INTERMOUNTAIN WEST CLIMATE SUMMARY

A product of the Western Water Assessment

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January 2012 Summary

Precipitation — *December saw above-average precipitation in southeastern Colorado northward along the Front Range, and portions of Wyoming, while most of Utah and western Colorado were drier than average.*

Hydrological Conditions — *Mountain snowpack on January 1 was well below average in nearly all of the region's basins, except for south-central Colorado and far southern Utah. Accordingly, the January 1 streamflow forecasts for nearly all basins call for below-average to much below-average spring-summer streamflows.*

ENSO — *The La Niña conditions which re-emerged in late summer have continued at weak to moderate strength, and are forecasted to persist into spring, though with weakening expected over the next three months.*

Climate Forecasts — *According to the NOAA CPC climate outlooks, the typical La Niña pattern of likely warmer and drier conditions to the south and east of our region, and cooler and wetter conditions to the north and west, is expected to affect the far southern and northern portions of the Intermountain West through the winter and spring seasons.*

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Announcements & News

WWA - USFS Region 4 - RMRS Utah *Bark Beetle and Watersheds Workshop*
December 1, 2011, Salt Lake City, UT

WWA, in collaboration with the U.S. Forest Service's Intermountain Region and Rocky Mountain Research Station (RMRS), convened an all-day workshop to explore the water-related impacts of bark beetle infestations in Utah and the Rocky Mountain West. The workshop built on three previous events held in Boulder. Despite a damaging windstorm in Salt Lake City that day, over 40 resource managers and researchers participated on-site, with several dozen others participating via live streaming videoconference. All of the workshop presentations are available both as video clips and PowerPoint files, as well as related information and resources, on the workshop webpage.

Reclamation seeking input for the Colorado River Basin Study

The Bureau of Reclamation, in collaboration with representatives of the seven Colorado River Basin States, is currently conducting the Colorado River Basin Water Supply and Demand Study (the "Basin Study") under Reclamation's Basin Study Program. Reclamation recently announced Phase 4 of the Basin Study: *Development and Evaluation of Opportunities for Balancing Water Supply and Demand.* During this phase, the Basin Study

team is seeking input on a broad range of options to help resolve future water supply and demand imbalances in the Colorado River Basin. The team will explore the effectiveness of various options and groupings of options for helping resolve projected future imbalances. Additional information, including the preliminary assessment of potential future imbalances, the process for submitting options, and how options will be evaluated, is available at the Basin Study homepage.

Hot off the Presses — Recent WWA-contributor publications

Climate change on the Shoshone National Forest, Wyoming

WWA and U.S. Forest Service postdoctoral associate Janine Rice has co-authored, with Linda Joyce and Andrew Tredennick, a new Forest Service report, *Climate change on the Shoshone National Forest, Wyoming: a synthesis of past climate, climate projections, and ecosystem implications.* The report synthesizes current understanding of the paleoclimate and historic climate of the Shoshone as a reference point, assesses what future climates may look like, and examines the potential effects of future climate on natural resources. The report, a Rocky Mountain Research Station General Technical Report, is available in PDF form from the Forest Service.

Projected future changes in hail occurrence on the Colorado Front Range

WWA team member Kelly Mahoney, a postdoctoral associate supported by Reclamation, NOAA Earth Systems Research Laboratory, and WWA, led a modeling study, published this month in *Nature Climate Change,* which examined strong summertime convective precipitation events producing hail on the eastern slopes of the Colorado Front Range. They found that the events modeled under a warmed future climate (2041–2070) produced virtually no hail at the surface due to higher freezing levels in the atmosphere. They also found that the same set of events produced more precipitation overall in the warmed future climate. See a NOAA ESRL press release describing the study. You can also request a PDF copy of the paper at wwa@noaa.gov.

The water-energy nexus in the West

WWA team member Doug Kenney has co-edited *The Water-Energy Nexus in the American West*, released this month by Edward Elgar Publishing. The seventeen chapters examine the use of water for energy production, the role of energy in water projects, and pathways towards greater efficiency and integration in both areas. Many of the contributing authors (including WWA's Kristen Averyt) and case studies are from our three-state Intermountain West region. The book is being offered at a discount from the publisher.

UCS report on water use in power plants

The Union of Concerned Scientists (UCS) released a report entitled "Freshwater Use by U.S. Power Plants: Electricity's Thirst for a Precious Resource". This report is the first systematic assessment of the effects of power plant cooling on water resources across the country, and of the quality of information in this area available to decision makers. WWA's Kristen Averyt served as lead researcher and lead author for the report. Go to the UCS website to learn more and download the report.

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Feature Article

Atmospheric Rivers: Harbors for Extreme Winter Precipitation

Zack Guido, Climate Assessment for the Southwest (CLIMAS)

(download pdf)

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Focus Article

There is no Focus Article this month.

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Recent Climate Conditions

Average temperatures for December ranged from below 10°F in high-elevation mountain regions of southern **Colorado** and northwestern **Wyoming** to up to 40°F across southern **Utah** and southeastern **Colorado** (Figure RC-1). Temperatures across the region were mostly below average, with cold departures of up to 10°F, but northeastern Wyoming and portions of western Colorado were warmer than average (Figure RC-2).

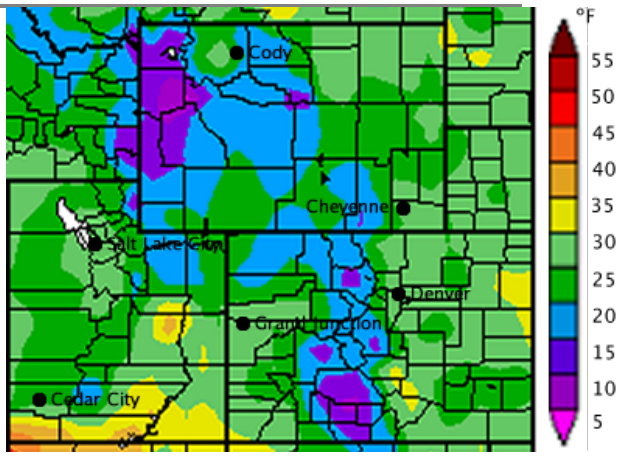

Figure RC-1. Average temperature for the month of December 2011 in °F. (Source: High Plains Regional Climate Center)

