INTERMOUNTAIN WEST CLIMATE SUMMARY

A product of the Western Water Assessment

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PRINTER-FRIENDLY VERSION

July 2009 Summary

Hydrological Conditions Ñ*Dry conditions have diminished throughout the region since May. Currently no part of the region is in drought status (D1ÐD4) for the first time since 2001. Small areas of abnormally dry conditions persist in southeast Colorado and southwest Utah.*

Temperature —*Monthly average temperatures in June were cooler than average across the Intermountain West region, with only scattered above-average anomalies in southern Utah and Colorado.*

Precipitation —*June 2009 was a wet month overall, with all areas except southern Utah seeing above-average precipitation, and precipitation anomalies exceeding 200% in far northern Utah, northern Colorado, and much of Wyoming.*

ENSO —*Sea surface temperatures in the equatorial Pacific continued their upward trend during June, and have now exceeded the threshold for an El Ni–o event. El Ni–o conditions are forecasted to persist into winter, influencing weather in the Intermountain West.*

Climate Forecasts Ñ*An increased risk of above-average temperatures is forecasted for much of Utah in August. The area of increased risk of warmer temperatures shifts to southern Utah and southern Colorado for the fall, and then expands across the region for OctoberÐDecember, reflecting the likelihood of continued El Ni–o conditions. An increased likelihood of above-average precipitation is forecasted for portions of Colorado and Wyoming in August and through the fall.*

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Announcements & News

New study by WWA team members on climate change impacts on Colorado River storage

A study led by Balaji Rajagopalan (University of Colorado, CEA Engineering & WWA) looked at the effects of a range of reductions in Colorado River stream flow on future reservoir levels and the implications of different management strategies. The study, "Water Supply Risk on the Colorado River: Can Management Mitigate?", is in press in the journal Water Resources Research. Other authors included Ken Nowak (University of Colorado), James Prairie (Bureau of Reclamation), Martin Hoerling (NOAA), Andrea Ray (NOAA & WWA), Joseph Barsugli (CIRES & WWA), Brad Udall (WWA) and Benjamin Harding (AMEC Earth & Environmental Inc.) The study was conducted with support from the WWA, CADSWES, and the Bureau of Reclamation.

(Read the CIRES press release, with link to paper in 2nd paragraph)

Changes in WWA and IWCS staff

Jessica Lowrey, who has served as writer/editor for the IWCS since it began in 2005, left WWA at the end of June in preparation for starting law school at the University of Colorado this fall. Filling her role in supporting the IWCS is Jeff Lukas, who recently joined WWA as full-time staff. He comes from the University of Colorado's Institute of Arctic and Alpine Research (INSTAAR), where he conducted WWA-supported research to develop tree-ring paleohydrologies in collaboration with water managers.

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Feature Article

Continuing paths and new directions for the Western Water Assessment

By Kristen Averyt (Western Water Assessment)

The Western Water Assessment is expanding the scope of its research, complementing its continuing focus on water resources with new studies on climate adaptation, the water-energy nexus, and climate impacts on ecosystems.

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Focus Article

NEW ENSO Alert System from NOAA Climate Prediction Center

By Jessica Lowrey (Western Water Assessment) and Michelle L'Heureux (NOAA Climate Prediction Center)

The NOAA Climate Prediction Center has introduced a new ENSO Alert System that more succinctly describes the onset and status of ENSO. This information can be used to plan and prepare for weather events that typically accompany El Ni–o or La Ni–a events.

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Recent Climate Conditions

Throughout most of the Intermountain West, temperatures ranged between average to 4¼ below average through the month of June. The only exceptions were pockets in the far southern corners of **Utah** extending across the New Mexico border, and a few isolated areas in **Colorado** and **Wyoming**, where temperatures reached 2¼F above average. The average temperature for June exceeded 75¼F in southwest **Utah** and eastern **Colorado**; and across the Rockies the average monthly temperature ranged from below 40¼F up to 55¼F.

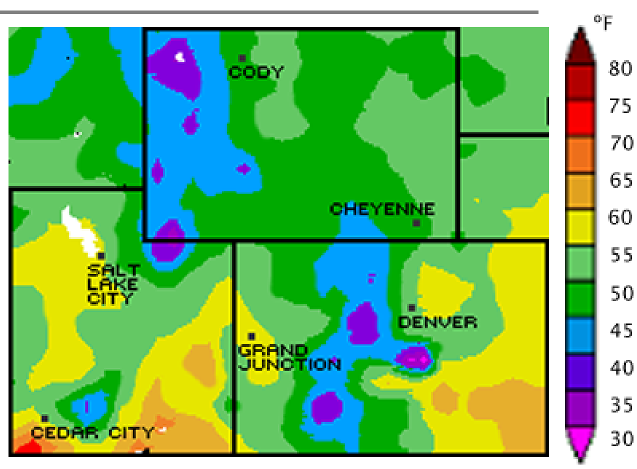

Figure RC-1. Average temperature for the month of June 2009 in ¡F. (Source: High Plains Regional Climate Center)

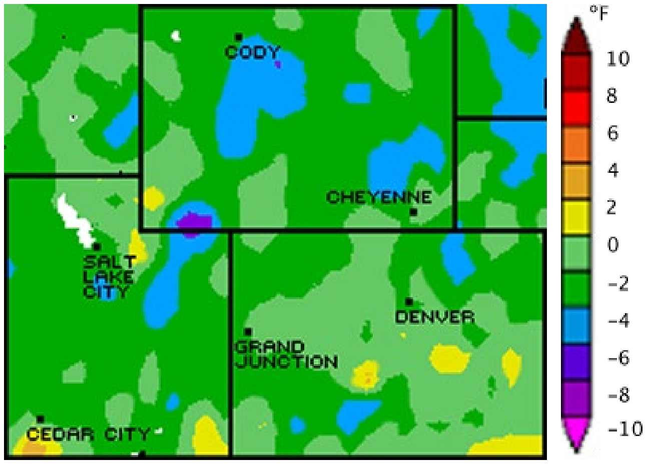

Figure RC-2. Departure from average temperature for the month of June 2009 in ïF. (Source: High Plains Regional Climate Center)

Location	Record	New	Old	Year
June 4				
Rawlins, WY	Daily Max Precipitation	0.64 inches	0.26 inches	1964
June 6				
Bryce Canyon Airport, UT	Low Min Temperature	20°	27°	1951
June 9				
Cheyenne, WY	Daily Max Snowfall	Trace	Trace	1979
June 22				
Bryce Canyon Airport, UT	Low Min Temperature	27°	30°	1977
June 23				
Denver International Airport, CO	Daily Max Precipitation	1.64 inches	0.69 inches	1906
ENTIRE MONTH				
Salt Lake City, UT	Days in June w/ any precip.	17 days	17 days	1967
Salt Lake City, UT	Days in June w/ >0.1" precip.	9 days	8 days	1998

Table RC-1. Record temperature and precipitation events in the Intermountain West during June 2009. (Source: NOAA National Weather Service)

With the cool temperatures came relatively large amounts of rain and snow, with approximately half the Intermountain West receiving more than 200% of average precipitation (Figure RC-4). For the most part, precipitation was delivered in multiple, smaller events throughout the month. This is reflected by the dearth of record precipitation events (Table RC-1), given the above-average rainfall (Figure RC-4).

