as of February 29, 2012. Reservoir data are shaded according to the "% of Average" value as follows: green: >90% of average; light green: 60–89%; yellow: 40–59%; orange: 20–39%; red: 0–19%

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ENSO Status and Forecast

Since January 2012, negative (cold) anomalies in sea surface temperature have further diminished in the central and eastern Pacific, and anomalies have become positive (warm) in portions of the far eastern Pacific, indicating the continued weakening of the current La Niña (Figure EN-1). According to the latest NOAA ENSO diagnostic discussion, the La Niña event is expected to transition to ENSO-neutral conditions by the end of April.

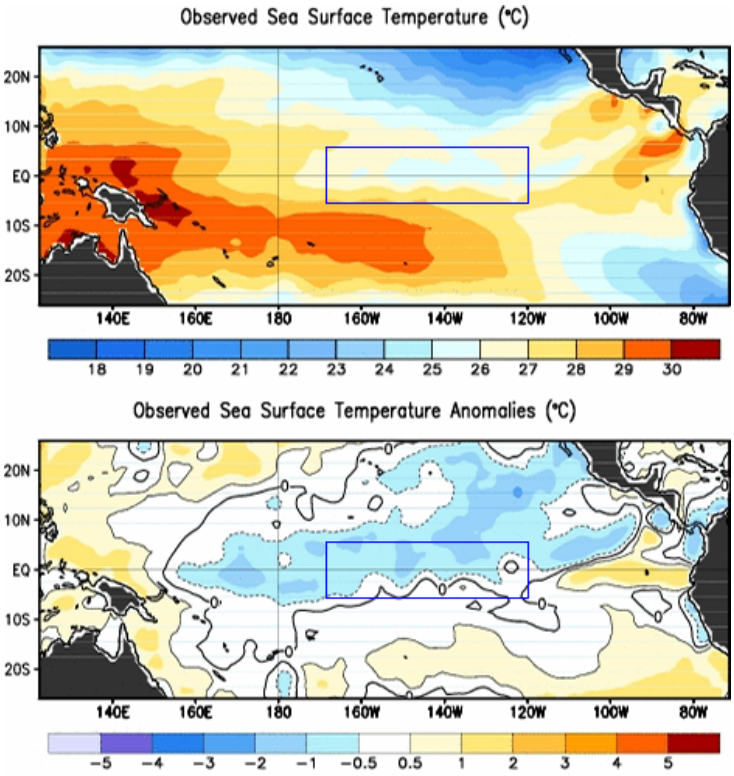

Figure EN-1. Observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. The Niño 3.4 region encompasses the area between 120°W–170°W and 5°N–5°S (blue outline). The graphics represent the 7-day average centered on March 7, 2012. (Source: NOAA Climate Prediction Center)

Across a broad set of dynamical and statistical ENSO forecast models compiled in mid-March, the vast majority of models indicate ENSO-neutral conditions occurring by April–June 2012 (Figure EN-2), with most models also indicating that these neutral conditions will persist through the summer. A minority of the models indicate the emergence of El Niño conditions by the end of the summer.

The NOAA ENSO Diagnostic Discussion will be updated on the first Thursday of April 2012.

