Intermountain West Climate Summary

by The Western Water Assessment

Issued March 24, 2008
Vol. 4, Issue 2

March 2008 Climate Summary

Hydrological Conditions — Severe drought persists in western Wyoming and northwestern Utah. The U.S. Drought Monitor considers eastern Colorado abnormally dry.

Temperature — Temperatures across most of the region were -2 to +2°F from average in February.

Precipitation — Precipitation across most of the region was near or above average in February, with parts of each state receiving above 120% of average.

ENSO — A strong La Niña event continued in the Pacific Ocean through February. It is likely to persist through May 2008 and may gradually diminish in the summer and fall.

Climate forecasts — La Niña impacts during April – June 2008 are for below average precipitation in the southwest, including Utah and Colorado. There is an increased chance of above average temperatures across much of the Intermountain West through September.

2008 Grand Canyon High Flow Experiment

On March 5, the USBR opened the jet tubes at Glen Canyon Dam to release about 41,500 cfs of Colorado River water for 60 hours (general range is 8,000 - 20,000 cfs). The purpose of this test was to determine the optimal peak flows needed for the long-term adaptive management of Grand Canyon. This is the third "high flow test," which redistributes sand built up at the bottom of the river channel into a series of sandbars and beaches along the river. The release will provide habitat for wildlife, camping beaches for recreationists, and sand for archaeological sites. See the full USBR article at: http://www.usbr.gov/uc/feature/GC-hfe/index.html.

Upcoming Workshops

- Colorado Section of the American Water Resources Association (AWRA) is hosting its Annual Symposium on April 18, 2008 at the Mt. Vernon Country Club in Golden. The theme this year is "Water, Energy, and Climate Change." See the website for more information: http://www.awra.org/state/colorado/.

In This Issue

Recent Conditions

Forecasts

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

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This publication was prepared by CIRES/WWA with support in part from the U.S. Department of Commerce/NOAA, under cooperative agreement NA17RJ1229 and other grants.

The Intermountain West Climate Summary is published monthly by Western Water Assessment (WWA), a joint project of the University of Colorado Cooperative Institute for Research in Environmental Sciences (CIRES) and the National Oceanic and Atmospheric Administration (NOAA) Earth System Research Laboratory, researching water, climate and societal interactions.

Diagnosis of Cause(s) for 2007 U.S. Precipiation Extremes

By the NOAA/ESRL Climate Attribution Team*: Contributors to this article include Taiyi Xu, Xiaowei Quan, Jon K Eisheid, Martin Hoerling, Tao Zhang.

The NOAA Climate Attribution Team, led by Dr. Martin Hoerling, investigated the causes of below average precipitation in both the southwestern and southeastern U.S. in 2007. This team calls themselves "Climate Scene Investigators," (CSI) because they try to understand and explain anomalous climatic behavior as it evolves. They also assess seasonal climate predictors and evaluate the reasons for seasonal forecast success and failure. The CSI team includes scientists from the NOAA Earth System Research Lab in Boulder, CO, other NOAA research labs across the U.S., and also NOAA's Climate Prediction Center in Washington D.C.

This article describes an effort by the CSI team to determine if below average precipitation in 2007 can be attributed to sea surface temperature (SST) anomalies. Since there was a strong El Niño in the winter/spring of 2007 and a La Niña beginning in late summer 2007, the team wanted to see if they could attribute the precipitation anomalies to the SST anomalies in the Tropical Pacific Ocean (i.e. the ENSO region). They analyzed SSTs in both the ENSO region and other regions including the Indian Ocena, the North Pacific and North Atlantic Oceans. As this article shows, the team found that it is unlikely that ENSO played a role in the US droughts of 2007. However, they found the atmosphere to have been sensitive to SST anomalies in other parts of the world oceans during 2007, and that was a factor in the U.S. dryness.