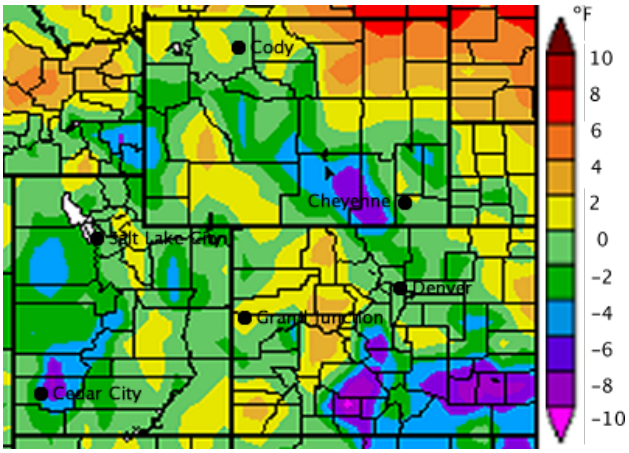

Figure RC-2. Departure from average temperature for the month of December 2011 in °F. (Source: High Plains Regional Climate Center)

Precipitation in December was unequally distributed across the region, with abundant upslope precipitation in southeastern **Colorado** northward along the Front Range, while most of **Utah** and the mountains of western **Colorado** remained very dry (Figure RC-4).

December's moisture pattern reinforced the picture for the 2012 water year-to-date (Figure RC-4b), in which the high mountains of the region are drier than average, while **Colorado** east of the Continental Divide and the intermontane basins in **Wyoming** are generally wetter than average.

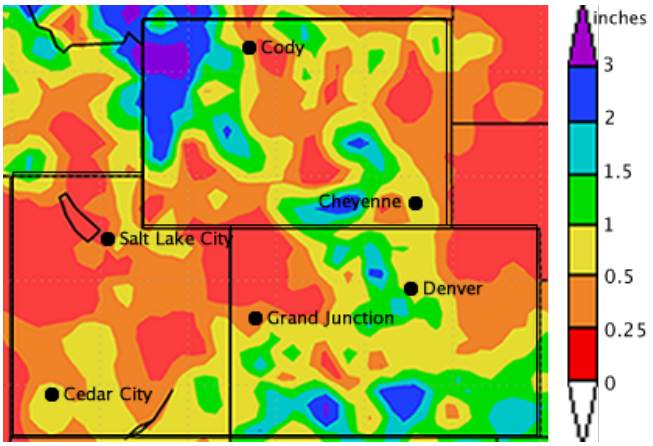

Figure RC-3. Precipitation for the month of December 2011 (inches). (Source: Gary Bates, NOAA ESRL Physical Science Division)

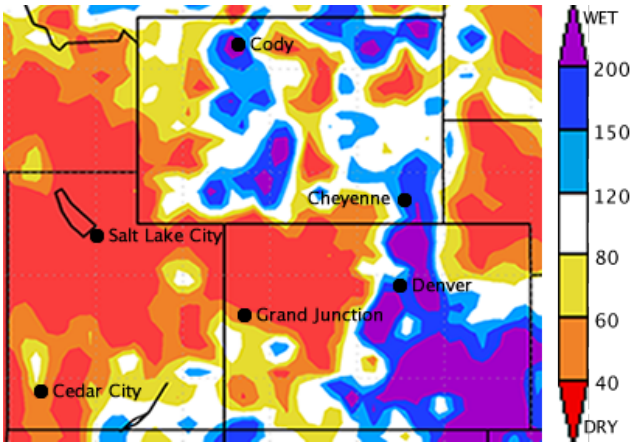

Figure RC-4. Precipitation for the month of December 2011 as percent of average precipitation for December. (Source: Gary Bates, NOAA ESRL Physical Science Division)

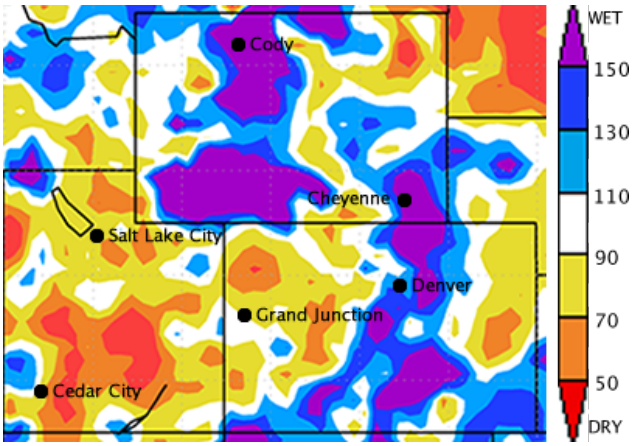

Figure RC-4b. Precipitation for water year 2012 to-date (October–December 2011) as percent of average precipitation for October–December. (Source: Gary Bates, NOAA ESRL Physical Science Division)

The 3-month SPI (Figure RC-5) shows near-normal conditions across the region, with moderately wet conditions in northeast **Colorado** and some areas of moderately dry conditions in northern **Wyoming** and western Utah. The 36-month SPI (Figure RC-6) shows moderately wet or very wet conditions in northeastern **Colorado**, southeastern

and northwestern **Wyoming**, and northeastern **Utah**, with only south-central **Colorado** being on the dry side of the ledger.

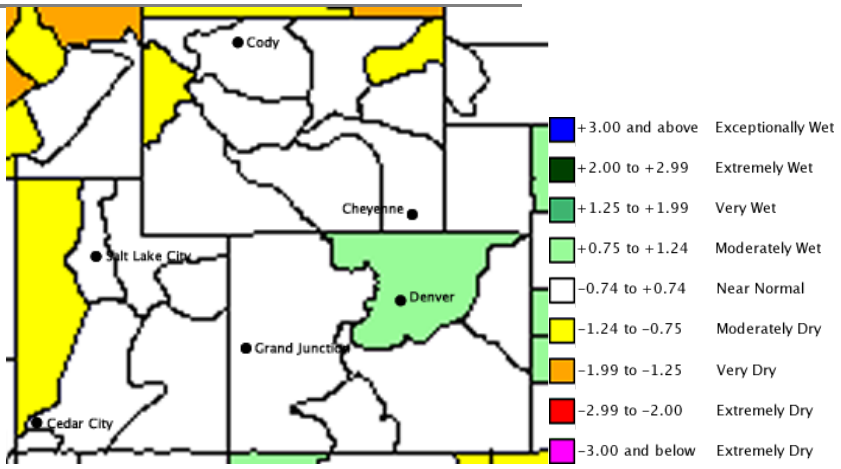

Figure RC-5. 3-month Intermountain West regional Standardized Precipitation Index as of the end of December 2011 (data from 10/01/11–12/31/11). (Source: Western Regional Climate Center)