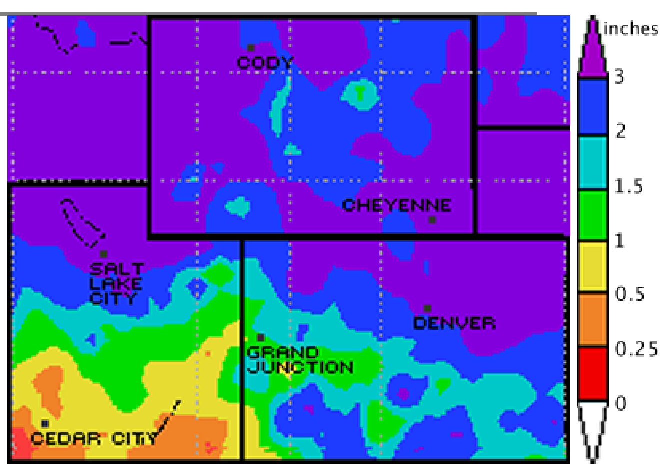

Figure RC-3. Precipitation for the month of June 2009 (inches). (Source: NOAA ESRL Physical Science Division)

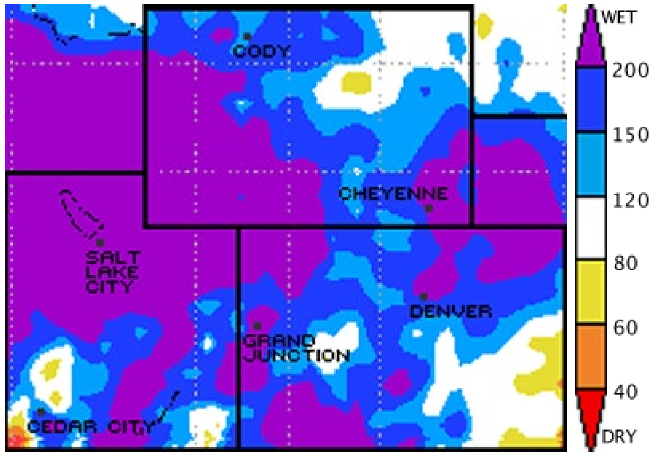

Figure RC-4. Precipitation for the month of June 2009 as percent of average precipitation for June. (Source: NOAA ESRL Physical Science Division)

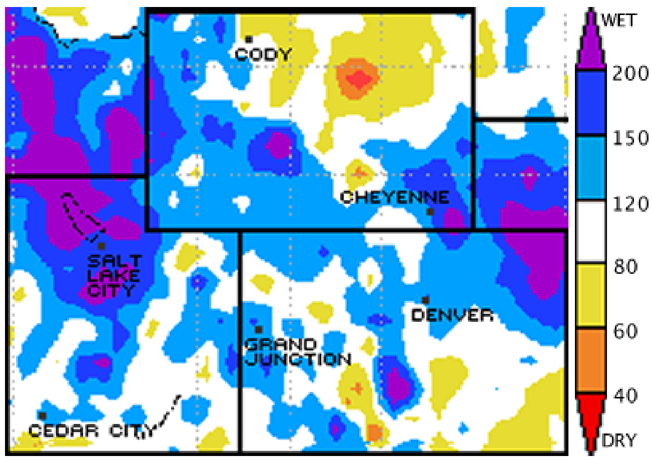

Figure RC-4b. Precipitation for water-year-to-date (October 2008ÐJune 2009) as percent of average precipitation for that period. (Source: NOAA ESRL Physical Science Division)

In most climate divisions within the Intermountain West, the precipitation was sufficient to cause a shift toward wetter conditions in the 3-month SPI (Figure RC-5). In **Colorado**, where precipitation accumulation exceeded 4Ó in many parts of the state (Figure RC-3), a dramatic shift occurred in the 36-month SPI (Figure RC-6), with the western slope and the northern portions of the state are now categorized as moderately wet (+0.75 to +1.24).

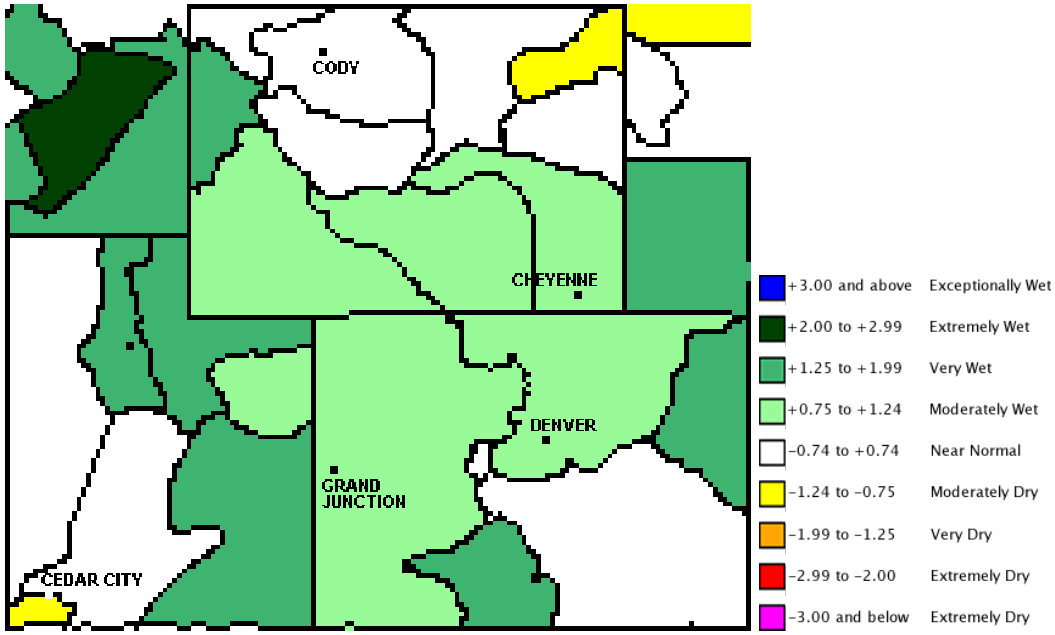

Figure RC-5. 3-month Intermountain West regional Standardized Precipitation Index as of the end of June 2009 (data from 4/01/09Ð 6/30/09). (Source: Western Regional Climate Center)