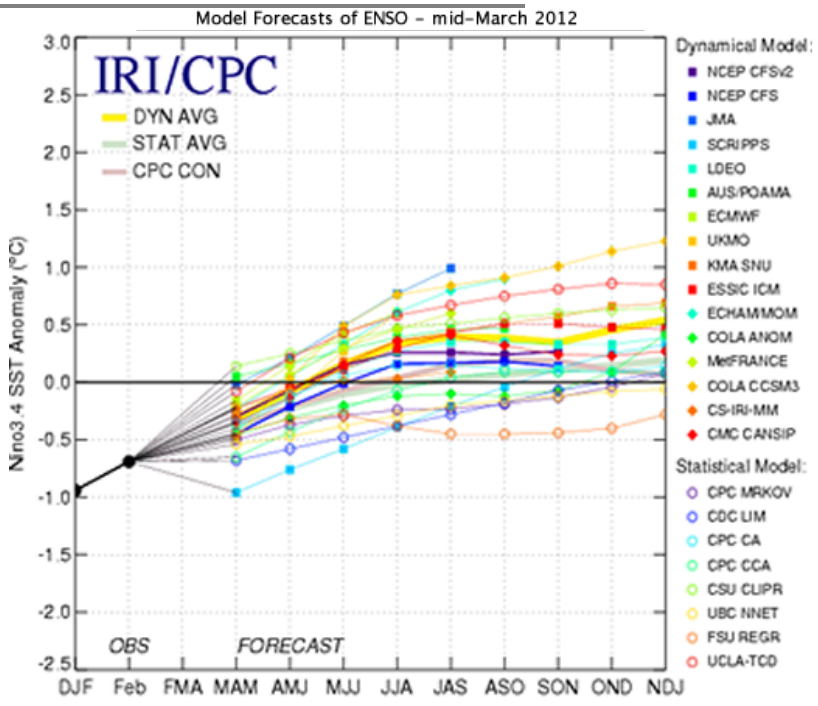

Figure EN-2. Forecasts made by dynamical and statistical models for sea surface temperatures (SST) in the Niño 3.4 region for nine overlapping 3-month periods from March–May 2012 to November 2012–January 2013 (released March 15, 2012). (Source: International Research Institute (IRI) for Climate and Society)

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Temperature Outlook
April–August 2012 (Released March 15, 2012)

The latest temperature outlooks from the NOAA Climate Prediction Center indicate enhanced odds of above-average temperatures for April 2012 across most of the U.S., including almost all of the Intermountain West (Figure TEMP-1). In April–June and subsequent seasons, the enhanced odds of warmer-than-average temperatures shifts to the south overall, but continues to cover most of our region, with the highest odds in southern Utah and southwest Colorado (TEMP-2 through TEMP-4). These outlooks for our region are consistent with the typical spring influence of La Niña conditions; even though the La Niña event is weakening, its effects are expected to persist due to its prior impacts (i.e., drying) on soil moisture.

Note: These climate outlooks are intended for use prior to the start of their valid period (in this case, prior to the beginning of April). Within any given valid period, observations and NWS short- and medium-range forecasts should be consulted. The April 2012 temperature forecast will be updated on March 31st on the CPC web page. This "zero-lead" monthly update will incorporate information from the short range numerical weather prediction models and the latest monthly predictions from the Climate Forecast System models. The Seasonal Outlooks are updated on the third Thursday of the month, and the next one will be issued on April 19th.

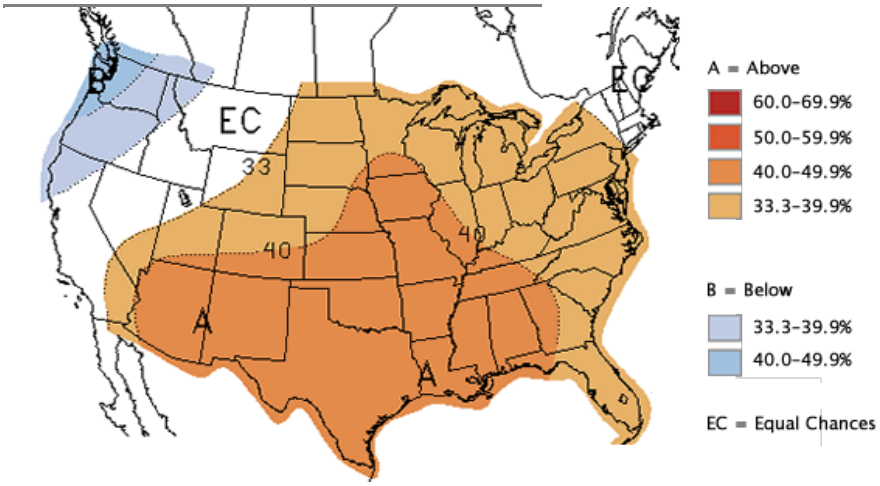

Figure TEMP-1. Long-lead national temperature forecast for April 2012. (Source: NOAA Climate Prediction Center)

