Intermountain West Climate Summary

by The Western Water Assessment

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July 2008 Climate Summary

Hydrological Conditions —The highest drought intensity continues to be in southeastern Colorado and southwest Wyoming. Drought conditions have improved in Utah: Last year the entire state was abnormally dry or in drought, but drought is not indicated in 75% of the state this month.

Temperature — Temperatures were near to below average across most of the region in June, with the highest departure from average across most of Wyoming (24ºF below average).

Precipitation — Precipitation was below average across most of the region in June, with the exception of the Utah-Colorado border and a small area in central Utah. Areas in central and southwestern Colorado and southwestern Utah had less than 40% of average precipitation.

ENSO — ENSO conditions moved to neutral in June, and the majority of models project that ENSO-neutral conditions will continue in the Pacific through 2008.

Climate Forecasts — For the Aug–Oct and Sept–Nov seasons, parts of southern Utah and eastern and southern Colorado have an increased chance of above average temperatures. An increased probability of above average precipitation is forecast for parts of Colorado and eastern Wyoming in those seasons as well.

NEW: Synthesis & Assessment products (SAP) from the U.S. Climate Change Science Program

http://www.gcrio.org/library/sap-final-reports.htm

Each of these products compiles research from over 1000 publications to assess the current state of knowledge about climate change impacts or adaptation options for our nation's natural resources. These are three of a series of recent reports; see the website for more information.

- *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States* (SAP 4.3)
- *Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources*" (SAP 4.4)
- *Weather and Climate Extremes in a Changing Climate* (SAP 3.3)

NEW: North American Monsoon Forecast Forum

http://www.cpc.ncep.noaa.gov/products/Global_Monsoons/American_Monsoons/NAME/

The NOAA-funded North American Monsoon Experiment (NAME) has a new website with experimental forecasts and observations of monsoon precipitation in the southwestern U.S. and Mexico. "Zonal Accum" shows this year's observed precipitation compared to the forecasts for eight sub-regions. "Spatial Distribution" shows forecasted and observed precipitation by month and season, including a comparison to average pecipitation.

In This Issue

On the Web: http://wwa.colorado.edu

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Desert Dust Enhancement of Mountain Snowmelt

By Andrew P. Barrett, National Snow and Ice Data Center, University of Colorado; Thomas H. Painter, University of Utah; and Christopher C. Landry Center for Snow and Avalanche Studies

Dust from the desert southwest of the U.S. is a common occurrence in the snow of the Colorado Rocky Mountains. Dust speeds up the rate of snowmelt because dust on the snow surface causes it to absorb more solar radiation. It is very likely that faster snowmelt and resulting shorter snow cover duration influence both the timing runoff and peak flows in the rivers that drain these mountains. An understanding of snowpack conditions and melt rates is necessary to accurately predict the seasonal volume of streamflows and the timing of streamflow peaks.

Since 2003, a collaborative “Dust on Snow” project among the Center for Snow and Avalanche Studies in Silverton, Colorado, the University of Colorado, and University of Utah. One objective of the project is to quantify the relationship between dust and snowmelt rates and timing with a view to providing improved streamflow forecasts. In this article we review dust deposition in mountains in the U.S. and worldwide, and the process by which dust impacts snowmelt. We present results from the Dust on Snow project from the San Juan Mountains of Colorado.

Mountain Dust Deposition

Dust is commonly found in the surface layers of late season snow in Colorado and other mountain ranges around the world. Dust layers have been observed in the Himalaya, the Japanese Alps and the European Alps. Dust layers in ice cores from the Himalaya indicate that dust has been deposited on snow and glaciers in that region each year throughout much of recent history. Also, the amount of dust deposition has increased over the last 100 years as a result of either increased aridity or land disturbance in dust source regions to the north and west of these mountains. In the western U.S., anecdotal evidence from backcountry rangers, avalanche professionals and citizens of mountain communities suggests that dusty snow is a frequent and common occurrence in most years.

Between 2003 and 2008, 4 to 8 dust deposition events have been observed annually by the Dust on Snow project team in the Senator Beck Basin Study Area in the San Juan Mountains (Figure 1a). Sampling by the project team during 2008 in central and northern Colorado indicates that many of these dust events occur over much of the State’s snowpack. Evidence of one notable event in February 2006 was also found in snowpacks as far south as northern New Mexico, and as far north as northern Wyoming, suggesting that dust on snow is a regional phenomena.

The Source of Dust in the Colorado Rockies

Dust deposited in the San Juan Mountains comes from the deserts of the Colorado Plateau, which encompasses northeast Arizona, southeast Utah and northwest New Mexico. The number of dust events in each year depends both on weather conditions over the western United States and soil and moisture conditions on the Colorado Plateau. Dust transport from the Colorado Plateau occurs during periods of strong southwesterly flow that result from low pressure systems centered over western Colorado. However, dust transport and deposition events are not just linked to the frequency of these large-scale weather events. It appears that winter precipitation amounts, vegetation cover, and levels of soil disturbance play a large role in determining whether or not dust is mobilized. Soil disturbance appears to be a key factor. Dust particles are mobilized from disturbed soil surfaces at much lower wind speeds than from undisturbed surfaces. Concentrations of desert soils in sediment cores from mountain lakes indicate that dust deposition in the Colorado mountains increased significantly after increased settlement and expansion of agriculture of the Colorado Plateau in the 19th century. Understanding the interaction among weather and climate, vegetation dynamics, and soil disturbance is necessary before dust emissions can be predicted.

How Dust Enhances Snowmelt

Snow is the most reflective natural surface on Earth. Dust deposited on snow decreases reflectivity, causing snow to absorb

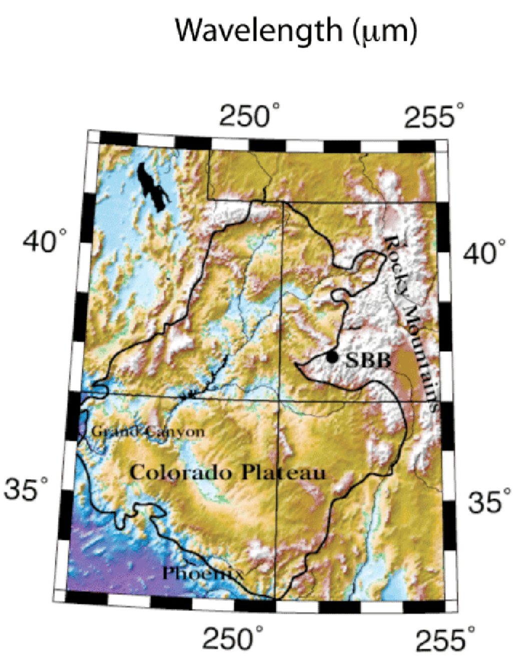


Figure 1a. The location of the Colorado Plateau, Colorado Rocky Mountains and Senator Beck Basin Study Area (SBB).

more solar radiation, warm-up to melting point faster and enhance rates of snowmelt. Albedo is a measure of reflectivity, and it is technically the ratio of reflected to incoming solar radiation expressed as a fraction. A surface that reflects all incoming solar radiation would have an albedo of 1.0. Radiation that is not reflected is absorbed. Albedo of clean, dry snow is between 0.8 and 0.97; less than 20% of incoming radiation is absorbed. Melting snow has slightly lower albedo (0.66 to 0.88). The impact of dust on snow surface conditions is quantified by measuring the change in albedo of the snow surface as a result of dust exposure. Measurements of the albedo of dust-covered snow made by the Dust on Snow project in the San Juan Mountains of Colorado were between 0.43 and 0.5; more than 50% of incoming solar radiation is absorbed. This extra energy from additional absorbed solar radiation either warms the snowpack to melting point or melts snow.

The Impact of Dust on Snowcover Duration

Although it is well known that dust enhances absorbed solar radiation and melt rates, these impacts have not been quantified in a natural setting. In two early studies, one of which made in 1913 at Wagon Wheel Gap, San Juan Mountains, Colorado, simple observations reported that dust deposited on snow may have shortened the duration of snow cover by as much as one month.

To quantify the impact of dust on snow melt rates and the duration of snowcover, we simulated snowmelt in 2005 and 2006. Two simulations of snowmelt were made: one represented the observed dust-covered snow conditions and the other represented estimated dust-free snow conditions. Based on these simulations, the occurrence of dust on snow caused melt-out to occur 22 to 35 days earlier (Figure 1b). Only 4 dust events occurred in 2005, while 8 events occurred in 2006. Snowmelt rates (measured in millimeters of melt per day) in 2006 were 40% faster than in 2005. The faster melt in 2006 can be attributed not only to a greater number of dust layers in the pack but also fewer snow storms and extended periods of cloud free days during spring, which maximized the exposure of dust at the snow surface and increased the amount of extra energy available for melting.

Outlook

Dust plays an important role in snowmelt in the Intermountain West, and its influence almost certainly extends to the timing of the onset of snowmelt runoff and peak streamflow. Results from our Dust on Snow project will improve the understanding of the interactions among changing weather conditions, dust deposition, and snowmelt timing, which have the potential to improve streamflow forecasts. This acquired knowledge should be combined with monitoring of dust deposition using satellite

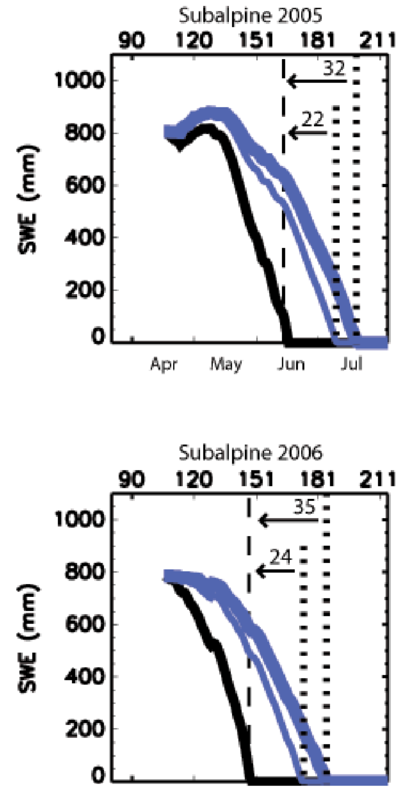


Figure 1b. Simulations of depleting snow water equivalent (SWE; 1” = 25.4 mm) for 2005 and 2006 for a subalpine site in the Senator Beck Basin Study Area. Black lines are depletion curves for observed dusty conditions. Blue lines are depletion curves for upper and lower estimates of dust-free snow albedo. Vertical dashed lines and numbers show melt out dates and differences in snowcover duration in days for dust and dust-free snow conditions.

remote sensing as well as on-the-ground observations in order to improve data collection and analysis.

Further Information

Some results from the Dust on Snow project are described in detail in a recent Geophysical Research Letters paper (Painter et al, 2008). An analysis of dust in lake sediment cores can be found in a recent Nature Geoscience paper (Neff et al, 2008). Information on the Center for Snow and Avalanche Center’s Senator Beck Basin Study Area can be found at www.snowscience.org.