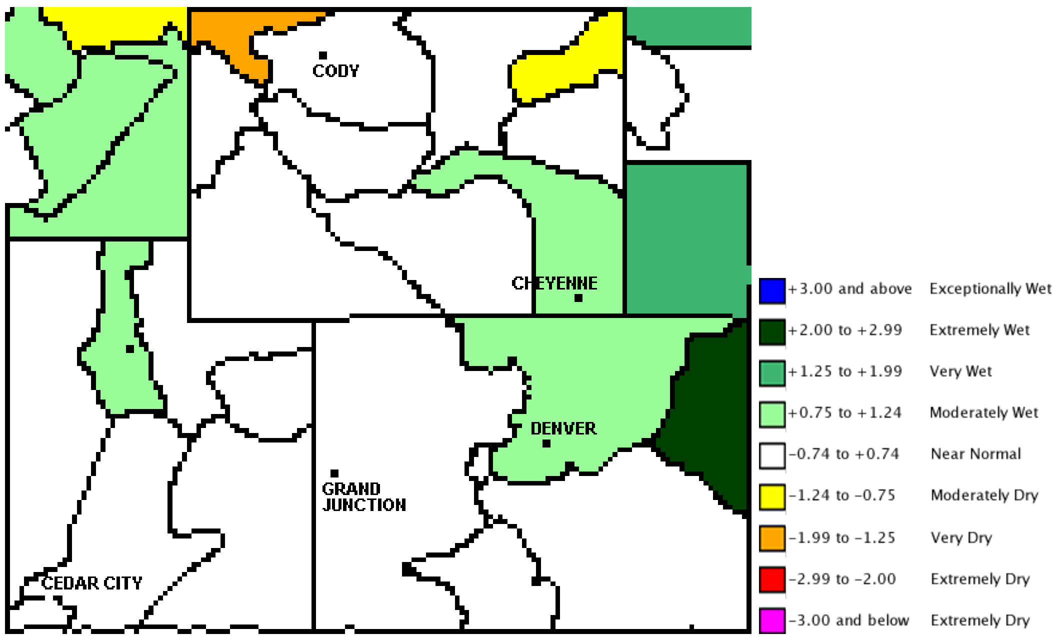

Figure RC-6. 36-month Intermountain West regional Standardized Precipitation Index as of the end of June 2009 (data from 07/01/06Ð6/30/09). (Source: Western Regional Climate Center)

For the first time since February 2001, the U.S. Drought Monitor (Figure RC-7) indicates no drought (D1ÐD4) across the entire Intermountain West, with only a small area of abnormally dry (D0) conditions in the far southeast corner of **Colorado** and a small sliver of southwestern **Utah**. Persistent below-average temperatures (Figure RC-2) in combination with significant precipitation (Figure RC-4) provided drought relief across the entire Intermountain West.

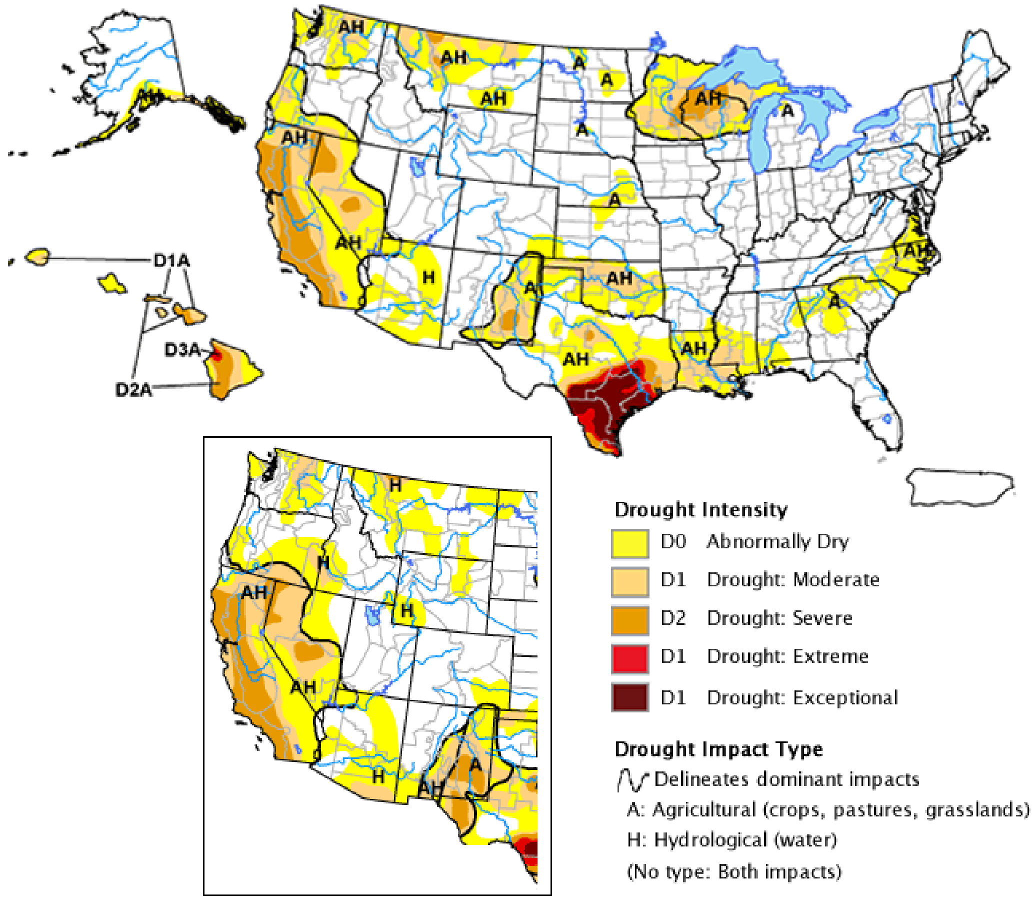

Figure RC-7. Drought Monitor from July 14, 2009 (full size) and June 16, 2009 (inset, lower left) for comparison. (Source: National Drought Mitigation Center)

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Intermountain West Snowpack

May's weather across the region was generally 1Ð5¼F warmer than average, and aided by widespread presence of multiple dust layers in the snowpack (see the Feature article in the July 2008 IWCS), caused an unusually rapid depletion of the snowpack during May, particularly in **Colorado** and **Utah**. As a result, the SWE values for June 1 were below average across the region, with the lowest values in southern **Utah** and southwest **Colorado**. The weather in June was much cooler and wetter than average across most of the region, which conserved the remaining snowpack in those basins that still had snow.

In **Colorado**, statewide snowpack sank to 32% of average on June 1 from 90% of average on May 1. The southwestern basins were particularly hard-hit by the accelerated meltout caused by the dust layers and essentially melted out by June 1, despite wetter than average conditions in May across those basins. Cool and wet conditions in June, with multiple snow events, slowed the meltout in the northern and central mountains, with many observers by late June and early July noting unusually deep and extensive snowpacks remaining above treeline.

The trajectory of the snowpack in **Utah** was similar to **Colorado**, with statewide SWE dropping to just 18% of average on June 1. In the southeast and southwest basins, where the dust layers were most prevalent, the snowpack was gone by June 1. Despite cool and very wet weather in the northern part of the state in June, no sites in those basins indicated any snow remaining by the end of June.

Across **Wyoming**, the snowpack fared better in May than to the south, with statewide June 1 SWE at 61% of average. The June 1 snowpack was greatest in the northwestern basins (73%), and least in the northeastern basins (37%).