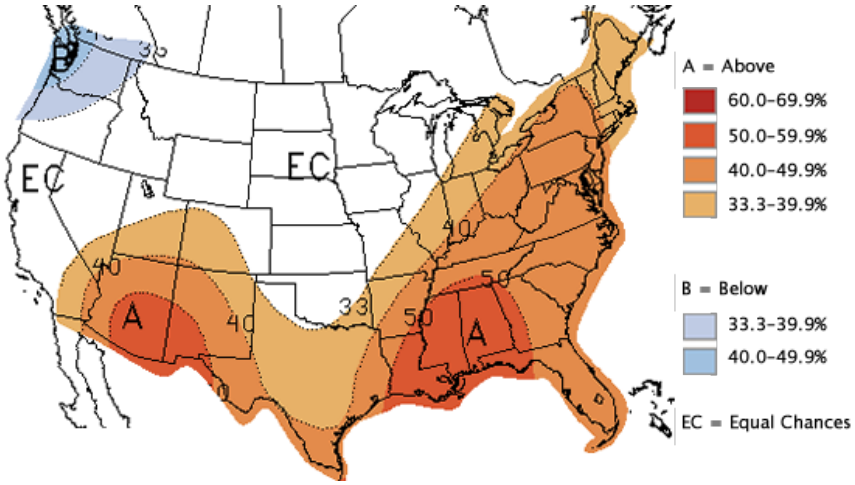

Figure TEMP-2. Long-lead national temperature forecast for April–June 2012. (Source: NOAA Climate Prediction

Center)

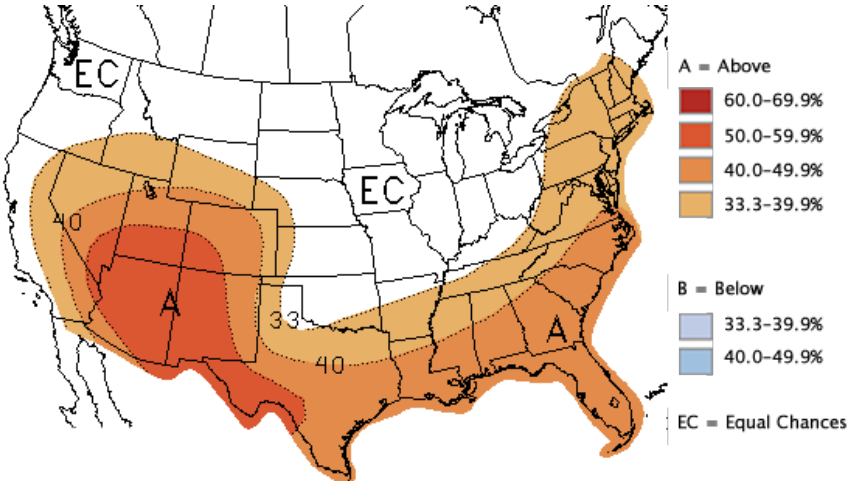

Figure TEMP-3. Long-lead national temperature forecast for May–July 2012. (Source: NOAA Climate Prediction Center)

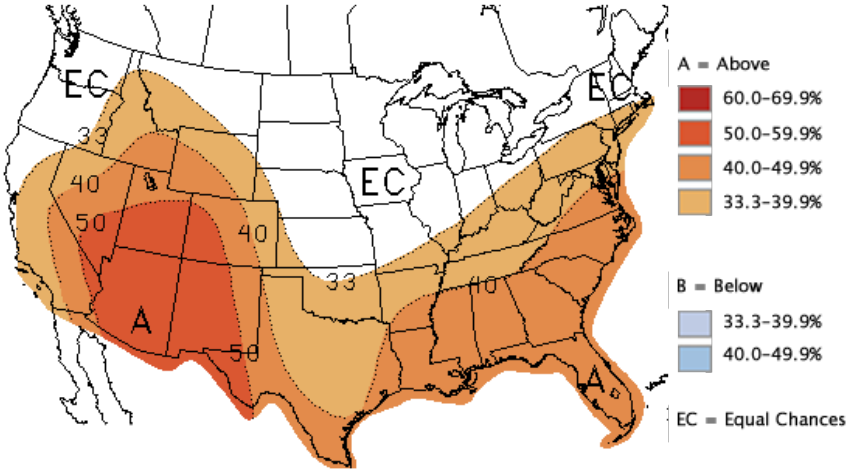

Figure TEMP-4. Long-lead national temperature forecast for June–August 2012. (Source: NOAA Climate Prediction Center)