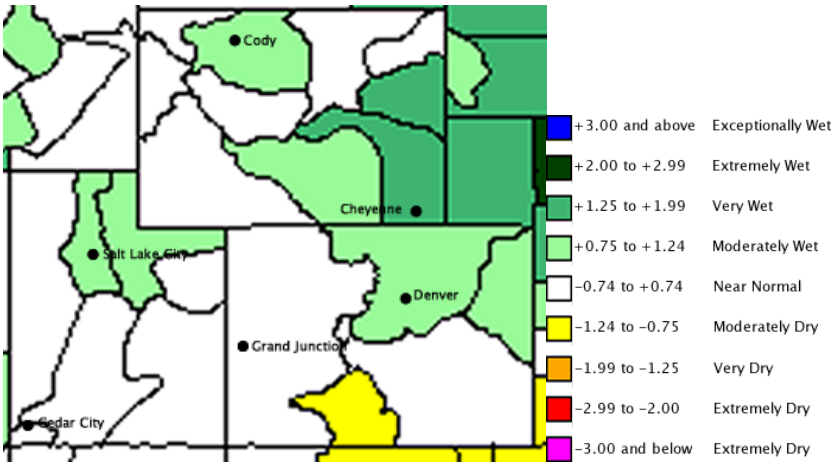

Figure RC-6. 36-month Intermountain West regional Standardized Precipitation Index as of the end of December 2011 (data from 1/01/09–12/31/11). (Source: Western Regional Climate Center)

The U.S. Drought Monitor valid for January 10 indicates that moderate to severe drought conditions (D1 and D2) persist in southeastern **Colorado**, despite the recent moisture there (Figure RC-7). Abnormally dry conditions (D0) also persist in far southeastern **Utah**. Continued dry weather has recently led to abnormally dry conditions (D0) being extended across northern and central **Utah**, into northwest **Colorado** and southwest **Wyoming**.

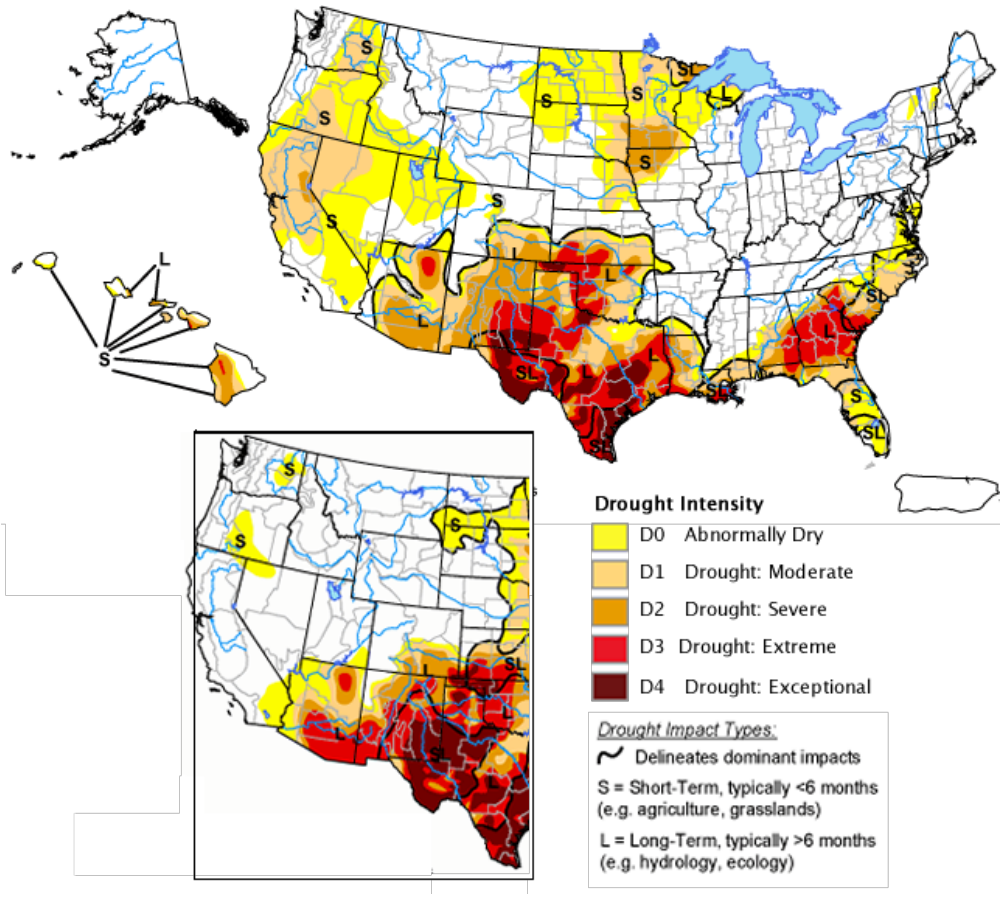

Figure RC-7. U.S. Drought Monitor from January 10, 2012 (full size) and November 29, 2011 (inset, lower left) for comparison. (Source: National Drought Mitigation Center)

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Intermountain West Snowpack

The 2012 water year is off to a slow start, with January 1 snowpacks well below average for most of the region. Northern **Wyoming** and the Escalante basin in **Utah** stand out with near-average snowpacks. October precipitation was near to above average across much of the region, while November was below average for all of **Utah**, **Colorado** and western **Wyoming**, and December was very dry for most of the region. As a result, January 1 SWE (snow-water equivalent) across the region was below average in nearly all basins (Figure SP-1). It is important to remember that most of the snow accumulation season still lies ahead and a wide range of seasonal snowpack outcomes are still possible.

In **Colorado**, January 1 snowpacks were below average in all basins, and together made the lowest January 1st statewide snowpack (71%) since 2002. While October produced near- to above-average precipitation for much of the state, warm temperatures resulted in little snow accumulation. November was mostly below average, and December produced much below average precipitation in western Colorado and much above in eastern Colorado. Basinwide percentages ranged from a high of 96% in the Arkansas to a low of 62% in the Yampa and White.