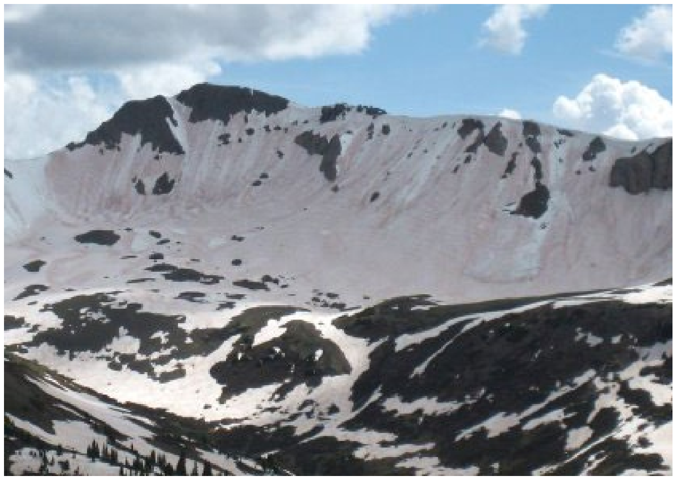

Figure SP-W. An extensive reddish dust layer exposed by the melting snowpack at Independence Pass in central Colorado on June 18, 2009. The deposition of multiple dust layers in the snowpack speeded up melt throughout the region. (Source: Klaus Wolter)

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Spring and Summer Streamflow - Forecasted and Observed

Prior to its accelerated depletion, the regional snowpack had peaked at near-average levels in most basins. Also, the conversion of snowpack to runoff appears to have been relatively efficient. As a result, the region-wide spring runoff was running near-average overall as of July 1.

With the early melt, peak runoff shifted 1Ð4 weeks earlier than average, so that May volumes were generally well above average around the region. Since June and July volumes were expected to be much lower than average as this early peak runoff quickly tapered off, the overall AprilÐJuly flows as forecasted on June 1 indicate only minor changes from the May 1 forecasts in most basins. But cool and wet weather in June augmented the runoff and reduced evapotranspiration losses, leading to unexpectedly large June volumes. Streamflow for July was still forecasted to be below average across most of the region.

In **Colorado**, the June 1 forecasts for AprilÐJuly volume were at least 90% of average for all basins except the San Juan, Animas, Dolores, San Miguel, the southern tributaries of the Arkansas, and the headwaters of the South Platte. The wet weather in June caused a secondary peak in runoff on several major rivers, improving the prospects for greater than forecasted AprilÐJuly runoff. For example, the June 1 forecast for the Colorado River Basin (Cameo gage) AprilÐJuly flow was for 2.67 MAF (110% of average), but with near-average June flows, the observed AprilÐJune volume was about 2.45 MAF, so even if July flows are much less than average (0.5 MAF), the forecast will be exceeded.

In **Utah**, the June 1 forecasts for AprilÐJuly volume in basins across the state were mainly from 80-100% of average, with a low of 50% and a high of 110% of average. But as in **Colorado**, the wet June weather boosted the springÐsummer runoff above forecasted levels in many basins. For example, on the Duchesne River near Duchesne, the June 1 forecast for AprilÐJuly volume was 158 KAF, 84% of average, but after above average June flow, the observed AprilÐJune total was already at 210 KAF.

In **Wyoming**, June 1 forecasts for the AprilÐJuly and JuneÐSeptember yields were generally below average statewide. But the very wet June weather across the state has improved the outlook for summer flows. For example, on the Green River above Fontanelle Reservoir, the June 1 forecast for AprilÐJuly volume was 705 KAF, 82% of average, but after a well-above average June flow, the observed AprilÐJune total was about 720 KAF.

For the whole Upper Colorado River Basin, AprilÐJuly inflows to Lake Powell were forecasted on June 1 to be 7.1 MAF, 90% of average. With precipitation in June across the upper basin estimated at 215% of average, observed June inflows were 0.4 MAF higher than forecasted, and observed AprilÐJune total inflows were 6.4 MAF. Accordingly, the Bureau of Reclamation on July 9 revised the forecasted AprilÐJuly inflows upward, to 7.55 MAF (95% of average).

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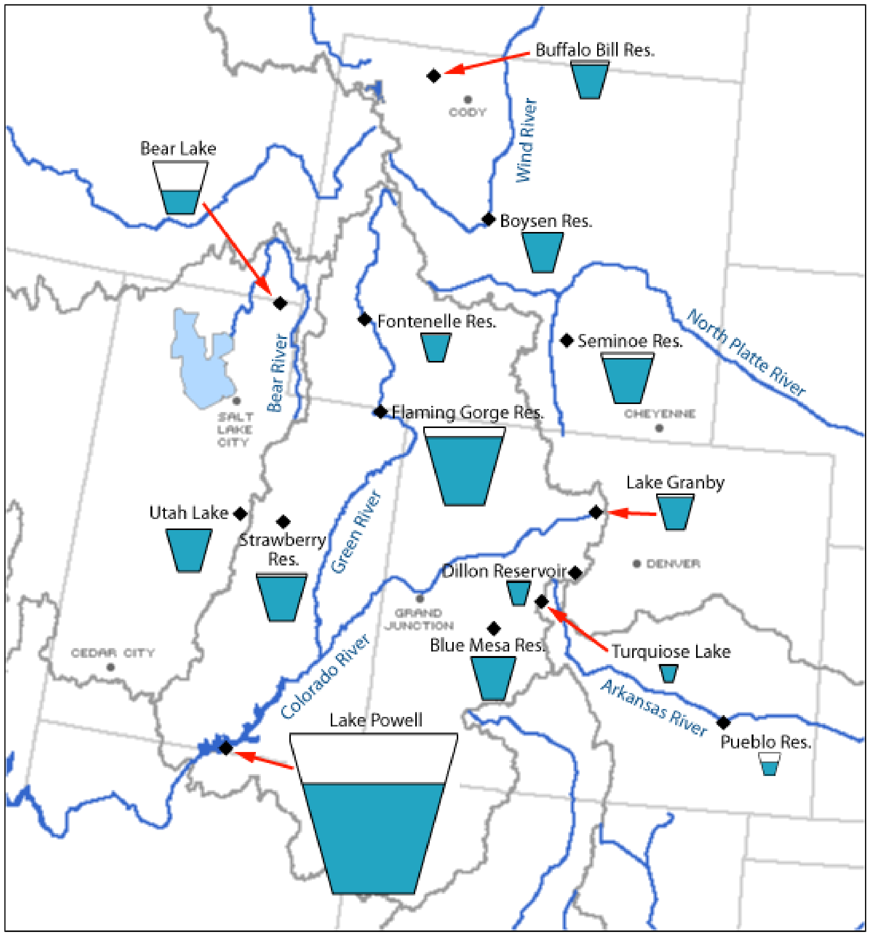
Reservoir Supply

The Òfront-loadingÓ of the springÐsummer runoff due to accelerated snowmelt, plus the generally greater than expected June runoff, led to generally above-average reservoir levels across the region for the beginning of July. Lake Powell, much depleted by multi-year drought, has recovered to 66% of capacity, its highest level since spring 2002 (Figure RES-1).