Painter, T.H., A.P. Barrett, C.C. Landry, J.C. Neff, M.P. Cassidy, C.R. Lawrence, K.E. McBride and G.L. Farmer. 2007. Impact of disturbed desert soils on duration of mountain snowcover. Geophysical Research Letters, 34. DOI:10.1029/2007GL030284.

Neff, J.P., A.P.Ballantyne, G.L. Farmer, N.M. Mahowald, J.L. Conroy, C.C. Landry, J.T. Overpeck, T.H. Painter, C.R. Lawrence and R.L. Reynolds. 2008. Increasing eolian dust deposition in the western United States linked to human activity. Nature Geoscience, 1, 189-195.

Temperature 06/01/08 – 06/30/08

Monthly average temperature for June 2008 in the Intermountain West region ranged from 45–75°F (Figure 2a). The warmest areas (70–75°F) were across southern Utah and southeastern Colorado. The coolest areas were in low elevations of eastern Wyoming (55–60°F) and at higher elevations in western Wyoming and central Colorado (45–55°F).

Temperatures in early June were near to below average across the region, attributed to the waning La Niña event (see page 15), according to the Southwest Forecast Discussion (see On the Web; Figure 2b). These below average temperatures delayed snowmelt at higher elevations until later in the month of June, when high elevation snowmelt occurred with near average temperatures.

Due to cooler conditions early in the month, most of Wyoming reported below average temperatures, with some areas as low as 4°F below average. Colorado and Utah were mostly near average, with the majority of both states reporting temperatures within 2°F from average for June.

Record low temperatures were set in several locations in the IMW during June 2008. The Salt Lake City NWS reported a record low temperature in southeastern Utah at the Hite Ranger Station on June 5. The new record low temperature of 49°F broke the previous record of 54°F, set in 2005. The Pueblo NWS reported that Alamosa, in south-central Colorado, set a new record low of 25°F on June 12, breaking the previous record of 29°F set in 1975 and tied in 2002 and 2004. Later in the month, a record high temperature of 104°F was set on June 21 in Delta, located in central Utah, breaking the previous record of 101°F set in 1961.

In 2007, June temperatures were higher than in 2008 throughout most of the IMW region (0–6°F above average; Figure 2c). Higher than average temperatures in lead to above average snowmelt and reservoir levels in June 2007. The exceptions were a few areas in southeastern Colorado, which were around 0–4°F below average in June 2007.

Notes

Figures 2a–c are experimental products from the High Plains Regional Climate Center. These data are considered experimental because they utilize the most recent data available, which have been subject to minimal quality control. These maps are derived by taking measurements at individual meteorological stations and interpolating (estimating) values between known points to produce continuous categories. Interpolation procedures can cause incorrect values in data-sparse regions. For maps with individual station data, please see web sites listed below. *Average* refers to the arithmetic mean of annual data from 1971–2000. Departure from average temperature is calculated by subtracting current data from the average. The result can be positive or negative.

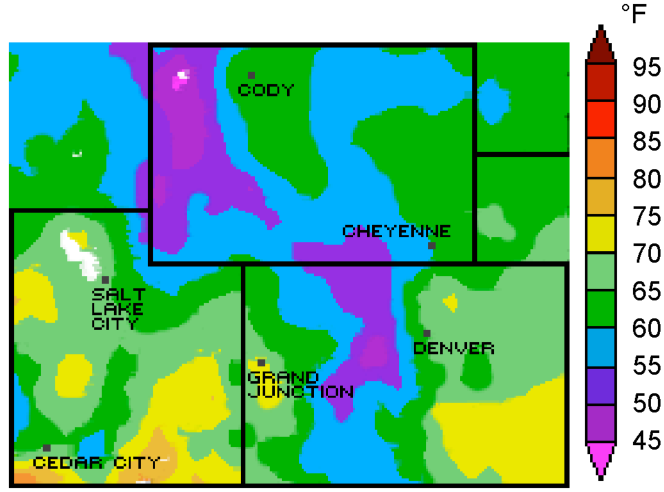


Figure 2a. Average temperature for the month of June 2008 in °F.

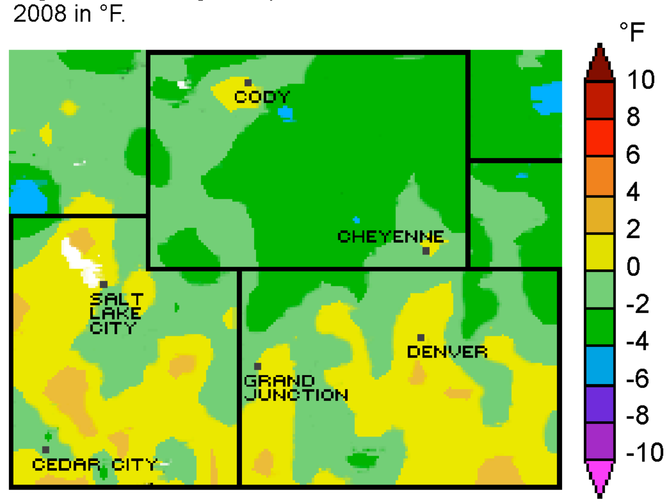


Figure 2b. Departure from average temperature for the month of June 2008 in °F.

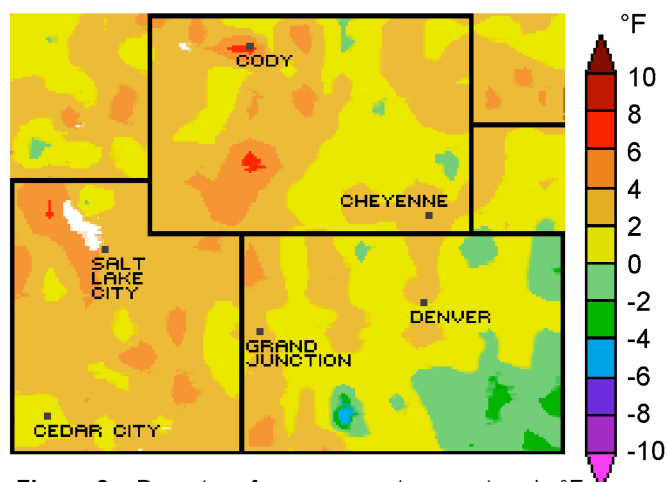


Figure 2c. Departure from average temperature in °F for last year, June 2007.

On the Web

- For maps like Figures 2a–c and maps of other climate variables including individual station data, visit: http://www.hprcc.unl.edu/maps/current/.
- For information on temperature and precipitation trends, visit: http://www.cpc.ncep.noaa.gov/trndtext.htm.
- For a list of weather stations in Colorado, Utah, and Wyoming, visit: http://www.wrcc.dri.edu/summary.
- For current discussions about the El Niño Southern Oscillation (ENSO), visit: http://www.cpc.noaa.gov/products/analysis_monitoring/enso_advisory/.
- For current Southwest Forecast discussions, visit: http://www.cdc.noaa.gov/people/klaus.wolter/SWcasts/index.html.

Precipitation 06/01/08 – 06/30/08

Total precipitation for June 2008 in the Intermountain West region ranged from 0.25–3+ inches (Figure 3a). The highest precipitation was in northeast and northwest **Wyoming** and northeast **Colorado** (2+ inches). The lowest precipitation was in southern **Utah** and southwest **Colorado** (0.25–0.5 inches).

Most of the region had near or below average precipitation for June (Figure 3b). Central **Utah**, areas along the **Utah/Colorado** border, and the far northeast corner of **Wyoming** were the only areas to receive above average precipitation (>120% of average). Most of **Colorado**, southwest **Utah**, and portions of central **Wyoming** all received well below average precipitation in June (<40–80% of average). Most of the total monthly precipitation reported in eastern **Colorado** and **Wyoming** came early in the month. Several passing cold fronts caused 0.71" of precipitation at the Denver International Airport (DIA) during the first five days of June, as reported by the NWS Boulder. The total precipitation at DIA for the rest of June 2008 was only 0.02", making the total for the month 0.73" or 47% of average. As in Denver, a majority of the precipitation in Riverton, **Wyoming**, happened early in the month, with 0.23" of the 0.27" total for the month falling on June 5 during a passing cold front. The total precipitation recorded at Riverton for June 2008 (0.27") was 24% of average.

At the end of May 2008, a large part of the IMW region had received above average precipitation since the start of the water year (October 2007), but drier conditions in June brought more of the IMW region to closer to average precipitation (Figure 3c). Southeast **Colorado** has the lowest percent of average precipitation, with areas reporting less than 50% of average since the start of the water year.

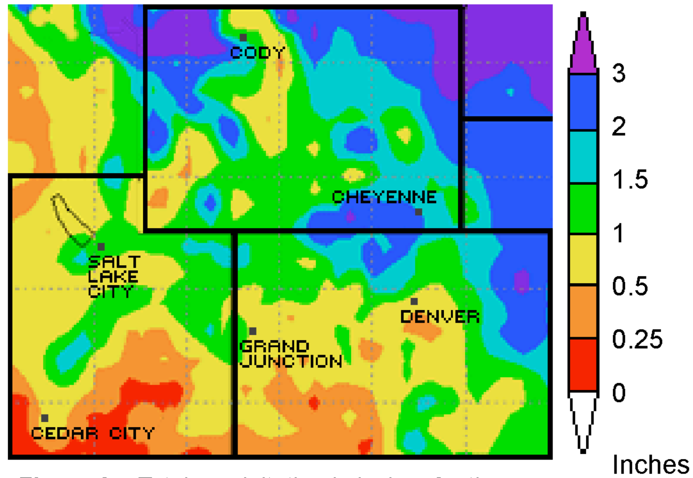


Figure 3a. Total precipitation in inches for the month of June 2008.

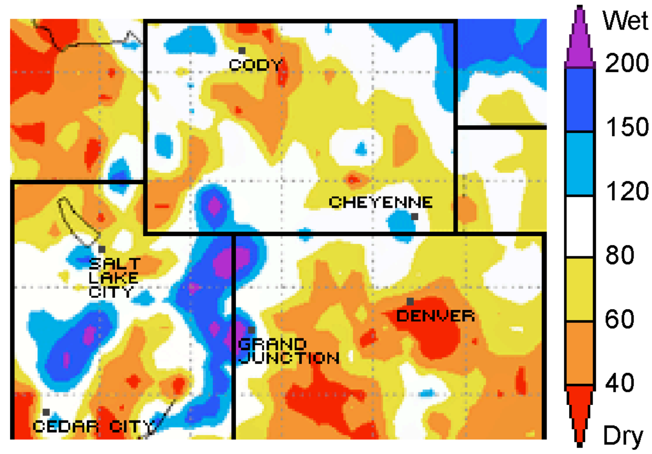


Figure 3b. Percent of average precipitation for the month of June 2008.