Utah statewide snowpack on January 1, in marked contrast to last year, was the lowest in the three-state region, at 58% of average. Major basins ranged from 46% in the Provo to 76% for southwest Utah. New record low January 1 SWE was set at eight SNOTEL sites, and continued dry weather increased that number to 23 sites with record low SWE by January 12th. Statewide precipitation was above average in October, but below average in November, and much below average at 36% for the month of December, leading to 80% of average for the water year-to-date.

Wyoming snowpacks were below average across most of the state, but still the highest of the three-state region with a statewide average of 88% on January. Above-average January 1 snowpacks were measured in the northeastern portion of the state at 119%, decreasing to the west and south, with the southwestern portion of the state recording 69% of average. December precipitation was below average throughout the state, ranging from a high of 94% of average in the Powder and Tongue River basins to a low of 25% in the Upper Bear River Basin.

Snowpack update, January 17: Through January 13, most of the basins in the region continued to fall behind the average SWE trajectory (Figure SP-2). But a storm dropped up to 1.5" of SWE in central **Colorado** on the 16th-17th, and a more potent storm entering the region on the 18th is forecasted to bring significant mountain snows to **Wyoming**, **Colorado**, and northern **Utah**.

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

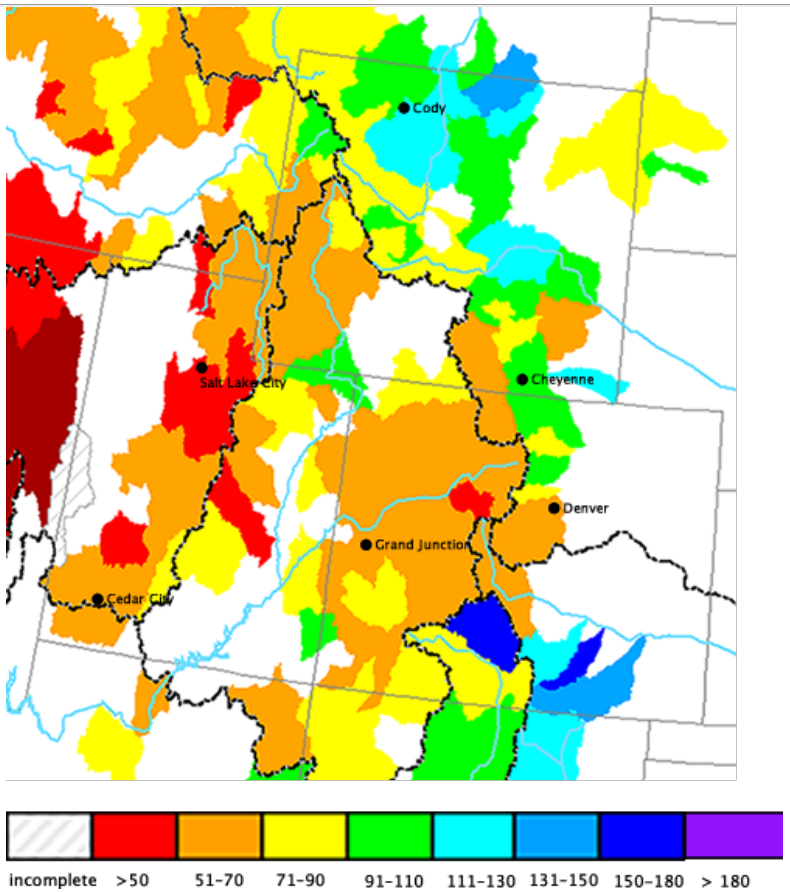

Figure SP-1. Snow water equivalent (SWE) as a percent of average for available SNOTEL and snow course sites, averaged across each basin, in the Intermountain West as of January 1, 2012. (Source: Natural Resources Conservation Service)

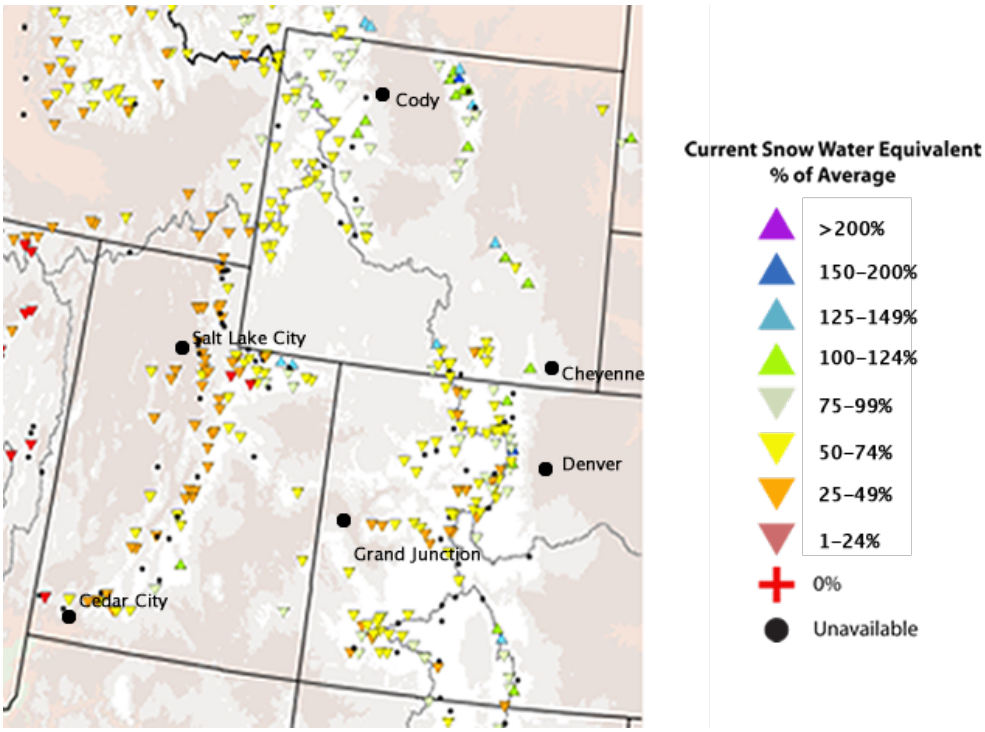

Figure SP-2. Snow water equivalent (SWE) as a percent of average for individual SNOTEL sites as of January 13, 2012. (Source: Natural Resources Conservation Service)

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Spring and Summer Streamflow Forecasts for the 2012 Runoff Season

January is the first month in the water year in which the NRCS issues streamflow forecasts for the approaching spring and summer runoff. Although streamflow forecasts can change considerably from January to April, the January forecast does provide a preliminary indication of the likely runoff anomaly. Reflecting the generally below-average January 1 snowpacks, streamflow is forecasted to be below average in most basins across the Intermountain West, with the highest forecasted flows in northeastern **Wyoming** and the lowest in central **Utah** (Figure STRM-1).