	RESERVOIR	current storage (af)	capacity (af)	% full	% of average for 6/30
COLORADO	Dillon Reservoir	256,100	254,036	101%	102%
	Turquiose Lake	126,742	129,390	98%	109%
	Lake Granby	495,327	539,758	92%	116%
	Blue Mesa	826,302	829,500	100%	119%
	Pueblo	222,645	354,000	63%	139%
UTAH	Strawberry	1,047,000	1,106,500	95%	147%
	Utah Lake	909,000	870,900	104%	104%
	Bear Lake	509,400	1,302,000	39%	52%
	Lake Powell	16,060,989	24,322,000	66%	81%
WYOMING	Fontenelle	329,819	344,800	96%	122%

	Flaming Gorge	3,342,446	3,749,000	89%	103%
	Seminoe	932,091	1,017,273	92%	135%
	Boysen	768,592	741,594	104%	128%
	Buffalo Bill	596,981	644,126	93%	123%

Figure RES-1. Tea-cup diagram and table of several large reservoirs in the Intermountain West Region. The size of each Òtea-cupÓ is proportional to the size of the reservoir, and the amount the tea-cup is relative to the current storage as a percent of capacity (% full in table). All reservoir content data is from June 30, 2009. Percent full ranges are color coded as follows: green: 80Ð100%; light green: 60Ð79%; yellow: 40Ð59%; orange: 20Ð39%; red: 0Ð19%

In **Colorado**, overall reservoir levels are at their highest point since spring 2000, with every basin above average for the end of June. Blue Mesa Reservoir in late June peaked at its highest level since 1999, nearly spilling before the Bureau of Reclamation initiated bypass operations.

In **Wyoming**, total storage at the end of June was also above average in most basins, except for the Belle Fourche and Cheyenne Basins, and the North Platte basin. Pathfinder Reservoir in the North Platte Basin, while still below its long-term average, improved to its highest end-of-June level since 2001.

In **Utah**, statewide storage at the end of June was well ahead of last year at this time, with all basins except the Bear River and Sevier storing at least 75% of capacity. Strawberry Reservoir has improved to 95% of capacity.

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ENSO Status and Forecast

NOAA scientists announced the arrival of an El Ni–o event in the July ÒENSO Diagnostic Discussion,Ó as part of the new ENSO Alert System (see the Focus Page in this issue). NOAA expects this El Ni–o to continue developing during the next several months, with further strengthening possible. The event is expected to last through winter 2009Ð10. Although often associated with negative impacts, El Ni–o typically brings beneficial winter precipitation to the arid Southwest, can help suppress Atlantic hurricane activity, less wintry weather across the North, and a reduced risk of Florida wildfires.

Sea surface temperatures (SSTs) in the equatorial Pacific Ocean are now well above average (Figure EN-1). Subsurface water temperatures also are well above average in the upper 200 meters of the tropical Pacific, making it likely that above-average SSTs will continue into the rest of summer, fall, and winter.

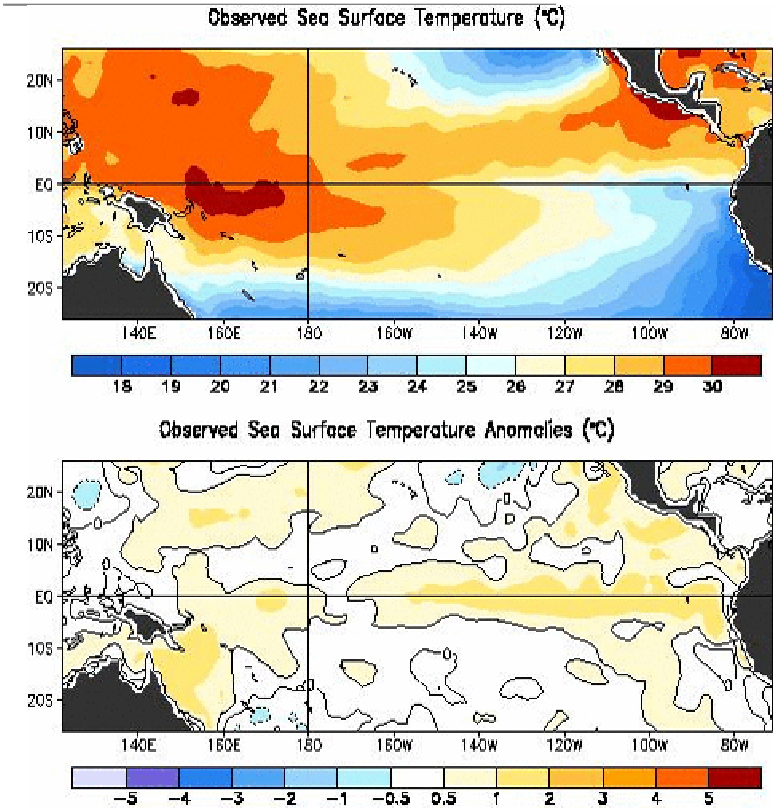

Figure EN-1. Observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. The Ni–o 3.4 region encompasses the area between 120iWÐ170iW and 5iNÐ5iS. The graphics represent the 7-day average centered on July 15, 2009. (Source: NOAA Climate Prediction Center)

Model forecasts of SST anomalies (Figure EN-2) reflect a strong consensus for the continuation, if not strengthening, of El Ni–o conditions (+0.5iC or greater in the Ni–o-3.4 region). The dynamical and statistical models continue to generally differ on the trajectory of ENSO conditions over the next 9Ð12 months, with all dynamical models forecasting continuation of this El Ni–o into winter, while several statistical models forecast a return to ENSO-neutral conditions. (None of the statistical models in May, however, forecasted the development of El Ni–o conditions at any time in 2009.)

El Ni–o has only spatially limited influence on North American temperature and precipitation during the summer and early fall, but this influence strengthens and expands during the late fall and winter. ENSO composites (the historical influences of ENSO on climate) were consulted for the forecasts reported this month.

The outlooks for temperature and precipitation from OctoberÐDecember 2009 through MarchÐMay 2010 are heavily influenced by the likelihood that El Ni–o conditions will continue. According to the NOAA Climate Prediction Center, it is still early to predict El Ni–o strength for the winter months (as reflected in the spread of ENSO forecasts; Figure EN-2). The evolution of SSTs in the equatorial Pacific in the coming months will be critical to the wintertime forecasts in the U.S.