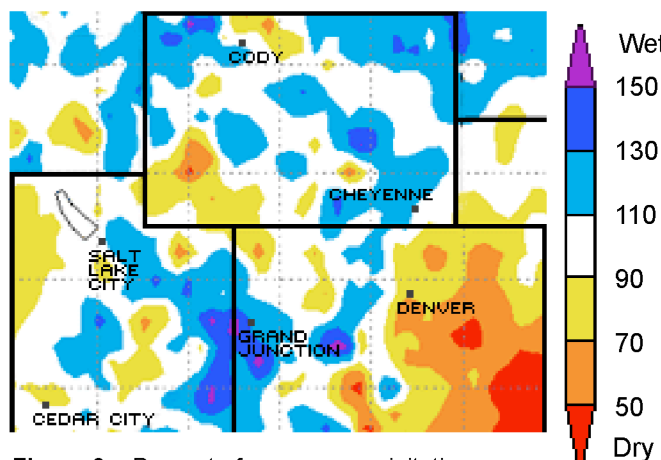


Figure 3c. Percent of average precipitation accumulation since the start of the water year 2008 (Oct. 1, 2007–June 30, 2008).

Notes

The data in Figs. 3 a–c come from the High Plains Regional Climate Center. These data are considered experimental because they utilize the most recent data available, which have been subject to minimal quality control. These maps are derived by taking measurements at individual meteorological stations and interpolating (estimating) values between known points to produce continuous categories. Interpolation procedures can cause incorrect values in data- sparse regions. For maps with individual station data, please see web sites listed below. The water year runs from October 1 to September 30 of the following year. The 2008 water year began October 1, 2007 (Figure 3c). The water year better reflects the natural cycle of accumulation of snow in the winter and run-off and use of water in the spring and summer. It is a better period of analysis for presenting climate and hydrologic conditions. Average refers to the arithmetic mean of annual data from 1971–2000. Percent of average precipitation is calculated by taking the ratio of current to average precipitation and multiplying by 100.

On the Web

- For precipitation maps like Figures 3a–c, which are updated daily visit: http://www.cdc.noaa.gov/Drought/.
- For other precipitation maps including individual station data, visit: http://www.hprcc.unl.edu/maps/current/.
- For National Climatic Data Center monthly and weekly precipitation and drought reports for Colorado, Utah, Wyoming, and the whole U. S., visit: http://lwf.ncdc.noaa.gov/oa/climate/research/monitoring.html.
- For a list of weather stations in Colorado, Utah, and Wyoming, visit: http://www.wrcc.dri.edu/index.html.

Regional Standardized Precipitation Index data through 06/30/08

The Standardized Precipitation Index (SPI) is used to monitor moisture supply conditions. The distinguishing traits of this index are that it identifies emerging droughts months sooner than the Palmer Index and that it is computed on various time scales. Three- and 6-month SPIs are useful in short-term agricultural applications. Longer-term SPIs (12 months and longer) are useful in hydrological applications.

According to the 3-month SPI, western **Utah** and eastern **Colorado** are in dry categories, northeast **Wyoming** is in wet categories, and the rest of the region is near average (Figure 4a). During the month of June, below average precipitation in **Wyoming** caused the Powder, Little Missouri, and Tongue Drainages division to change from the very wet to moderately wet category in the 3-month SPI. However, even with recent dry conditions, **Wyoming** is still in the near normal to very wet categories. No other divisions changed in the rest of **Wyoming** or all of **Colorado**. Due to around average to above average precipitation in **Utah,** five divisions changed to wetter categories. Now **Utah** has moderately dry to near average conditions. The Western and Dixie divisions changed from the very dry to the moderately dry category and the South Central, Uinta Basin, and Southeast Basin divisions all changed from the moderately dry to the near normal categories.

Longer-term SPIs can show hydrological or longer-term droughts. Even though locations such as southern **Wyoming** show near normal conditions on the 3-month SPI, these same divisions are classified as moderately to very dry on the 36-month SPI due to long-term below average precipitation (Figure 4b). Continued below average precipitation in the Western division in **Utah** has kept this division in the very dry category. On the 3-month SPI, eastern **Colorado** is in the moderately dry to the very dry categories. Recent below average precipitation in **Colorado** has only occurred during the past 12 months and it was not low enough to be reflected in the 36-month SPI.

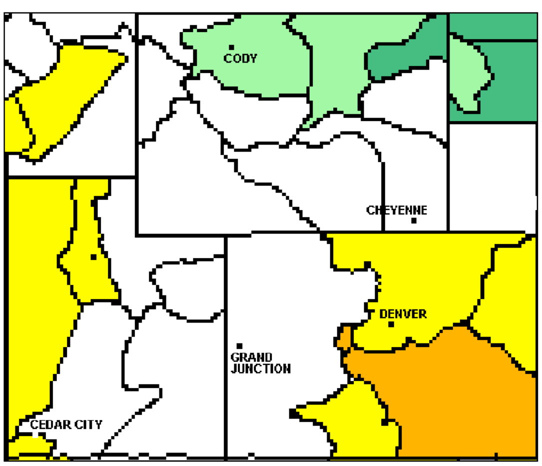


Figure 4a. 3-month Intermountain West regional Standardized Precipitation Index (data from 04/1/08–06/30/08).

Notes

The SPI is an index based on the probability of recording a given amount of precipitation, and the probabilities are standardized so that an index of zero indicates the median precipitation amount (half of the historical precipitation amounts are below the median, and half are above the median). The index is negative for drought, and positive for wet conditions. As the dry or wet conditions become more severe, the index becomes more negative or positive. The SPI is computed by the NOAA National Climatic Data Center (NCDC) for several time scales, ranging from one month to 24 months, to capture the various scales of both short-term and long-term drought. The Colorado Climate Center describes the SPI as valuable in monitoring both wet and dry periods, and it can be applied to other types of data (e.g. streamflow, reservoir levels, etc.). Near normal SPI means that the total precipitation for the past 12 months is near the long-term average for one year. An index value of -1 indicates moderate drought severity and means that only 15% would be expected to be drier. An index value of -2 means severe drought with only 2.5% of years expected to be drier.

The 3-month SPI uses data for the last three months and represents short-term precipitation patterns (Figure 4a). The 36-month SPI (Figure 4b) compares precipitation patterns for 36 consecutive months with the same 36 consecutive months during all the previous years of available data. The SPI at these time scales reflect long-term precipitation patterns. Figures 4a and b come from the Western Regional Climate Center, which uses data from the NCDC and the NOAA Climate Prediction Center.

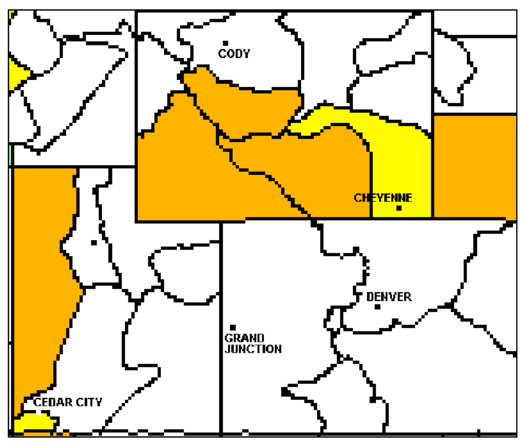


Figure 4b. 36-month Intermountain West regional Standardized Precipitation Index (data from 05/1/07–06/30/08).

+3.00 and above	Exceptionally Wet
+2.00 to +2.99	Extremely Wet
+1.25 to +1.99	Very Wet
+0.75 to +1.24	Moderately Wet
-0.74 to +0.74	Near Normal
-1.24 to -0.75	Moderately Dry
-1.99 to -1.25	Very Dry
-2.99 to -2.00	Extremely Dry
-3.00 and below	Exceptionally Dry

On the Web

- For information on the SPI, how it is calculated, and other similar products for the entire country, visit: http://www.wrcc.dri.edu/spi/spi.html.
- For information on past precipitation trends, visit: http://www.hprcc.unl.edu/products/current.html.
- For SPI products directly form the NCDC, visit: http://lwf.ncdc.noaa.gov/oa/climate/research/prelim/drought/spi.html. These maps use the same data as Figures 4a and b, but the categories are defined slightly differently.

U.S. Drought Monitor conditions as of 6/17/08

The U.S. Drought Monitor shows that the pattern of drought severity in the IMW is relatively consistent with last month (Figure 5; see inset). The highest drought intensity in the region continues to be in southeastern **Colorado** (D4: exceptional drought), and D2 conditions (severe drought) persist in southwest **Wyoming**. Conditions in northeast **Colorado** have increased from abnormally dry (D0) to drought (D1) in the past month. In both **Colorado** and **Wyoming**, drought conditions do not occur in approximately 50% of the state (47% and 56%, respectively). In **Utah**, drought is not indicated in 74% of the state, whereas last year at this time, the entire state was classified as abnormally dry (D0) or in drought (D1 or greater).

Fewer drought impacts were reported compared to last month, although the Drought Impact Reporter still indicates several problems in the IMW, particularly in southeastern **Colorado**. There, Governor Ritter is seeking federal drought relief assistance to help farmers and ranchers in Baca, Bent, Kiowa and Prowers counties. In addition, ranchers in these counties, as well as Philips and Yuma counties, are permitted to use Conservation Reserve Program (CRP) land for emergency haying and grazing. This will be allowed through September 30, 2008. In southern **Utah**, wildfires burned 1300 acres in Dixie National Forest (June 27); no impacts were reported in **Wyoming**.

Notes

The U. S. Drought Monitor (Figure 5) is released weekly (every Thursday) and represents data collected through the previous Tuesday. The inset (lower left) shows the western United States from the previous summary's map.

The U. S. Drought Monitor maps are based on expert assessment of variables including (but not limited to) the Palmer Drought Severity Index, soil moisture, streamflow, precipitation, and measures of vegetation stress, as well as reports of drought impacts. It is a joint effort of several agencies.