Important note about "percent of average": The NRCS streamflow forecasts referred to here use the 1971–2000 period for calculating the percent of average, while the forecasts provided by the NWS Colorado Basin River Forecast Center (CBRFC)—though coordinated with the NRCS forecasts in terms of runoff volumes—starting this year use the 1981–2010 period for calculating the percent of average. 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 January 1 forecast for April-July Lake Powell inflow is for 5050 KAF, which NRCS calculates as 64% of average (1971–2000) while CBRFC calculates it as 71% of average (1981–2000).

In **Colorado**, January 1 streamflow forecasts are below average across the state with the exception of two forecast points in the lower Arkansas basin. The other forecast points are in the range from 60 to 99% of average. October precipitation was above average the mountains of Colorado, and this should lead to high soil moisture, and improved runoff efficiency this spring.

Utah streamflow forecasts are below- to much below-average throughout the state. Most forecasts are the 50% to 80% range, with the highest in the Uinta Basin, with the remainder of the state closely competing for the 'lowest' category. High baseflows and decent soil moisture carried over from last year's huge snowpack and runoff

season mean that Utah forecasts are higher than they would otherwise be, given the very low snowpack conditions.

Wyoming January 1 streamflow forecasts are overall below average with a state average of 81%. The forecasts ranged from a high of 120% for the Powder and Tongue River Basins to a low of 58–60% for the Upper and Lower North Platte. Generally, runoff projections are more favorable to the north and east, and less favorable to the south and west.

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

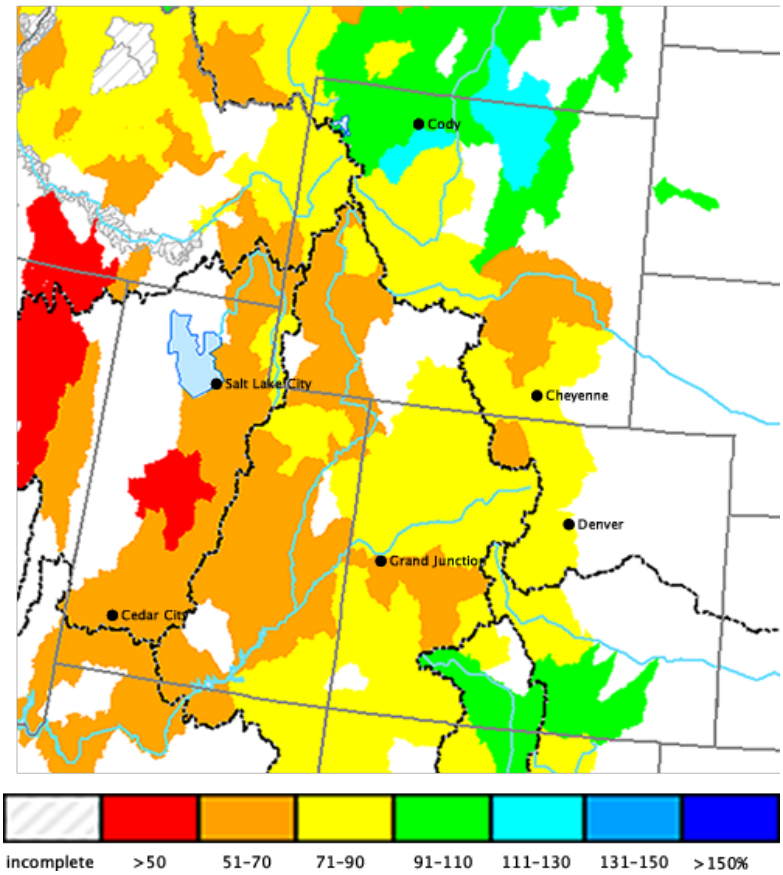

Figure STRM-1. January 1 NRCS outlook for natural streamflows for spring and summer in the Intermountain West region as a percent of average streamflows. (Source: Natural Resources Conservation Service)

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ENSO Status and Forecast

The La Niña conditions which re-emerged in August have persisted into mid-winter, with sea surface temperature anomalies from -0.5° to -2°C across a broad swath of the equatorial Pacific. The weekly SST index in the Niño-3.4 region remained near -1°C throughout December, indicating a weak to moderate La Niña. (Figure EN-1). The Multivariate ENSO Index (MEI) for November–December 2011 remained at -1.0 sigma, likewise indicating moderate conditions. By comparison, the MEI in November–December 2010 was lower (= stronger La Niña), at -1.6 sigma.

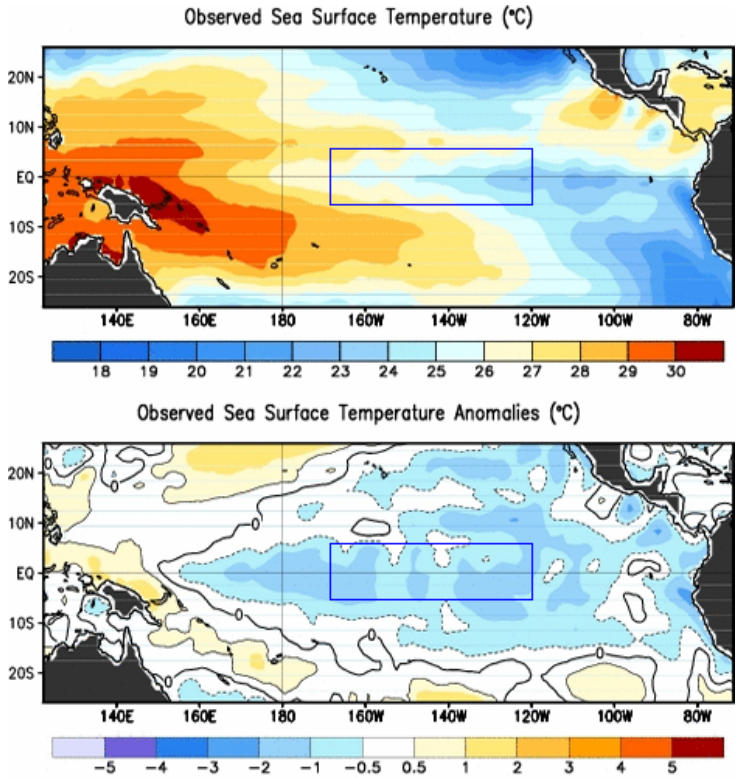

Figure EN-1. Observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. The Niño 3.4 region encompasses the area between 120°W–170°W and 5°N–5°S (blue outline). The graphics represent the 7-day average centered on January 4, 2012. (Source: NOAA Climate Prediction Center)