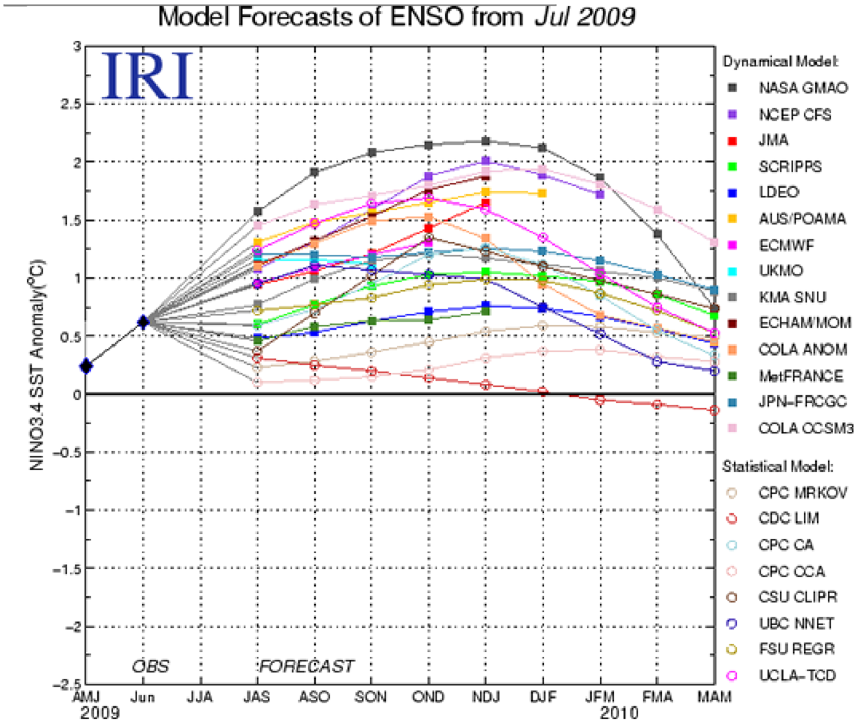

Figure EN-2. Forecasts made by dynamical and statistical models for sea surface temperatures (SST) in the Ni–o 3.4 region for nine overlapping 3-month periods from JulyÐSeptember 2009 to MarchÐMay 2010 (released July 16, 2009). (Source: International Research Institute (IRI) for Climate and Society)

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Temperature Outlook
August–December 2009 (Released July 16, 2009)

The latest temperature outlooks from the NOAA Climate Prediction Center indicate an enhanced risk of above-average temperatures across much of the West, including **Utah** and adjacent areas in **Colorado** and **Wyoming** in August 2009, and for southern **Utah** and **Colorado** in the AugustÐOctober season (Figures TEMP-1 and TEMP-2). For OctoberÐDecember and NovemberÐJanuary (Figures TEMP-3 and TEMP-4), there is an increased risk of above-average temperatures across the Intermountain West.

Although an El Ni–o event is beginning, temperature impacts over the U.S. are typically weak during the summer and early fall, and generally strengthen during the late fall and winter. ENSO composites are considered in the August and near-term forecasts, and then heavily influence the outlooks for temperature for OctoberÐDecember and subsequent seasons.

The August 2009 temperature forecast will be updated on July 31st on the CPC web page. This Òzero-leadÓ 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 August 20th.

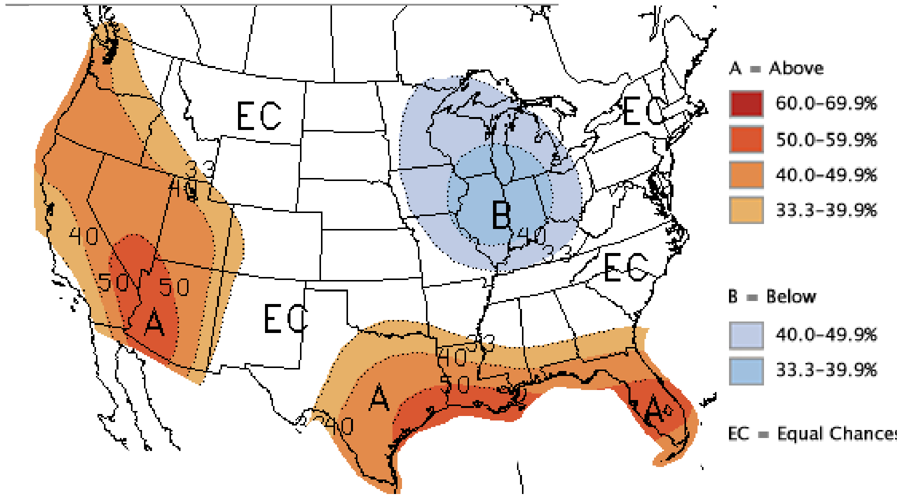

Figure TEMP-1. Long-lead national temperature forecast for August 2009. (Source: NOAA Climate Prediction Center)

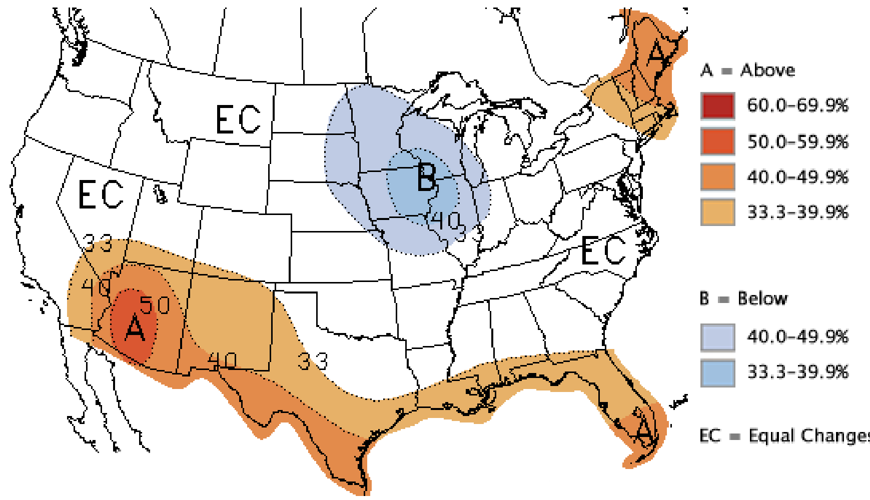

Figure TEMP-2. Long-lead national temperature forecast for AugustÐOctober 2009. (Source: NOAA Climate Prediction Center)

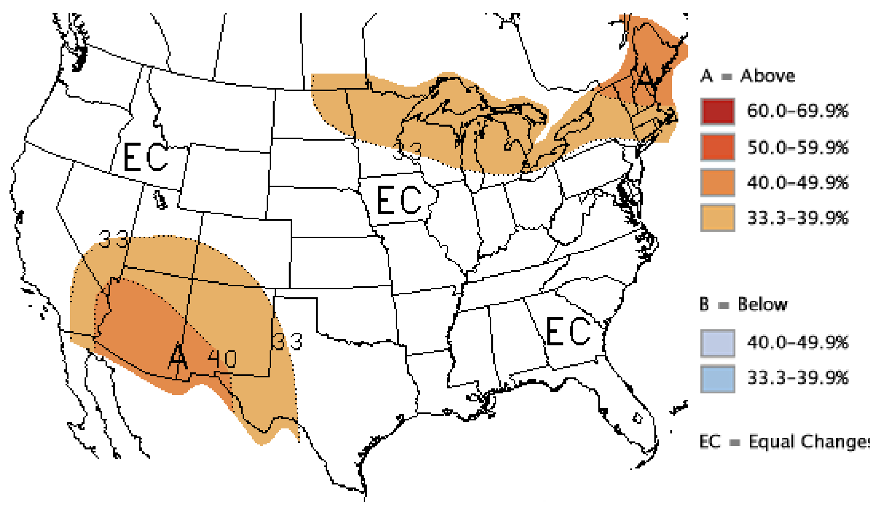

Figure TEMP-3. Long-lead national temperature forecast for SeptemberÐNovember 2009. (Source: NOAA Climate Prediction Center)