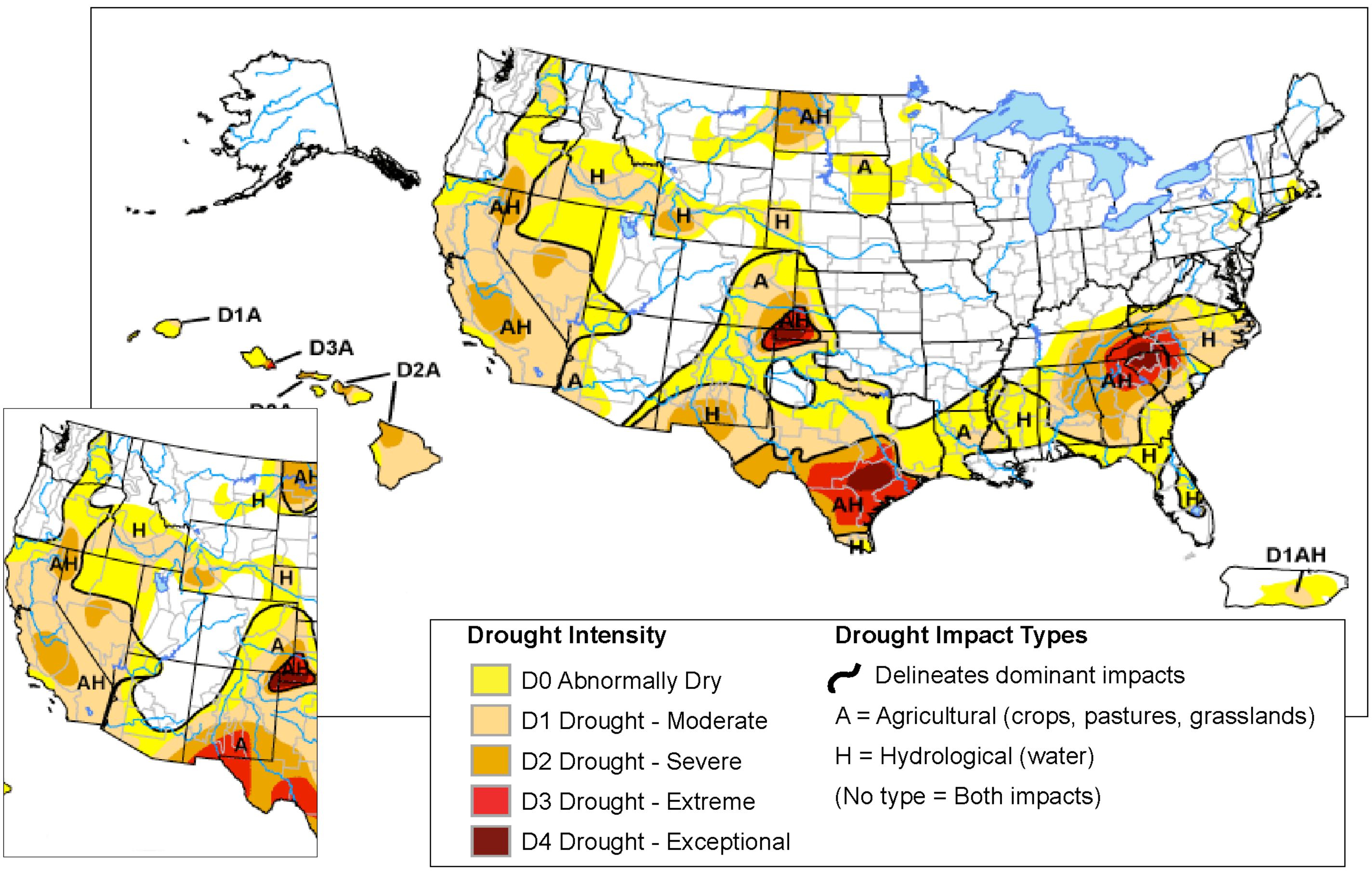


Figure 5. Drought Monitor from July 15, 2008 (full size) and June 17, 2008 (inset, lower left) for comparison.

On the Web

- For the most recent Drought Monitor, released every Thursday, visit: http://www.drought.unl.edu/dm/monitor/html. This site also includes archives of past drought monitors.
- Drought Impact Reporter (National Drought Mitigation Center): http://droughtreporter.unl.edu/.
- NIDIS Drought Portal: http://www.drought.gov.

Reservoir Supply Conditions

Reservoirs continued to fill in June, and almost all reservoirs in Figure 6 increased their storage as a percent of capacity since last month. The biggest gains in storage were in **Wyoming**, where storage in Seminoe, Boysen, and Buffalo Bill Reservoirs increased 25, 20, and 22 percentage points, respectively. Fontenelle Reservoir gained 47 percentage points in percent of capacity, bringing the storage to 98% full. The USBR Upper Colorado Region increased releases from Fontenelle from 4000 cfs to 4200 cfs July 7–10, 2008 in order to avoid spills during this peak streamflow time.

While all reservoirs in **Utah** increased their storage, the lowest gains this month were in **Utah**, where the highest gain in percent of capacity was 9 percentage points in Lake Powell. Lake Powell has risen 42 feet since it began filling in March and it is now 69 feet below full pool elevation, according to Brian McInerney of NWS. The USBR expects Lake Powell's elevation to peak by early August when they will begin releases to achieve equalization with Lake Mead.

Reservoirs in **Colorado** have all increased their percent of capacity, and the most gains in storage were in Turquoise Lake which went from 42% full on May 31 to 77% full on June 30. All the other reservoirs in **Colorado** in Figure 6 have above average storage, with Pueblo the highest at 145% of average. The USBR has been releasing water from Blue Mesa since mid June in anticipation of inflows that were projected to be 146% of average. They expect the reservoir to fill by the end of July.

Notes

The size of each "tea-cup" is proportional to the size of the reservoir, as is the amount the tea-cup is filled (Figure 6). The first percentage shown in the table is the current contents divided by the total capacity. The second percentage shown is the current contents divided by the average storage for this time of year (not shown). Reservoir status is updated at different times for individual reservoirs.

Reservoir	Current Storage (KAF)	Total Capacity (KAF)	% Full	% of Average
Colorado				
Dillon Reservoir	257.7	254.0	101%	103%
Turquiose Lake	99.9	129.4	77%	85%
Lake Granby	444.7	539.7	82%	106%
Blue Mesa Res.	725.9	829.5	88%	104%
Pueblo	232.4	354.0	66%	145%
Utah				
Strawberry Res.	966.7	1,106.5	87%	136%
Utah Lake	815	870.9	94%	93%
Bear Lake	407.4	1302.0	31%	42%
Lake Powell	15150.5	24322.0	62%	76%
Wyoming				
Fontenelle Res.	337.4	344.8	98%	125%
Flaming Gorge Res.	3028.9	3749.0	81%	94%
Seminoe Res.	661.0	1017.2	65%	95%
Boysen Res.	662.6	741.6	89%	108%
Buffalo Bill Res.	616.0	644.1	96%	127%

KAF = Thousands of Acre Feet

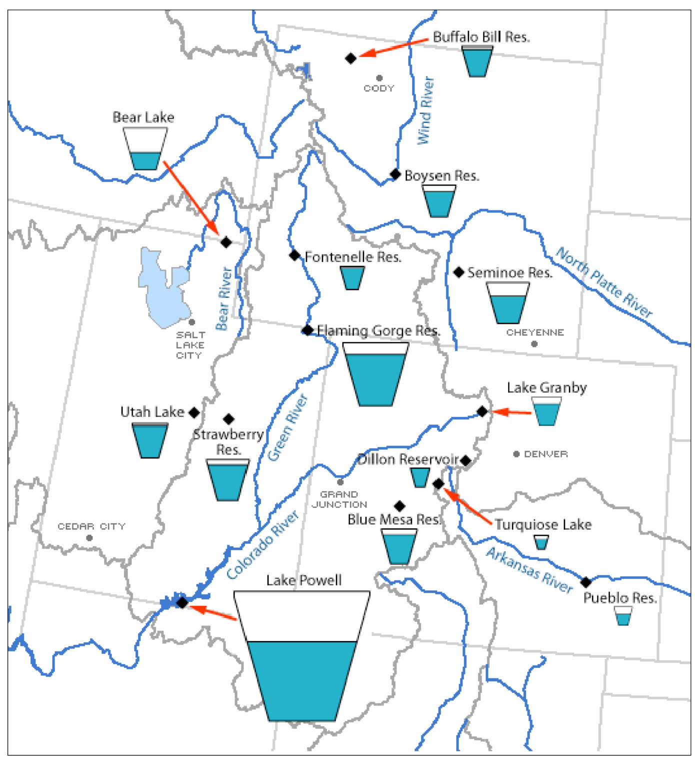


Figure 6. Tea-cup diagram and table of several large reservoirs in the Intermountain West Region. All reservoir content data is from June 30–July 7, 2008.

On the Web

- For individual reservoir information including management agency, operations, and storage content, visit the WWA website at: http://wwa.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary/links.html, and click on individual links. The NOAA/NWS Seasonal Runoff Volume Forecast website is: http://www.cbrfc.noaa.gov/westernwater.
  - For individual site-specific streamflow forecasting information, click on desired region and drag mouse over square box.
  - For individual forecast point plot graphs click on the desired square box.
- For monthly reports from NRCS on water supply conditions & forecasts for major CO river basins, visit: http://www.wcc.nrcs.usda.gov/cgibin/bor.pl.
- For water Supply Outlook for the Upper Colorado River Basin, produced by the CBRFC at: http://www.cbrfc.noaa.gov/wsup/wsup.cgi.

Colorado Water Availability

In the beginning of July streamflows continued to be above average through out most of Colorado, especially in the west. As of June 7, 2008, the majority of the USGS streamflow sites in western Colorado had values in the above average (75th – 90th percentile) to much above average (above the 90th percentile) categories (Figure 7a). Streamflows were mostly in the near average (25th – 75th percentile) category in the east, with one site – Fountain Creek near Colorado Springs – at 8% of average.

Across eastern Colorado, PDSI values (Figure 7b) are in the severe drought category (-3.0 to -3.9) in the Arkansas Drainage division and in the moderate drought category (-2.0 to -2.9) in the Kansas and Rio Grande divisions. Western Colorado and the Platte River divisions are in the near average category. Eastern Colorado needs up to 6 inches of precipitation to bring the Palmer Drought Index value to near average (-0.5), according to the NOAA Climate Predication Center (Figure 7c). The North American monsoon has begun to bring precipitation to the southwestern U.S., and it should bring precipitation to southern Colorado in the next few months as well.

Notes

The average streamflow conditions for the past 7 days are compared to streamflows during the same time period in past years (Figure 7a). The "near normal" or 25th – 75th percentile class indicates that the stream flows are in the same range as 25–75% of past years. Note that this "normal" category represents a wide range of flows. Only stations having at least 30 years of record are used. This data is provisional and may be subject to significant change.

The PDSI (Figure 7b) is a meteorological drought index produced by the NOAA Climate Prediction Center, which provides a standardized measurement of moisture conditions to compare between locations over time. It incorporates precipitation and temperature data as well as the current soil moisture conditions (for more information on the PDSI, see the Feature Article in the July 2007 IMW Climate Summary).

Drought conditions are expressed in Figure 7c in terms of precipitation needed in addition to average precipitation to bring the weekly PDSI to -0.5 (the near normal category). It is a somewhat artificial calculation, but provides users a conceptualization of the precipitation needed to end precipitation deficits in the next week. This calculation is made weekly for each climate division; if a given division receives above average rainfall in a week, the precipitation deficit is lower, and the following week, the precipitation needed to bring the PDSI to near normal conditions is likely to be lower.

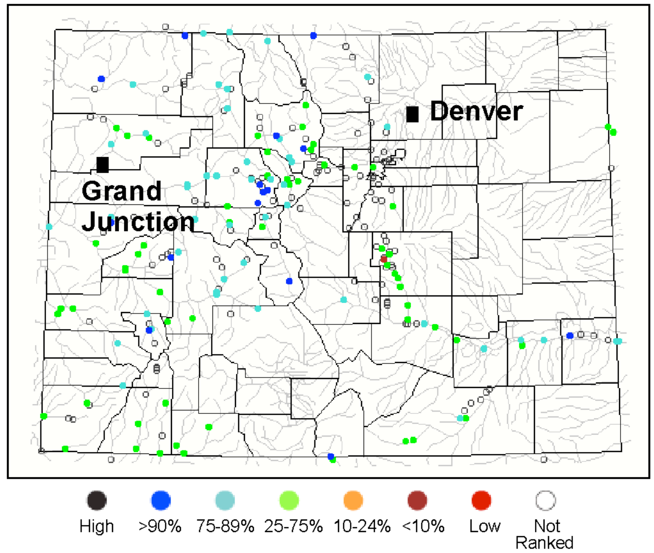


Figure 7a. 7-day average streamflow conditions for points in Colorado as of July 7, 2008 recorded at USGS gauging stations.