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Precipitation Outlook
April–August 2012 (Released on March 15, 2012)

The CPC precipitation outlook for April 2012 shows an enhanced odds of below-average precipitation for the Southwest, extending into **Colorado** and southern **Utah** (Figure PPT-1). For the April–June season, the area of enhanced odds of drier-than-average conditions shifts northward, covering all of **Utah** and **Colorado**, and southern **Wyoming**. (Figure PPT-2). For the summer seasons, (Figures PPT-3 and PPT-4) this area continues to shift north, with portions of **Wyoming** forecasted to have an enhanced odds of drier conditions. As with temperature, the precipitation outlooks for our region through June reflect the continuing, albeit weakening, influence of La Niña conditions.

Note: these climate outlooks are intended for use prior to the start of their valid period (in this case, prior to the beginning of April). Within any given valid period, observations and NWS short- and medium-range forecasts should be consulted. The April 2012 precipitation forecast will be updated on March 31st on the CPC web page. This "zero-lead" monthly update will incorporate information from the short range numerical weather prediction models and the latest monthly predictions from the Climate Forecast System models. The Seasonal Outlooks are updated on the third Thursday of the month, and the next one will be issued on April 19th.

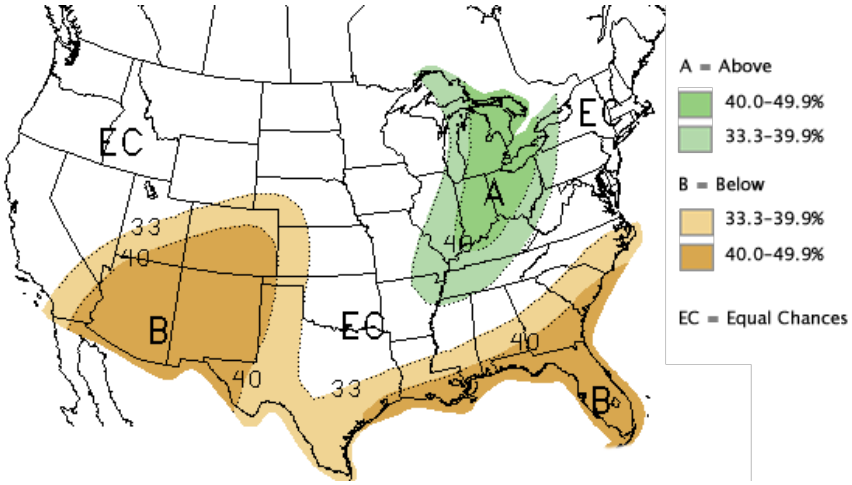

Figure PPT-1. Long-lead national precipitation forecast for April 2012. (Source: NOAA Climate Prediction Center)

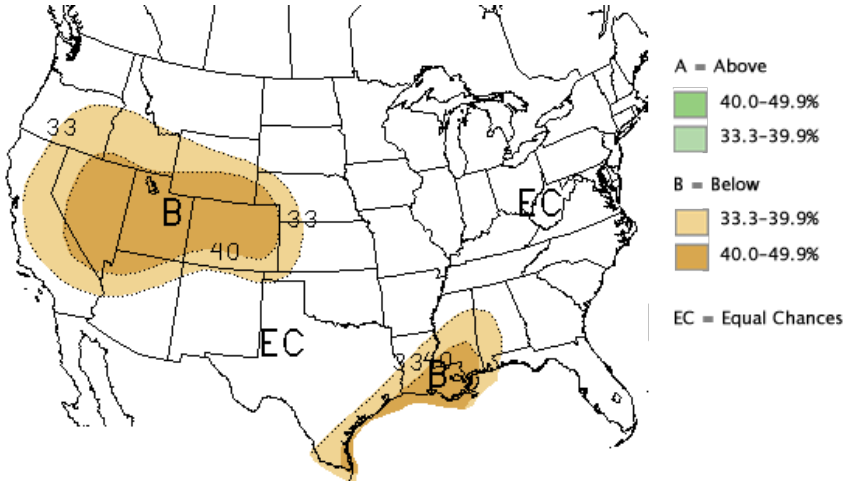

Figure PPT-2. Long-lead national precipitation forecast for April–June 2012. (Source: NOAA Climate Prediction Center)