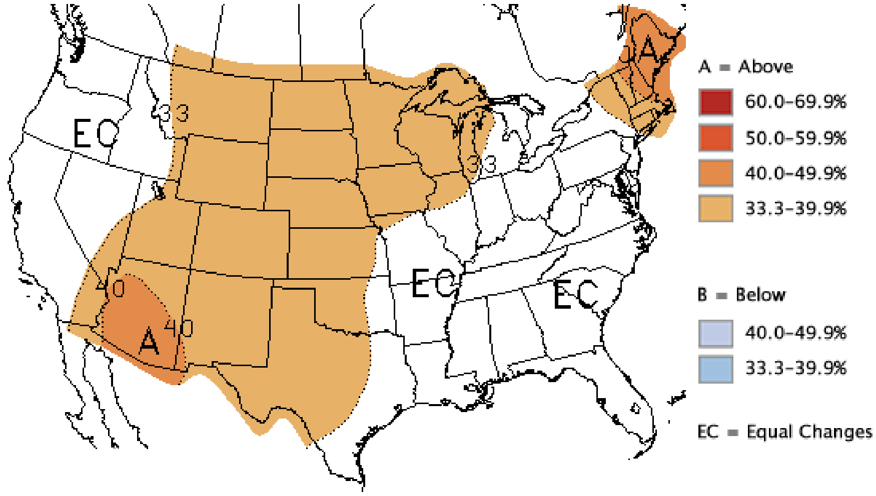

Figure TEMP-4. Long-lead national temperature forecast for OctoberÐDecember 2009. (Source: NOAA Climate Prediction Center)

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Precipitation Outlook
August–December 2009 (Released on July 16, 2009)

The CPC precipitation outlook for August 2009 and through the SeptemberÐNovember season (Figures PPT-1 and PPT-2) shows an increased probability of above-median precipitation in much of **Wyoming** and **Colorado** and across the High Plains, based on the Climate Forecast System models, ENSO composites, and precipitation trends. There are no clear signals in the outlook for the OctoberÐDecember season, resulting in a forecast for equal chances for below, near, or above-median precipitation in the Intermountain West (PPT-3); however, there is a signal for increased precipitation across the southern tier of the U.S. that is typical of El Nino winters.

The August 2009 precipitation forecast will be updated on July 31st on the CPC web page. This Òzero-leadÓ 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 August 20th.

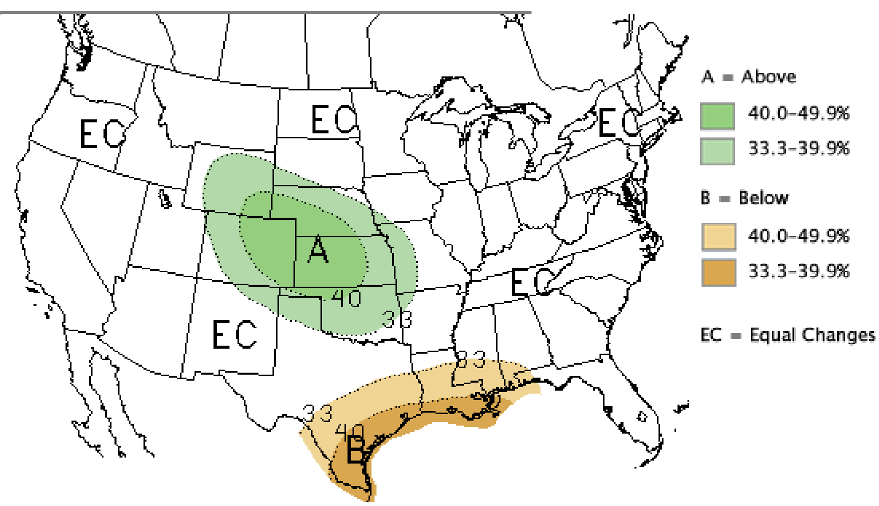

Figure PPT-1. Long-lead national precipitation forecast for August 2009. (Source: NOAA Climate Prediction Center)

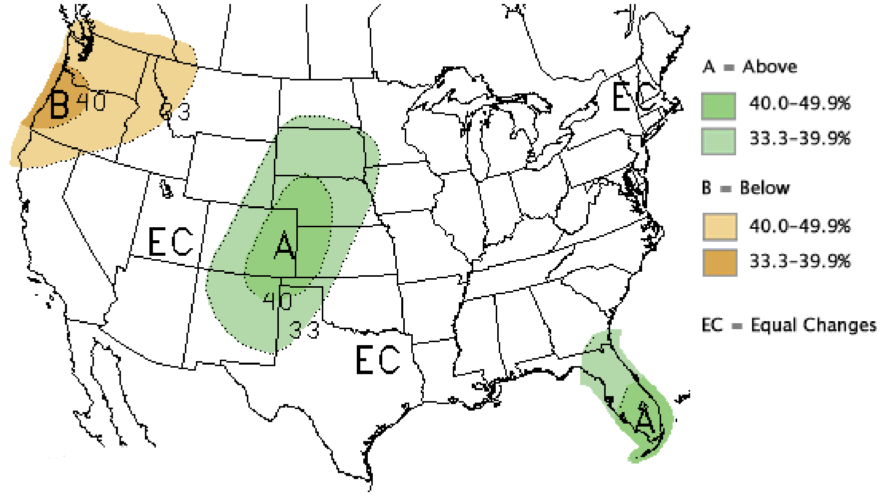

Figure PPT-2. Long-lead national precipitation forecast for AugustÐOctober 2009. (Source: NOAA Climate Prediction Center)

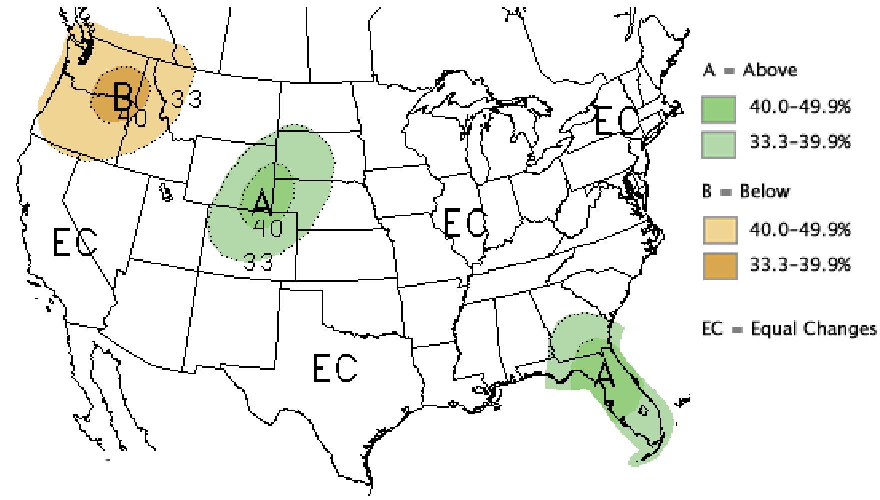

Figure PPT-3. Long-lead national precipitation forecast for SeptemberÐNovember 2009. (Source: NOAA Climate Prediction Center)