Model forecasts of SST anomalies as compiled by the International Research Institute for Climate and Society (IRI) show a consensus that La Niña conditions will persist through late winter 2012 (January–March). A majority of models predict La Niña to peak during the December–February season, and then to continue into the spring season before dissipating during the March–May period (Figure EN-2).

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

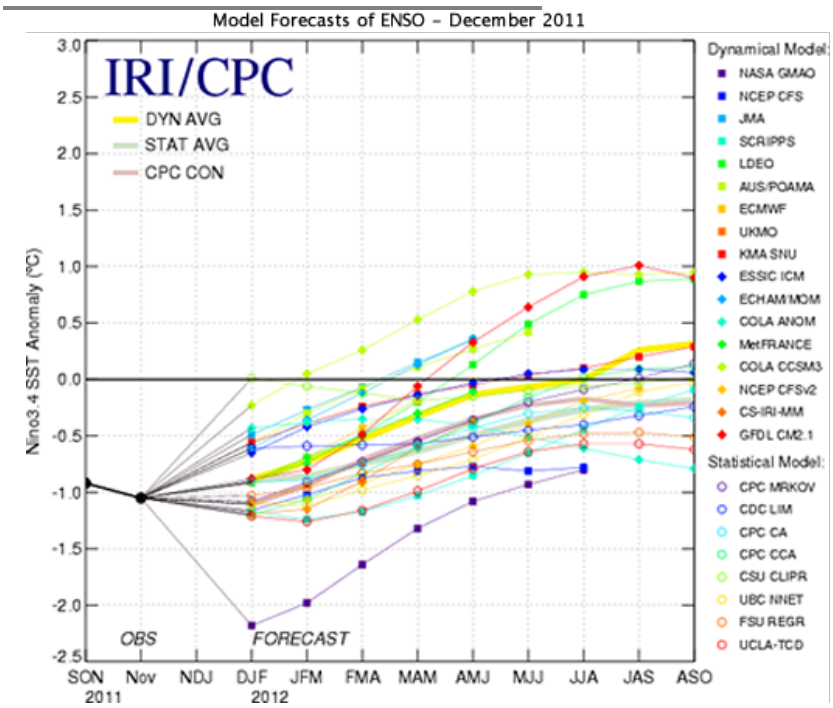

Figure EN-2. Forecasts made by dynamical and statistical models for sea surface temperatures (SST) in the Niño 3.4 region for nine overlapping 3-month periods from December 2011–February 2012 to August–September 2012 (released December 15, 2011). (Source: International Research Institute (IRI) for Climate and Society)

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Temperature Outlook
January–May 2012 (Released December 15, 2011)

The latest temperature outlooks from the NOAA Climate Prediction Center indicate an enhanced risk of above-average temperatures across the southeatern U.S. in January–March 2012 and subsequent seasons, with that region of warming risk extending into southern **Colorado** in all three time periods (Figures TEMP-1 to TEMP-3).

Temperature impacts of La Niña over the U.S. are typically weak during the summer and early fall, and strengthen in subsequent seasons. With the forecasted persistence of La Niña conditions, the ENSO state has influenced these outlooks for temperature for spring.

Note: these climate outlooks are intended for use prior to the start of their valid period. Within any given valid period observations and NWS short- and medium-range forecasts should be consulted. The Monthly and Seasonal Outlooks are updated on the third Thursday of the month, and the next one will be issued on January 19th.

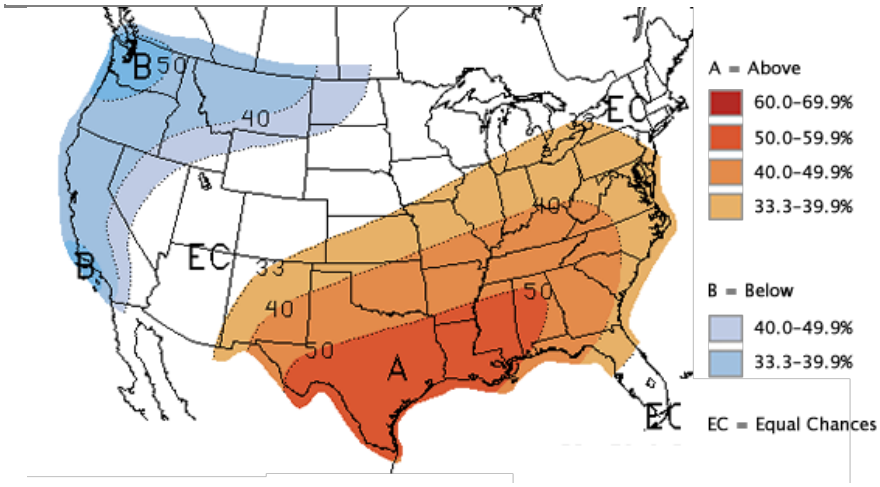

Figure TEMP-1. Long-lead national temperature forecast for January-March 2012. (Source: NOAA Climate Prediction Center)