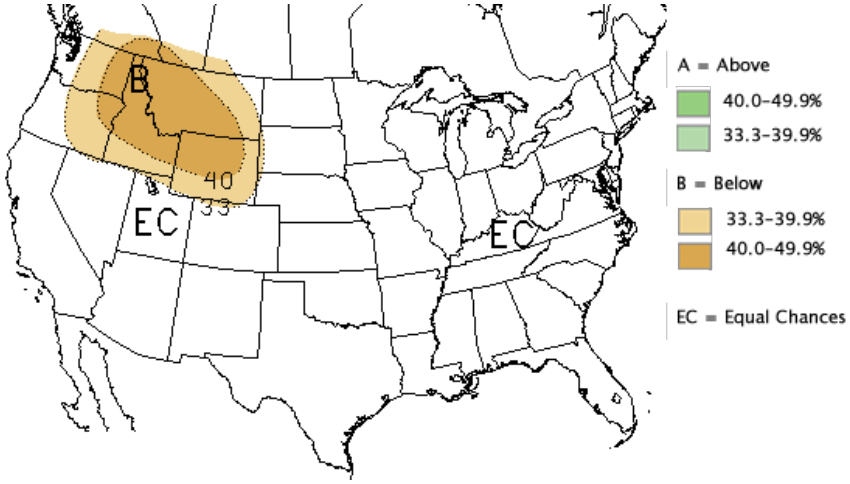

Figure PPT-3. Long-lead national precipitation forecast for May–July 2012. (Source: NOAA Climate Prediction Center)

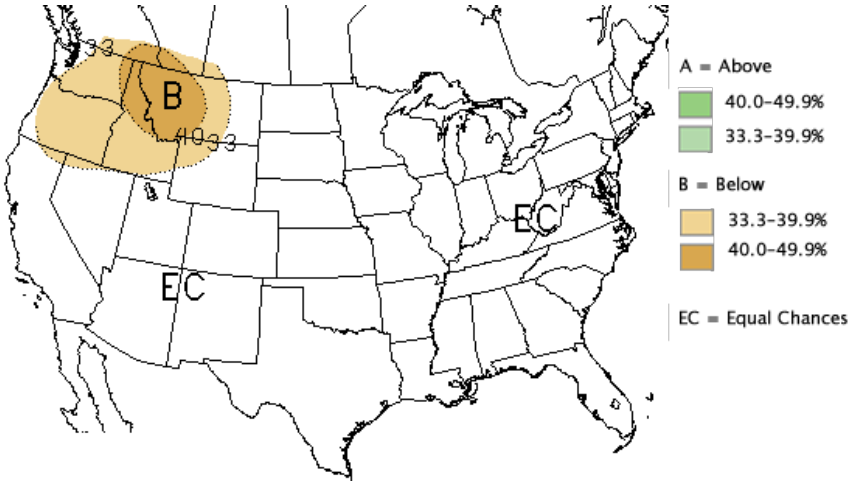

Figure PPT-4. Long-lead national precipitation forecast for June–August 2012. (Source: NOAA Climate Prediction Center)

According to the experimental PSD Precipitation Forecast Guidance, (Figure PPT-5), the outlook for April–June is dry for southwestern and far northeastern Colorado, neutral in the eastern plains of Colorado (i.e., enhanced chances for the middle tercile of precipitation), and equal chances for rest of Colorado, consistent with a spring in which La Niña transitions to ENSO-neutral conditions. Northern Utah has a plus sign, indicating a slight tilt towards wetness, with neutral in southwestern Utah, and equal chances elsewhere. If an El Niño were to develop quickly this spring (as happened in 2009), there would be a better chance for enhanced moisture, but the odds of rapid El Niño are quite low, according to the Forecast Guidance Executive Summary.