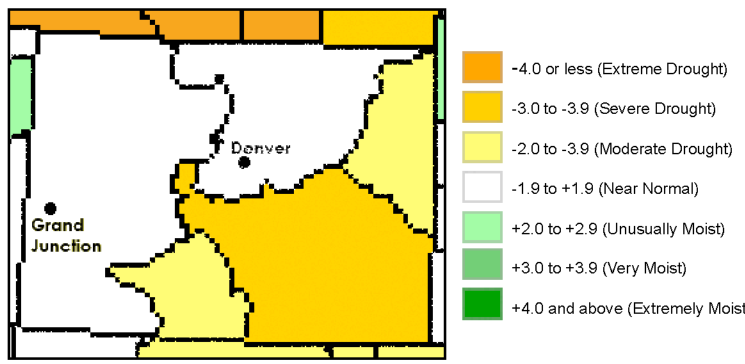


Figure 7b. Long term Palmer Drought Severity Index for the week ending July 5, 2008.

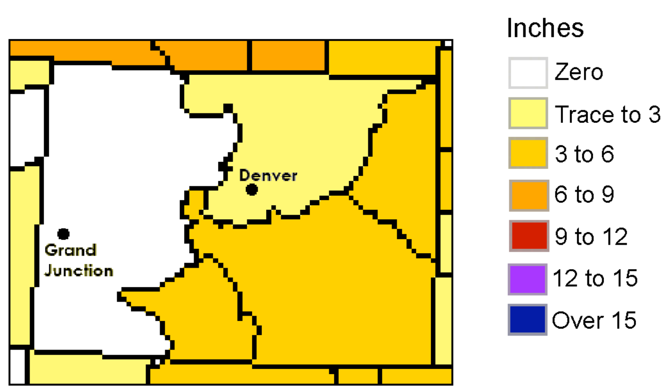


Figure 7c. Additional precipitation (in inches) in each climate division in Colorado needed to bring the Palmer Drought Severity Index to near average values (data as of July 5, 2007).

On the Web

- For current streamflow information from USGS, Figure 7a, visit: http://water.usgs.gov/waterwatch/.
- The Palmer Drought Severity Index (Figure 7b) can be accessed from the NOAA CPC monitoring and data page: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/.
- For weekly NOAA CPC maps of additional precipitation needed to bring PDSI to normal for the continental US like Figure 7c visit: http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.
- The Colorado SWSI along with more data about current water supply conditions for the state can be found at: http://www.co.nrcs.usda.gov/snow/fcst/watershed/current/monthly/maps_graphs/index.html.
- The Colorado Water Availability Task Force information, including agenda & minutes of upcoming & previous meetings is available at: http://www.cwcb.state.co.us/Conservation/Drought/taskForceAgendaMinPres.htm.

Wyoming Water Availability

Streamflows at the beginning of July were mostly higher than they were at the beginning of June. As of July 7, 2008, the majority of the USGS streamflow sites in Wyoming are in the near average to above average categories (25th – 89th percentile; Figure 8a). Streamflows are highest in the Snake River Basin, located in western Wyoming, and the Tongue River Basin, located in north-central Wyoming (75th – >90th percentile). Buffalo Fork Creek in the Snake River Basin reported streamflows in the 96th percentile. The lowest streamflows were in the Wind-Big Horn River Basin, located in central Wyoming. Bull Lake Creek in the Wind-Big Horn River Basin reported streamflows in the 10th percentile.

Western and southern Wyoming climate divisions are all in drought catagories, according to the Palmer Drought Severity Index (PDSI; Figure 8b). Southern Wyoming and the Yellowstone Drainage division in northwest Wyoming are experiencing an extreme drought with values of -4 or less. The Yellowstone Drainage division needs 9-12" of precipitation to bring the PDSI value to near average, according to the NOAA Climate Predication Center (see On the Web; Figure 8c). Southern Wyoming needs 6-9" of precipitation to have near average PDSI values.

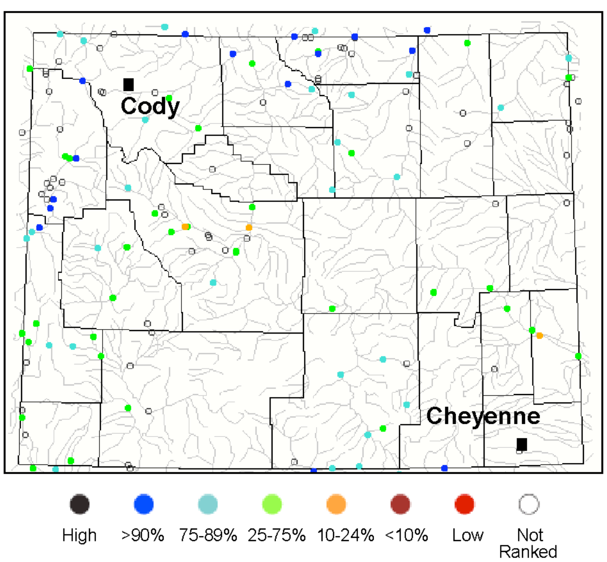


Figure 8a. 7-day average streamflow conditions for points in Wyoming as of July 7, 2008 recorded at USGS gauging stations.

Notes

The average streamflow conditions for the past 7 days are compared to streamflows during the same time period in past years (Figure 8a). The "near normal" or 25th – 75th percentile class indicates that the stream flows are in the same range as 25 – 75% of past years. Note that this "normal" category represents a wide range of flows. Only stations having at least 30 years of record are used. This data is provisional and may be subject to significant change.

The PDSI (Figure 8b) is a meteorological drought index produced by the NOAA Climate Prediction Center, which provides a standardized measurement of moisture conditions to compare between locations over time. It incorporates precipitation and temperature data as well as the current soil moisture conditions (for more information on the PDSI, see the Feature Article in the July 2007 IMW Climate Summary).

Drought conditions are expressed in Figure 8c in terms of precipitation needed in addition to average precipitation to bring the weekly PDSI to -0.5 (the near normal category). It is a somewhat artificial calculation, but provides users a conceptualization of the precipitation needed to end precipitation deficits in the next week. This calculation is made weekly for each climate division; if a given division receives above average rainfall in a week, the precipitation deficit is lower; and the following week, the precipitation needed to bring the PDSI to near normal conditions is likely to be lower.

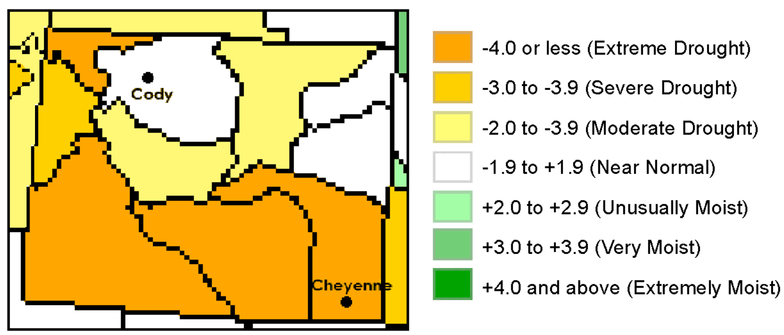


Figure 8b. Long term Palmer Drought Severity Index for the week ending July 5, 2008.

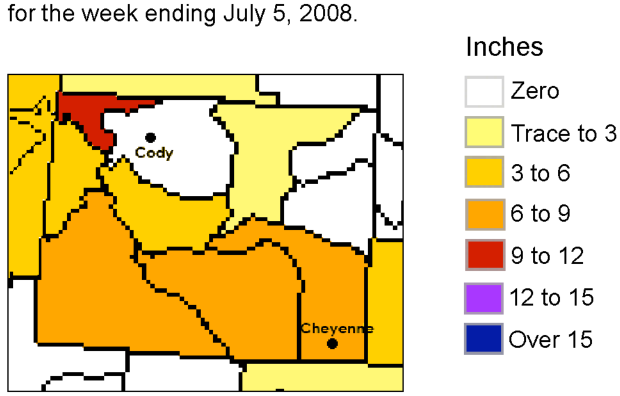


Figure 8c. Additional precipitation (in inches) in each climate division in Wyoming needed to bring the Palmer Drought Severity Index to near average values (data as of July 5, 2007).

On the Web

- For current streamflow information from USGS, Figure 8a, visit: http://water.usgs.gov/waterwatch/.
- The Palmer Drought Severity Index, Figure 8b, can be accessed from the NOAA CPC monitoring and data page: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring.
- For weekly NOAA CPC maps of additional precipitation needed to bring PDSI to normal for the continental US like Figure 8c, visit: http://www.cpc.ncep.noaa.gov/products/monitoring_and_date/drought.shtml.
- Wyoming Water Resource Data system's drought page is located at: http://www.wrds.uwyo.edu/wrds/wsc/dtf/drought.html.

Utah Water Availability

Streamflows in the beginning of July are mostly higher than they were in the beginning of June. As of July 7, 2008, the majority of the USGS streamflow sites in Utah are in the near average category (25th – 75th percentile; Figure 9a). Streamflows are highest in the north with some points in the above average category (75th – 90th percentile). Two sites in the Upper Sevier River basin are near 90% of average. Streamflows are lowest in the Virgin River basin in the southwest and the Uinta Basin in the northeast.

Only western Utah is in drought categories, according to the long term Palmer Drought Severity Index (PDSI; Figure 9b) The Uinta division in the northeast the only climate division in the western U.S. to be in a wet category: +2.0 to +2.9 (unusual moist spell). Most of the state needs up to 3 inches of precipitation to bring the PDSI value to near average (-0.5), according to the NOAA Climate Predication Center (Figure 9c). This is in contrast to the Drought Monitor (page 7) where drought is not indicated in 75% of the state. The North American monsoon has begun to bring precipitation to the southwestern U.S., and it should bring precipitation to southern Utah in the next few months as well.

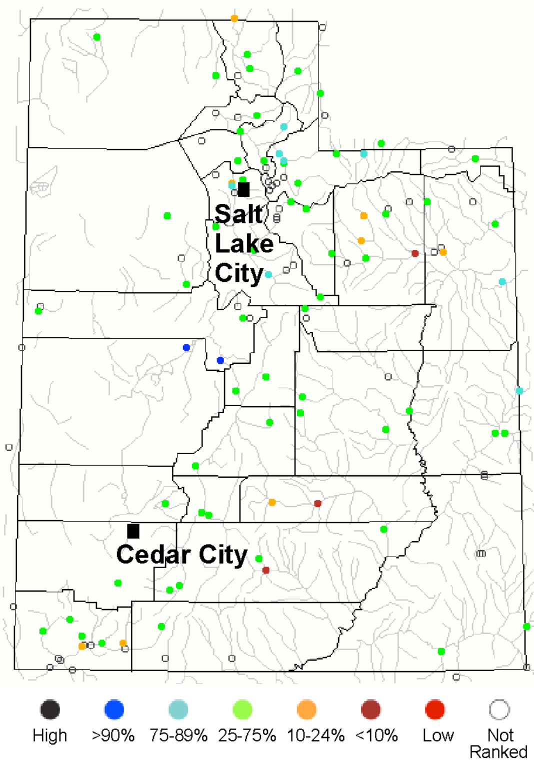


Figure 9a. 7-day average streamflow conditions for points in Utah as of July 7, 2008, recorded at USGS gauging stations.