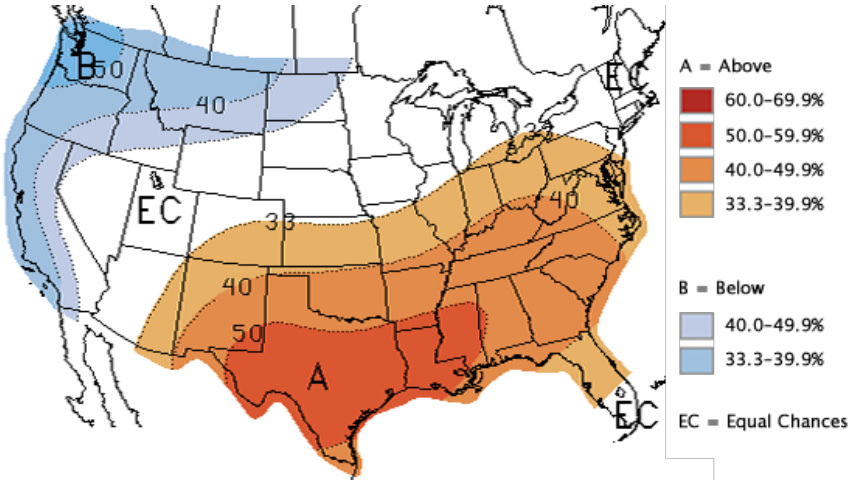

Figure TEMP-2. Long-lead national temperature forecast for February–April 2012. (Source: NOAA Climate Prediction Center)

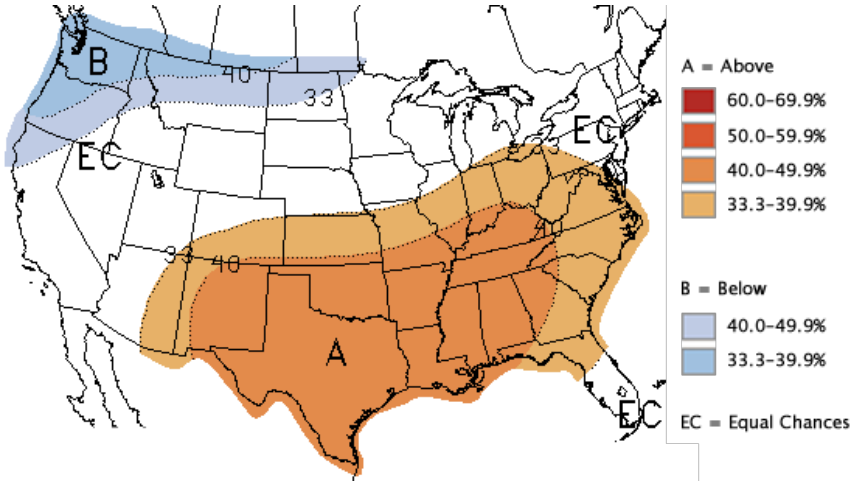

Figure TEMP-3. Long-lead national temperature forecast for March–May 2012. (Source: NOAA Climate Prediction Center)

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Precipitation Outlook
January–May 2012 (Released on December 15, 2011)

The NOAA CPC precipitation outlooks for January–March 2012 and subsequent seasons (Figure PPT-1 to PPT-3) show an enhanced risk of drier-than-average conditions across the southern tier of the U.S. This region of risk of drying extends into **Colorado** and southern **Utah** in one or more of the seasons. Meanwhile, a region of enhanced risk of wetter-than-average conditions extends from the Pacific Northwest into **Wyoming** and northern **Utah** in the January–March and February–April seasons.

The areas of below-median precipitation described above are largely due to expected La Niña impacts on climate, including the typical La Niña-influenced tilt of the odds towards below-average precipitation for some areas of the southern tier.

Note: these climate outlooks are intended for use prior to the start of their valid period. Within any given valid period, observations and NWS short- and medium-range forecasts should be consulted. The Monthly and Seasonal Outlooks are updated on the third Thursday of the month, and the next one will be issued on January 19th.

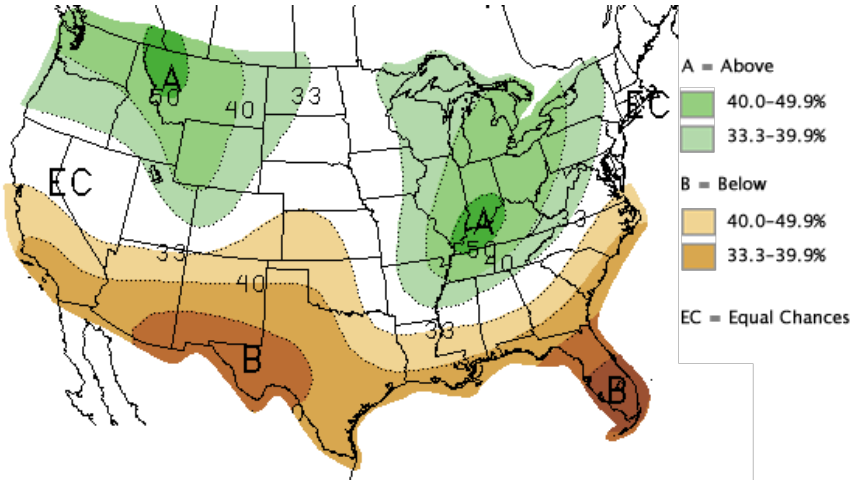

Figure PPT-1. Long-lead national precipitation forecast for January–March 2012. (Source: NOAA Climate Prediction Center)

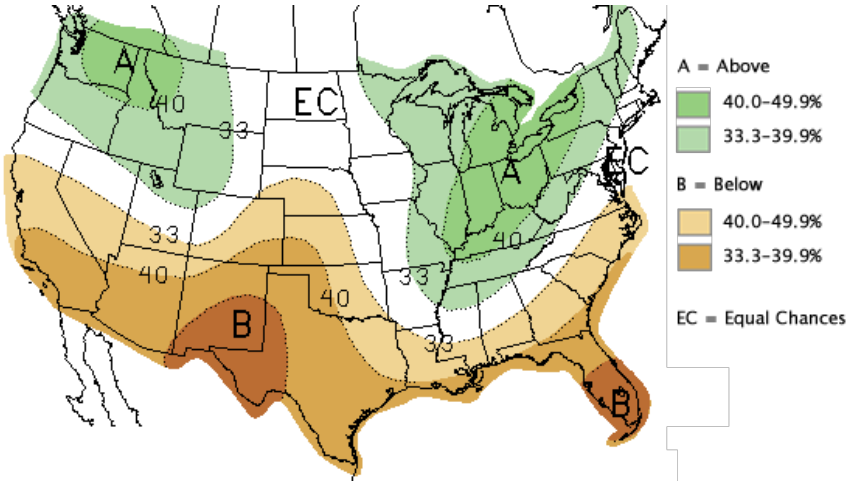

Figure PPT-2. Long-lead national precipitation forecast for February–April 2012. (Source: NOAA Climate Prediction Center)