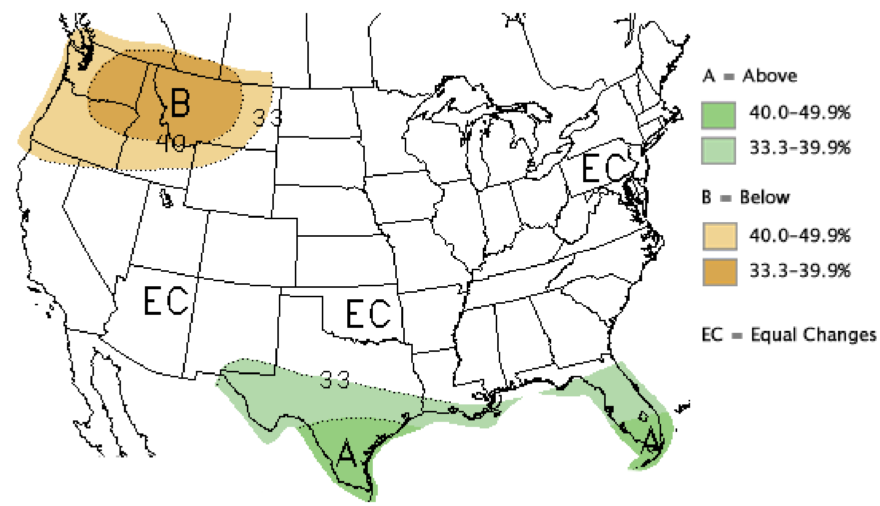

Figure PPT-4. Long-lead national precipitation forecast for OctoberÐDecember 2009. (Source: NOAA Climate Prediction Center)

According to the experimental SWcast discussion (early version) released on July 16th, JuneÕs early monsoon-like pattern has been replaced in July by a drier pattern that would have been more typical of late June conditions ahead of the monsoon season, though a return to more typical monsoon-like weather is expected by the end of July.

The experimental forecast guidance for the monsoon season (JulyÐSeptember 2009) supports slightly enhanced precipitation chances in eastern **Colorado**, while northwestern **Utah** faces a slight risk of drier conditions (Figure PPT-5). Compared to earlier experimental forecasts for the monsoon season, precipitation odds are about the same or slightly more favorable. The weak-to-moderate El Ni–o conditions that have become established since June have increased the odds for a wet monsoon season in much of **Colorado**, especially on the eastern plains.

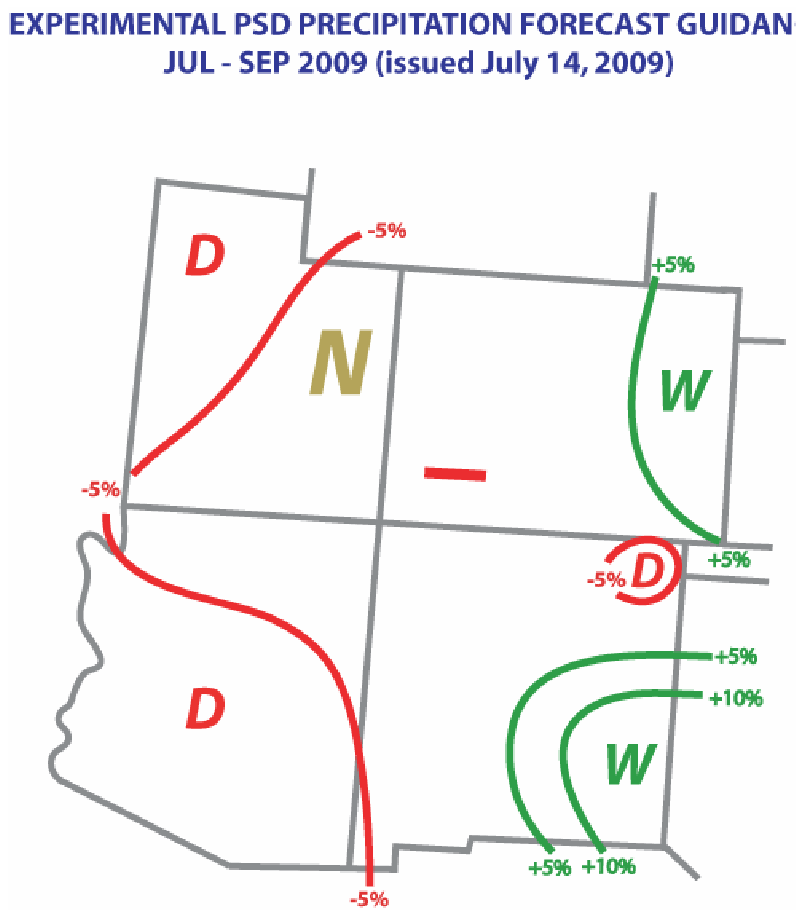

Figure PPT-5. Experimental precipitation forecast guidance. Forecasted shifts in tercile probabilities for JulyÐ September 2009. (Source: NOAA ESRL Physical Science Division)

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Seasonal Drought Outlook
through October 2009 (Released July 16, 2009)

Only two areas of the Intermountain West are categorized as abnormally dry (D0 category) as of July 16th: a small area in southwestern **Utah** and an area in southeastern **Colorado** (Figure RC-7 above). 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. No change is indicated for the two areas in the region currently categorized in D0, and no new areas of drought development are projected in the region (Figure DO-1).

Readers interested in the next 5 and 6Ð10 days can consult the ÒLooking AheadÓ section of each weekÕs Drought Monitor for near-term drought outlook conditions. The next Seasonal Drought Outlook will be issued August 6th.

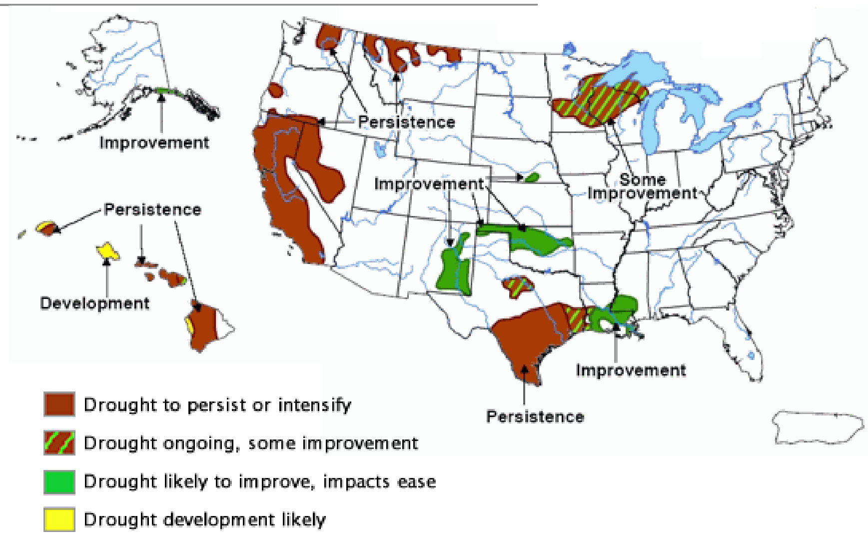

Figure DO-1. Seasonal Drought Outlook for July 16, 2009ÐOctober 2009. (Source: NOAA Climate Prediction Center)

Notes & Weblinks

(provides explanations of graphics and additional information sources)

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