Notes

The average streamflow conditions for the past 7 days are compared to streamflows during the same time period in past years (Figure 9a). The "near normal" or 25th – 75th percentile class indicates that the stream flows are in the same range as 25 – 75% of past years. Note that this "normal" category represents a wide range of flows. Only stations having at least 30 years of record are used. This data is provisional and may be subject to significant change.

The PDSI (Figure 9b) is a meteorological drought index produced by the NOAA Climate Prediction Center, which provides a standardized measurement of moisture conditions to compare between locations over time. It incorporates precipitation and temperature data as well as the current soil moisture conditions (for more information on the PDSI, see the Feature Article in the July 2007 IMW Climate Summary).

Drought conditions are expressed in Figure 9c in terms of precipitation needed in addition to average precipitation to bring the weekly Palmer Drought Severity Index to -0.5 (the near normal category). It is a somewhat artificial calculation, but provides users a conceptualization of the precipitation needed to end precipitation deficits in the next week. This calculation is made weekly for each climate division; if a given division receives above average rainfall in a week, the precipitation deficit is lower and the following week, the precipitation needed to bring the PDSI to near normal conditions is likely to be lower.

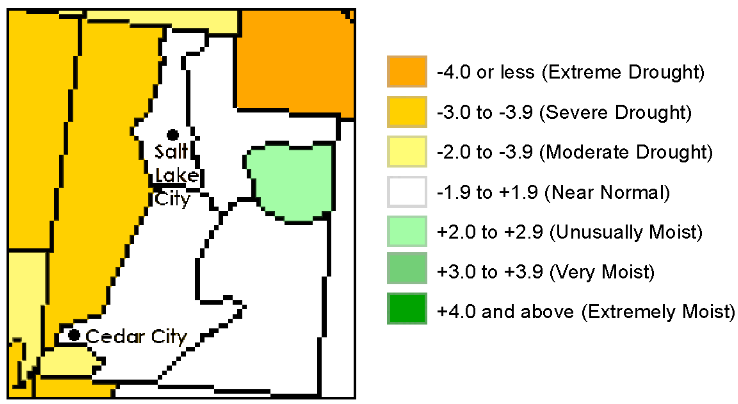


Figure 9b. Long term Palmer Drought Severity Index for the week ending July 5, 2008.

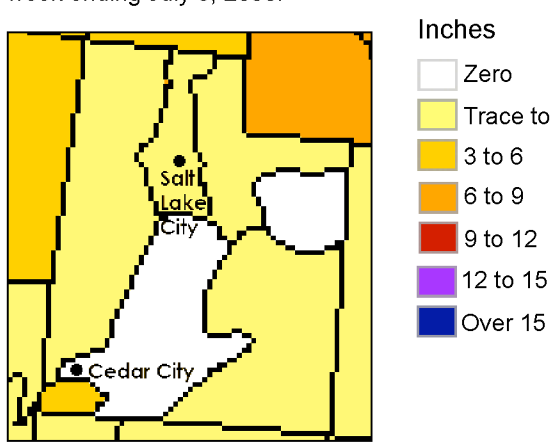


Figure 9c. Additional precipitation (in inches) in each climate division in Utah needed to bring the Palmer Drought Severity Index to near average values (data as of July 5, 2007).

On the Web

- For current streamflow information from USGS, Figure 9a, visit: http://water.usgs.gov/waterwatch/.
- The Palmer Drought Severity Index (Figure 9b) can be accessed from the NOAA CPC monitoring and data page: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/.
- For weekly NOAA CPC maps of additional precipitation needed to bring PDSI to normal for the continental US like Figure 9c visit: http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.
- The Lake Powell Status Summary is updated at the first of each month and is available at http://www.usbr.gov/uc/.

Temperature Outlook August–October 2008

The latest temperature outlooks from the NOAA Climate Prediction Center indicate that in August 2008, an enhanced probability of above normal temperatures in **Utah**, largely based on recent strong summer temperature trends in the Southwestern U.S. (Figure 10a).

In the August–October and September–November seasons, parts of southern **Utah/Colorado** and eastern **Colorado** have an increased chance of above average temperatures as part of a region that extends across much of the southern tier of the U.S (Figures 10b–c). These outlooks are based primarily on recent temperature trends and follow closely the recent objective consolidation forecast (CON, see feature article in the June 2007 Summary), with additional support from statistical forecast tools.

The Seasonal Outlooks are updated on the third Thursday of the month, and the next one will be issued on August 21st.

Notes

The CPC seasonal temperature outlooks predict the likelihood (percent chance) of temperatures occurring in the above-average, near-average, and below-average categories. The numbers on the maps do not refer to actual temperature values, but to the probability, in percent, that temperatures will be in one of these three categories. The skill of the temperature outlooks largely comes from the status of ENSO and recent trends. The categories are defined based on the 1971–2000 climate record; each 1- or 3-month period is divided into 3 categories (terciles), indicating the probabilities that the temperature in the period will fall into the upper third of the years (upper tercile), the middle third of the years (middle tercile, or around average), or the lowest third of the years (lower tercile). The forecast map depicts the probability that temperature will be in the above-average (A, orange shading) or below-average (B, blue shading) tercile--with a corresponding decrease in the opposite category. The near-average category is preserved at 33.3% likelihood, unless the anomaly forecast probability is very high. Equal Chances (EC) represents equal chances or a 33.3% probability for each tercile, indicative of areas where signals are weak or conflicting and the reliability (i.e., 'skill') of the forecast is poor. For a more detailed description, see notes on the precipitation outlook page.

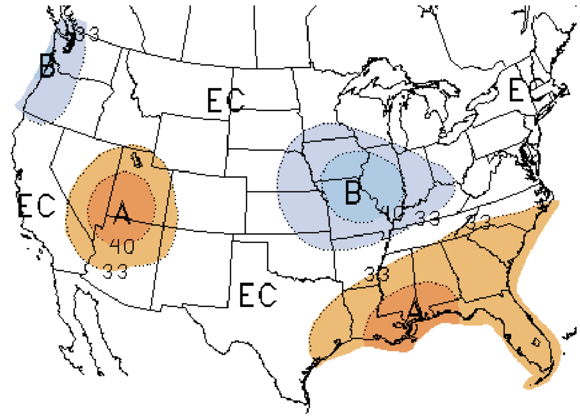


Figure 10a. Long-lead national temperature forecast for August 2008 (released July 17, 2008).

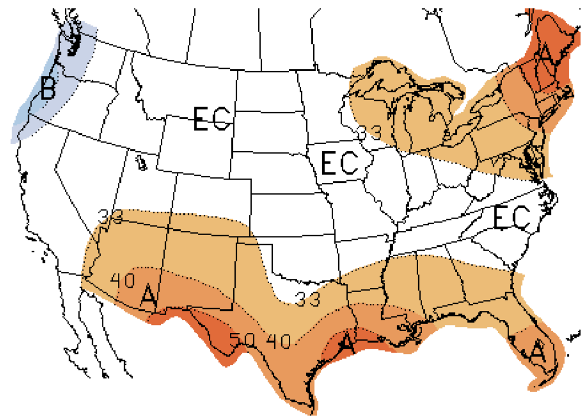


Figure 10b. Long-lead national temperature forecast for Aug.–Oct. 2008 (released July 17, 2008).

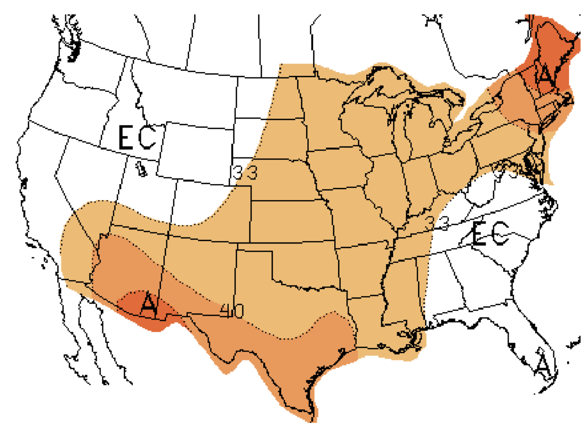


Figure 10c. Long-lead national temperature forecast for Sep.–Nov. 2008 (released July 17, 2008).

A = Above
- 60.0–69.9%
- 50.0–59.9%
- 40.0–49.9%
- 33.3–39.9%

B = Below
- 40.0–49.9%
- 33.3–39.9%

EC = Equal Chances

On the Web

- For more information and the most recent forecast images, visit: http://www.cpc.ncep.noaa.gov/products/predictions/90day/. Please note that this website has many graphics and may load slowly on your computer.
- The CPC "discussion for non-technical users" is at: http://www.cpc.noaa.gov/products/predictions/90day/fxus05.html.
- For IRI forecasts, visit: http://iri.columbia.edu/climate/forecast/net_asmt/.
- More information about temperature distributions at specific stations in Colorado, Utah, Wyoming, and across the West can be found at the Western Regional Climate Center, http://www.wrcc.dri.edu/CLIMATEDATA.html.

Precipitation Outlook August–November 2008

The CPC precipitation outlook for August 2008 shows "EC" or equal chances for above-, near-, or below-average precipitation for the interior West, indicating no skillful information on precipitation (Figure 11a). CPC forecasters note that the precipitation forecast for a period as short as a month - at 0.5 month lead - is often difficult and for August 2008 there is no strong signal, given the neutral state of ENSO.

However, there is skill for the following 3-month seasons. An increased probability of above average precipitation is forecast for parts of **Colorado** and eastern **Wyoming** in the August–October and September–November seasons. This forecast is based partly on the CON tool (see feature article in the June 2007 Summary) and is supported by recent trends in precipitation for the region. For the most recent 15 years, precipitation has been above normal in these seasons in 50% or more of these years in most of the climate divisions in an area stretching from eastern **Utah** through **Colorado**, southeast **Wyoming**, and western Nebraska into South Dakota. **Utah** shows "EC" for these seasons (Figures 11b–c).

The August 2008 precipitation forecast will be updated on July 31st. on the CPC web page. Because of the shorter lead-time, the "zero-lead" forecast (i.e. on the last day of the previous month) often has increased skill over the half-month lead forecasts shown here. The Seasonal Outlooks are updated on the third Thursday of the month, and the next one will be issued on August 21st.

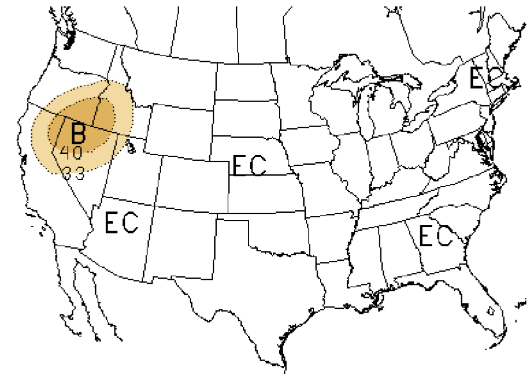


Figure 11a. Long-lead national precipitation forecast for August 2008 (released July 17, 2008).