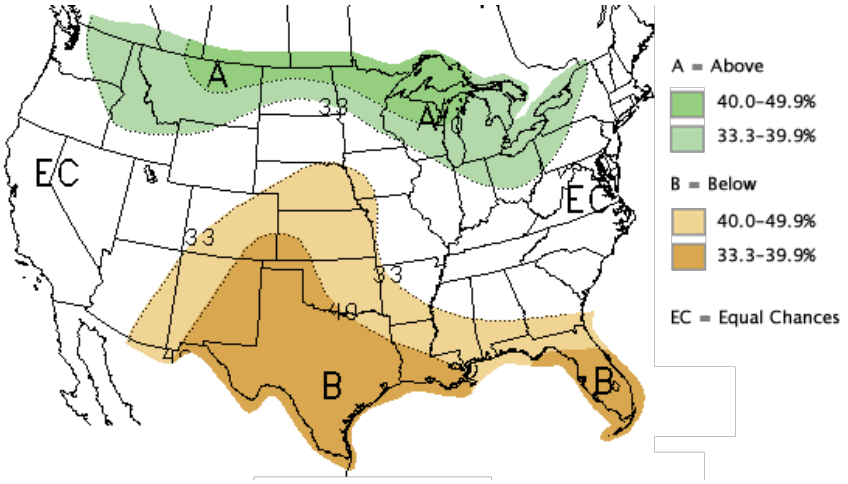

Figure PPT-3. Long-lead national precipitation forecast for March–May 2012. (Source: NOAA Climate Prediction Center)

The experimental PSD Precipitation Forecast Guidance released January 13 indicates a tilt towards drier-than-average conditions over most of **Colorado** and **Utah** for the January–March season (Figure PPT-5). Far south-central **Colorado** shows a slight tilt towards wetter conditions, while northeastern **Colorado** has enhanced (and equal) chances of conditions in either the wet and dry terciles relative to the middle tercile.

The second year of multi-year La Niña events is often drier than the first year, and the current outlook is consistent with this scenario over the mountains of **Colorado** and **Utah**. Given the current deficit of 20-40% in the two states' snowpacks, it would take an almost equally large positive anomaly to recover to average conditions by April 1st. Given the current outlook, the odds for this to occur are quite low, and less than in most years.

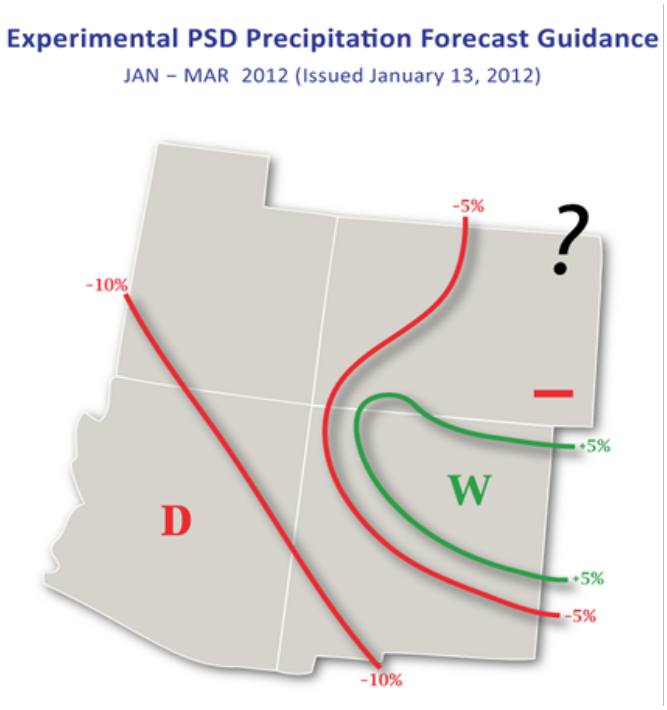

Figure PPT-5. Experimental precipitation forecast guidance. Forecasted shifts in tercile probabilities for January–March 2012. (Source: Klaus Wolter, NOAA ESRL Physical Science Division)

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Seasonal Drought Outlook
through March 2012 (Released January 5, 2012)

The U.S. Seasonal Drought Outlook projects how drought areas categorized in the U.S. Drought Monitor might change and where new drought areas might develop. The areas in southeastern **Colorado** currently experiencing moderate to severe drought (D1 and D2) are projected to have drought conditions persist over the next three months (Figure DO-1). Drought conditions are also expected to develop in a small area of northwestern **Utah** during that period.

Readers interested in the next 1–5 days 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 January 19th.

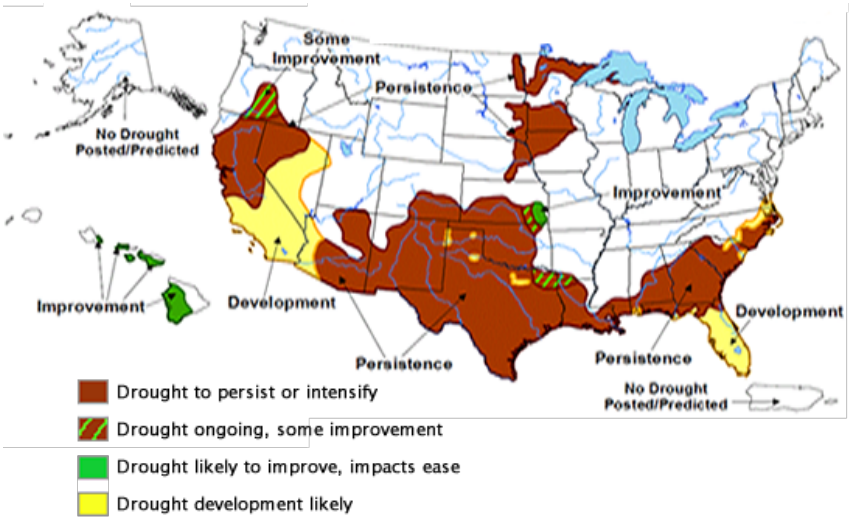

Figure DO-1. Seasonal Drought Outlook for January 5–March 31, 2012. (Source: NOAA Climate Prediction Center)

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