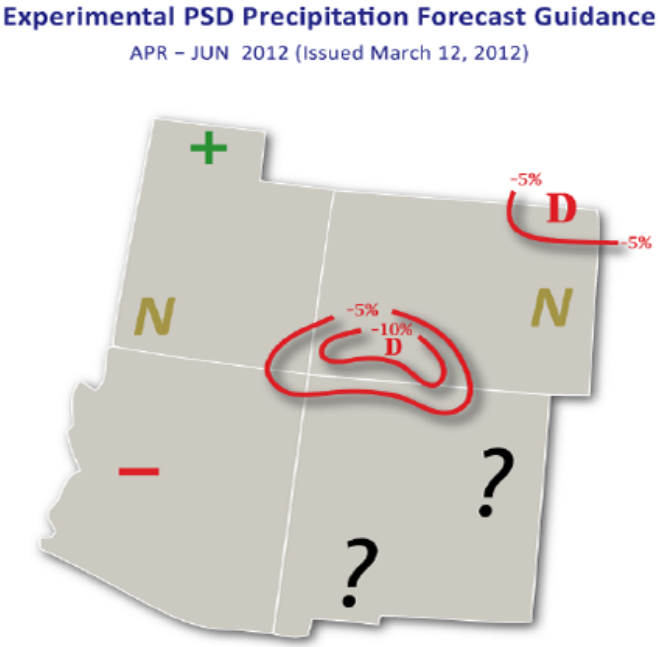

Figure PPT-5. Experimental Precipitation Forecast Guidance. Forecasted shifts in tercile probabilities for April–June 2012. (Source: NOAA ESRL Physical Science Division)

Notes & Weblinks

(provides explanations of graphics and additional information sources)

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Seasonal Drought Outlook
through June 2012 (Released March 15, 2012)

The U.S. Seasonal Drought Outlook (DO) builds on the Drought Monitor categories to project how these drought areas might change or where new drought areas might develop over the next few months (Figure DO-1). In our region, the areas of moderate (D1) and severe (D2) drought in Utah and Colorado are expected to persist or intensify, and the areas of abnormal dryness (D0) in those states are likely to develop into drought (D1 or worse). No improvement of drought areas is expected.

Readers interested in the next 5 and 6–10 days can consult the "Looking Ahead" section of each week's Drought Monitor for near-term drought outlook conditions. The next Seasonal Drought Outlook will be issued April 5th.

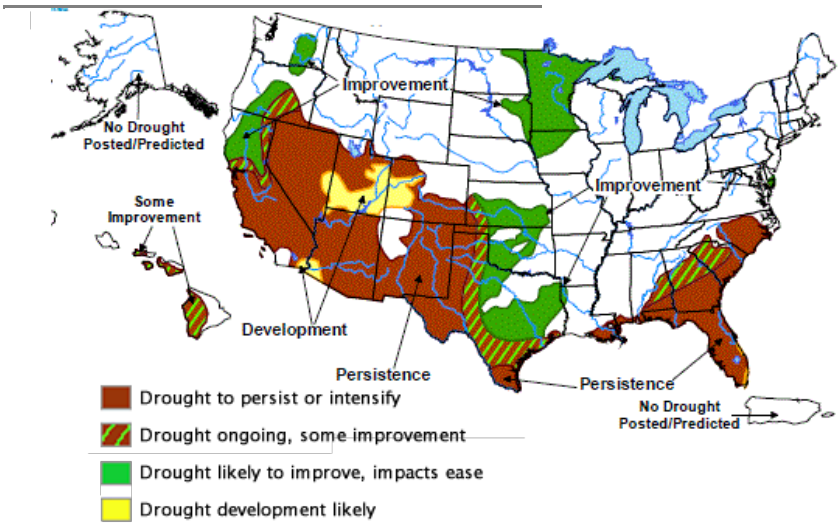

Figure DO-1. Seasonal Drought Outlook for March 15–June 2012. (Source: NOAA Climate Prediction Center)

Notes & Weblinks

(provides explanations of graphics and additional information sources)

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