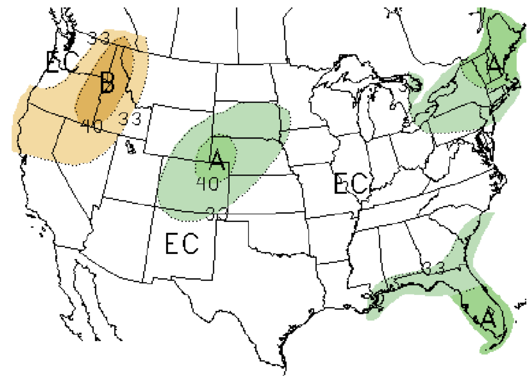


Figure 11b. Long-lead national precipitation forecast for Aug.–Oct. 2008 (released July 17, 2008).

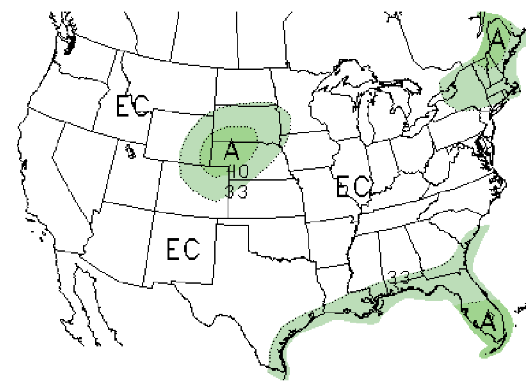
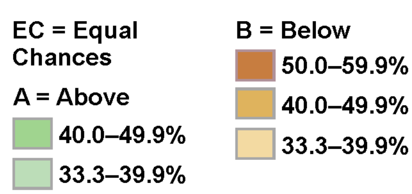


Figure 11c. Long-lead national precipitation forecast for Sep.–Nov. 2008 (released July 17, 2008).



Notes

The seasonal precipitation outlooks predict the likelihood (percent chance) of precipitation occurring in the above-average, near-average, and below-average categories. The numbers on the maps do not refer to actual precipitation values, but to the probability in percent that precipitation will be in one of these three categories. The categories are defined based on the 1971–2000 climate record; each 1- or 3-month period is divided into 3 categories (terciles), indicating the probabilities that the precipitation in the period will fall into the upper third of the years (upper tercile), the middle third of the years (middle tercile, or around average), or the lowest third of the years (lower tercile), each with a 33.3% chance of occurring. The middle tercile is considered the near-average (or normal) precipitation range. The forecast indicates the likelihood of the precipitation occurring in the below-average (B, brown shading) or above-average (A, green shading) --with a corresponding decrease in the opposite category, The near-average category is preserved at 33.3% likelihood, unless the anomaly forecast probability is very high.

Thus, areas with dark brown shading indicate a 40.0–50.0% chance of below-average, a 33.3% chance of near-average, and a 16.7–26.6% chance of above-average precipitation. Light brown shading displays a 33.3–39.9% chance of below-average, a 33.3% chance of near-average, and a 26.7–33.3% chance of above-average precipitation and so on. Equal Chances (EC) represents equal chances or a 33.3% probability for each tercile, indicative of areas where signals are weak or conflicting and the reliability (i.e., 'skill') of the forecast is poor. "N" indicates an increased chance of near-average conditions, but is not forecast very often.

On the Web

- For more information and the most recent CPC forecast images, visit: http://www.cpc.ncep.noaa.gov/products/predictions/90day/. Please note that this website has many graphics and may load slowly on your computer.
- The CPC "discussion for non-technical users" is at: http://www.cpc.noaa.gov/products/predictions/90day/fxus05.html.
- For IRI forecasts, visit: http://iri.columbia.edu/climate/forecast/net_asmt/.
- More information about precipitation distributions at specific stations in Colorado, Utah, Wyoming, and across the West can be found at the Western Regional Climate Center, http://www.wrcc.dri.edu/CLIMATEDATA.html.The NOAA/ESRL experimental guidance product, including a discussion and executive summary, is available on the web at: http://www.cdc.noaa.gov/people/klaus.wolter/SWcasts/index.html.

Seasonal Drought Outlook through October 2008

According to the U.S. Drought Monitor (page 7), drought conditions exist across a swath of central **Wyoming**, most of **Colorado** east of the Continental Divide, and along the western border of **Utah**. The U.S. Seasonal Drought Outlook (DO) builds on the DM categories to project how these drought areas might change or where new drought areas might develop. The DO issued July 17th, projects likely improvement for the southeast corner of **Colorado** (Figure 12). This projection is consistent with the 3-month precipitation outlook, which has an increased chance of above average precipitation in **Colorado** and eastern **Wyoming** for the August–October season (see page 13). "Improvement" indicates at least a 1-category change in the DM classification.

Drought in southwestern **Wyoming** is designated as likely to persist. Although June–August is typically one of the wetter times of the year, the official CPC precipitation forecasts favor near average precipitation through October for western **Wyoming** and all of **Utah**.

There are no new areas of drought development in the Interior West indicated in this DO. The next Seasonal Drought Outlook will be issued in two weeks, on July 31st.

Notes

The Seasonal Drought Outlook (DO) depicts general, large-scale trends from that date through the end of the forecast period (3 to 3.5 months, depending on the date of issue). The delineated areas in the DO (Figure 12) are defined subjectively based on expert assessment of numerous indicators described above, including outputs of short- and long-term forecasting models. Areas of continuing drought are schematically approximated from the Drought Monitor (D1 to D4). For weekly drought updates, see the latest Drought Monitor text on the website (updated weekly) see: http://www.drought.unl.edu/dm/monitor.html. NOTE: The green improvement areas imply at least a 1-category improvement in the Drought Monitor intensity levels, but do not necessarily imply drought elimination.

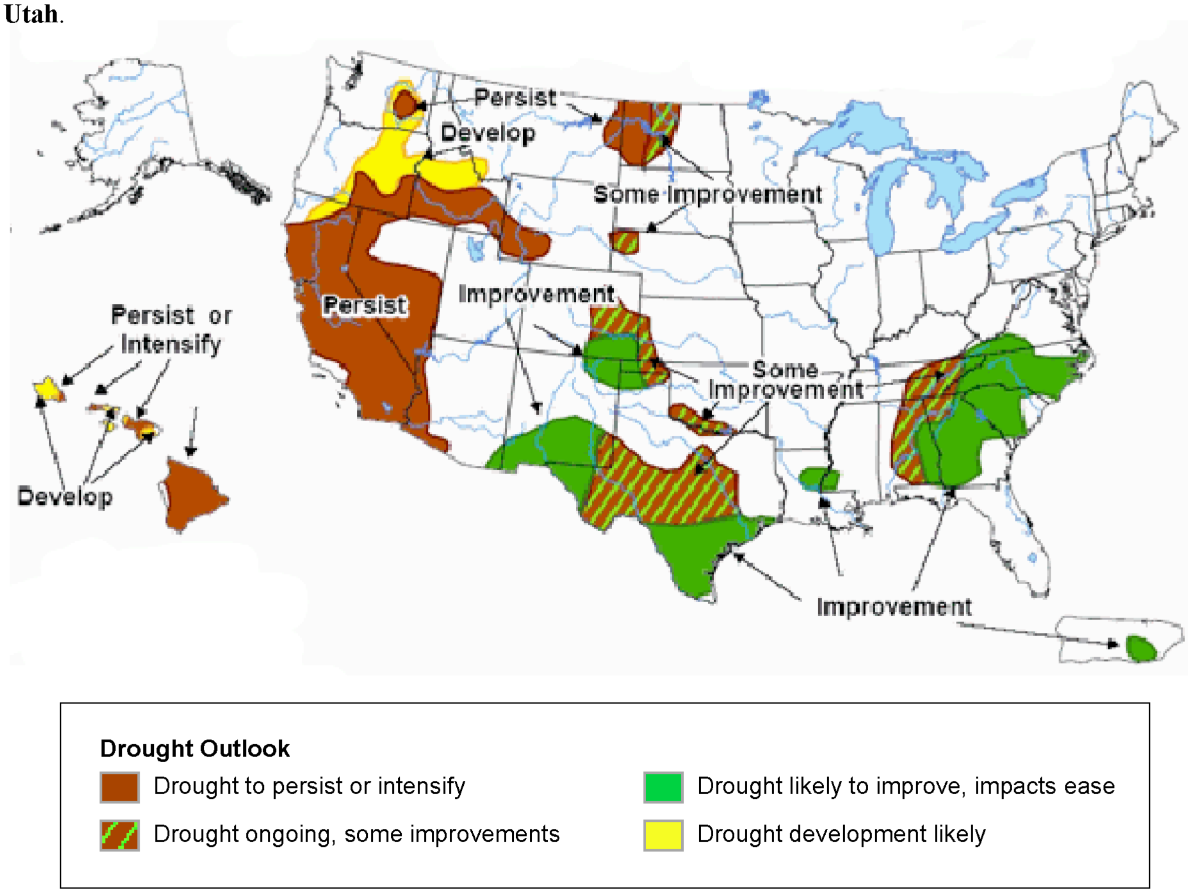


Figure 12. Seasonal Drought Outlook for July 17, 2008 through October 2008.

On the Web

- For more drought information, visit: http://www.drought.noaa.gov/.
- Forecasts of drought termination probabilities can be found at: http://www.ncdc.noaa.gov/oa/climate/research/drought/current.html.

El Niño Status and Forecast

The equatorial Pacific returned to ENSO neutral conditions during June 2008, according to NOAA's official definition of ENSO anomalies that involves a 3-month mean of SSTs: to be considered an El Niño or La Niña this index must exceed ± 0.5°C. According to NOAA and its partner the International Research Institute for Climate and Society (IRI), La Niña conditions have nearly completely disappeared in the equatorial Pacific (Figure 13a). Residual atmospheric effects of the recent La Nina are expected to have small impacts on U.S. temperatures and precipitation in August.

We are now largely through the "Spring Barrier" to ENSO prediction, which refers to the time of year (northern hemisphere spring) when predictions are especially difficult. Models are showing fair agreement in their ENSO forecasts through the 10-month forecast period (Figure 13b). For the current Jul-Aug-Sep season, the majority of the predictions indicate ENSO-neutral conditions. The majority of models also remain ENSO-neutral through 2008, while a couple models develop weak El Niño conditions and a couple re-develop weak La Niña conditions. Based on model forecasts and current observations of the ocean surface and subsurface, the probability of La Niña conditions is estimated at 10% for the Jul-Aug-Sep season in progress, a 15% chance of El Niño conditions, and the probability of maintaining ENSO-neutral conditions is 75%.

Notes

Two NOAA graphics in Figure 13a show observed SST (upper) and SST anomalies (lower) in the Pacific Ocean, averaged over a recent 7-day period. Data are from satellite observations and the NOAA TAO array of 70 moored buoys spread out over the Pacific Ocean, centered on the equator. The buoys measure temperature, currents, and winds and transmit data in real-time. NOAA uses these observations to predict short-term (a few months to one year) climate variations.

Figure 13b shows forecasts for SST forecastsin the Niño 3.4 region for nine overlapping 3-month periods. "Niño 3.4" refers to the region of the equatorial central Pacific from 120°W to 170°W and 5°N to 5°S, which is used as an SST-based index for defining ENSO. Abbreviations represent groups of three months (e.g. SON = Sept–Nov). The expected skills of the models, based on historical performance, vary among the models, and skill generally decreases with lead-time. Forecast skill also varies over the year because of seasonal differences in predictability of SSTs, e.g., forecasts made between June and December are generally better than those made between February and May (the spring predictability "barrier"). Differences among model forecasts in Figure 13b reflect differences in model design, which in turn reflect uncertainty in the forecast of the possible future SST scenarios.

Observed Sea Surface Temperature Anomalies (C°)

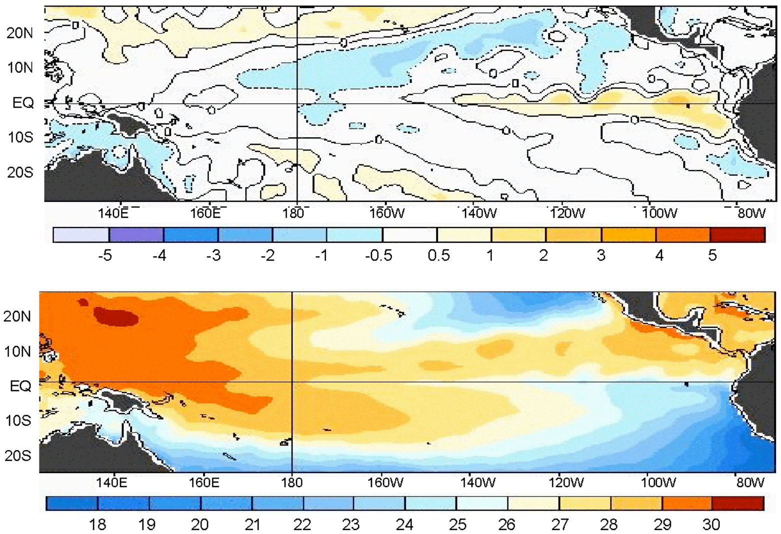


Figure 13a. Observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. The Niño 3.4 region encompasses the area between 120°W–170°W and 5°N–5°S. The graphics represent the 7-day average centered on July 9, 2008.

Model Forecasts of ENSO from July 2008

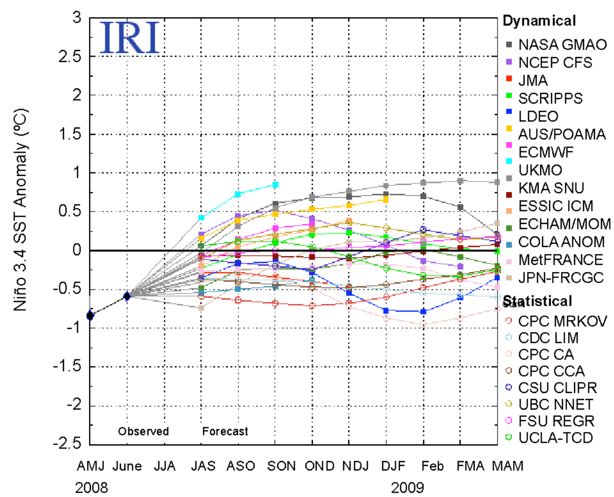


Figure 13b.Forecasts made by dynamical and statistical models for sea surface temperatures (SST) in the Niño 3.4 region for nine overlapping 3-month periods from July 2008–May 2009 (released July 15, 2008). Graphic is from the International Research Institute (IRI) for Climate and Society.

On the Web

- For a technical discussion of current El Niño conditions, visit the ENSO Diagnostic Discussion, a collaborative effort of the several parts of NOAA, including the research labs, the IRI, and other institutions funded by NOAA: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ (updated on the second Thursday of the month).
- For updated graphics of SST and SST anomalies like figure 13a, visit this site and click on "Weekly SST Anomalies": http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml#current.
- For more information about El Niño, including the most recent forecasts (Figure 13b), visit: http://portal.iri.columbia.edu/climate/ENSO/. The "forecast plume" showing multiple model projections is updated on the third Thursday of the month.
- The Multivariate ENSO Index is available at: http://www.cdc.noaa.gov/people/klaus.wolter/MEI/.

The Denver/Boulder National Weather Service Forecast Office

By Julie Malmberg, WWA

The mission of the NOAA National Weather Service (NWS) is to "provide, weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy" (NWS 2004). There are 128 NWS Weather Forecast Offices (WFO) across the United States, Guam, and the American Samoa. The employees at each WFO perform specific tasks related to providing high quality weather, climate, and hydrology products. Several positions are common to all WFOs:

- The Meteorologist in Charge (MIC) manages each WFO. The Warning Coordination Meteorologist (WCM) acts as the liaison to the public.
- The Science and Operations Office (SOO) trains the staff in the current science and technological breakthroughs.
- The Data Acquisitions Program Manager (DAPM) is the administrator of data collection programs, including climate data.
- The Service Hydrologist manages all the hydrology programs such as streamflow forecasts and flood stages.
- Senior, General, and Intern Meteorologists issue forecasts, watches, and warnings.

In this article, we focus on the unique duties of the Service Hydrologist and one of the meteorologists , the Climate Service Focal Point.

The Denver/Boulder WFO is located in Boulder, Colorado and it covers 22 counties, over 29,000 square miles, and represents a population of 3.5 million people in northeast and north-central Colorado . The elevation in the coverage area ranges from 3,500 feet above sea level in northeast Colorado to over 14,000 feet at mountain peaks, which is one of the largest elevation ranges that any WFO covers. The Rocky Mountains complicate forecasting because the giant peaks disrupt the flow of air currents; this causes regional and local changes in air temperature and humidity, and thus weather.

One novel aspect is that the WFO is collocated with the David Skaggs Research Center (DSRC), and the staff has easy access to current research on drought, water supply, snowpack, and climate change. The DSRC (Figure 14a) is the largest NOAA laboratory in the nation, making this an ideal location for interactions with many well-known experts in atmospheric science. The DSRC is home to over 900 scientists, including winners of the National Medal of Science, the Blue Planet Prize, and many who shared the 2007 Nobel Peace Prize for work on climate change issues. NWS meteorologists and hydrologists collaborate with NOAA scientists and attend scientific meetings, such as a weekly climate and weather discussion lead by NOAA meteorologist Klaus Weickmann.

The Denver/Boulder WFO strives to provide useful, accurate, and timely hydrology, climate, and weather information and products to all its customers, including water managers. The Service Hydrologist and the Climate Service Focal Point are two important WFO contacts for water managers (Figure 14b). Treste Huse is the Service Hydrologist for the Denver/Boulder WFO, and her main roles include managing the hydrology program for the WFO and providing NWS hydrologic support to the Colorado Emergency Management and other water resource agencies located in Denver and surrounding cities. The hydrology program involves monitoring and forecasting streamflows and river and lake stages, which can be complex due to the mountains, foothills, plains, and canyons in the region. Huse updates this information using an online hydrology product (Figure 14c). She assists local water resource managers by providing weather and hydrologic information to various task forces that address flooding, drought, water

Figure 14a. The Denver/Boulder WFO is located in the NOAA David Skaggs Research Center in Boulder, Colorado.

Figure 14b. Two friendly faces at the Denver/Boulder WFO: Mike Baker, Climate Service Focal Point, and Treste Huse, Service Hydrologist

availability, and other water resource issues in Colorado.

Mike Baker is the Climate Service Focal Point (CSFP) and his job is to help the rest of the WFO staff keep up to date with current climate information and forecast tools, several of which are available on the WFO website (see On the Web box). Along with his primary forecasting and warning responsibilities, as CSFP he ensures that the WFO staff understands how to access and interpret climate outlook products and climate data search engines. The WFO commonly gets questions about climate, but most meteorologists are not trained in climatology. Baker also promotes climate education outreach via workshops, conferences, school talks, public lectures, and media interviews. He serves as the WFO's point of contact for regional and national climate service offices, the public, and members of the climate community, including the Colorado State Climatologist, universities and state and local partners.

The Denver/Boulder WFO has a unique opportunity to collaborate with NOAA scientists, Western Water Assessment researchers, and local water managers. The geography and climate of the region make the weather hard to predict at times, but the WFO strives to provide current climate and weather information to its customers. Their website is continually updated and they encourage you to use it!

Thank you to Treste Huse and Mike Baker for all their help and information!

Works Cited

NWS (2004). "National Weather Service Mission Statement". Available online: http://www.nws.noaa.gov/mission.shtml.

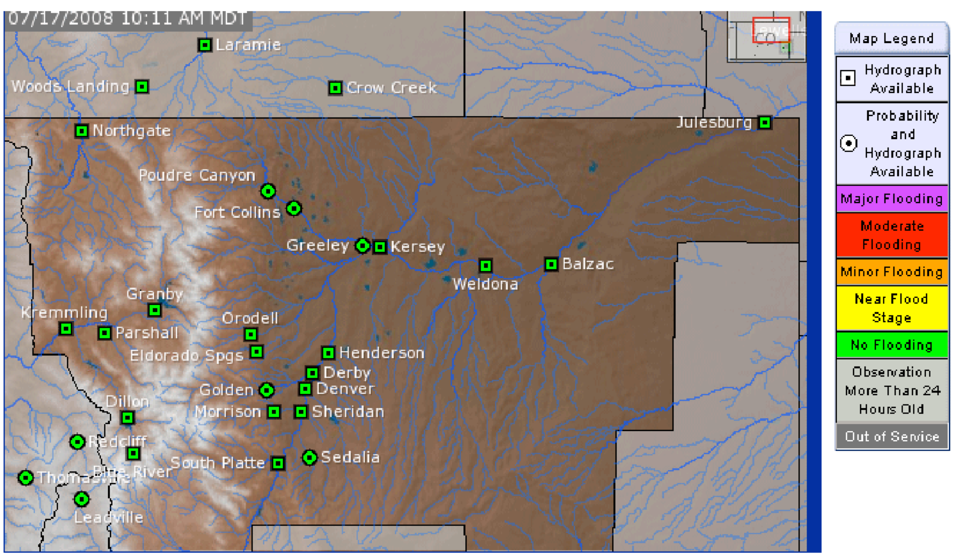


Figure 14c. A hydrology product issued by the Denver/Boulder WFO: major rivers in the region and their current flood stage.

On the Web

- Denver/Boulder WFO homepage: http://www.crh.noaa.gov/bou/; Phone: 303-494-4221.
  - Current hydrologic conditions and forecasts: http://www.crh.noaa.gov/ahps2/index.php?wfo=bou.
  - Local climate data: http://www.weather.gov/climate/index.php?wfo=bou.
- For a complete list of acronyms used by the NWS: http://www.srh.noaa.gov/jetstream//append/acronyms_a.htm.