Calendar Year 2007 Precipitation Departures

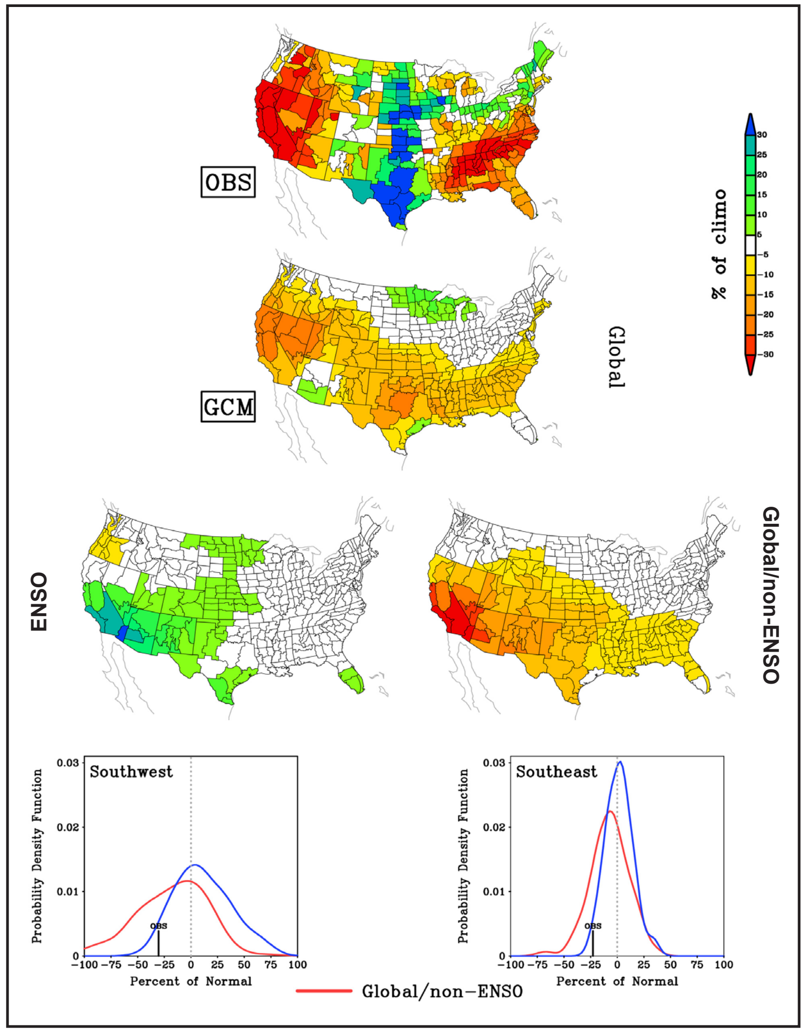


Figure 1. The U.S. 2007 annually averaged (January-December) precipitation departures expressed as % of the 1971-2000 climatologies for observations (top), for simulations based on global SST forcing (middle, contour interval half as for OBS), for simulations based on tropical east Pacific SST forcing (bottom left, same contour interval as for OBS), and for simulations based on global SST forcing excluding the tropical east Pacific (global/non-ENSO; bottom right, same contour interval as for OBS). The probability distribution functions of regional precipitation departures of the individual 150-member runs for the ENSO forced (blue curve) and global/non-ENSO forced regions (red curve) are shown for the Southwest U.S. (left) and the Southeast U.S. (right). Observed 2007 annual precipitation departures are shown by vertical gray bar.

Investigating global ocean influences on 2007 U.S. precipitation

For the contiguous United States (U.S.), large deficits in annually averaged (January-December) precipitation occurred in the Southwest and the Southeast regions (Fig. 1, top). There, accumulated annual departures have exceeded -30% of the 1971-2000 climatologies. Below normal precipitation was a remarkably persistent feature of the 2007 climate conditions in these two regions; all seasons during 2007 yielded abnormally low precipitation.

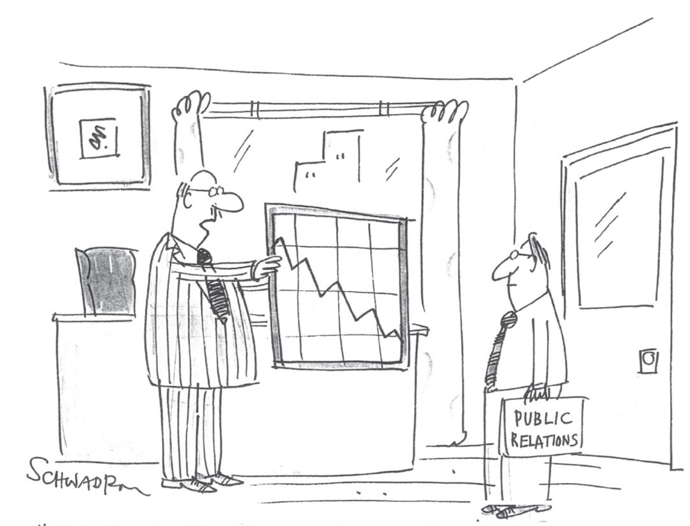
To assess whether such dryness was related to global sea surface temperature (SST) conditions, three different atmospheric climate models (NCEP-GFS, NCAR-CCM3, and GFDL-AM2.1, with nominal resolution of ~200 km) were forced with the monthly varying global 2007 SSTs. For these so-called GOGA (Global Ocean-Global Atmosphere) runs, 50 separate realizations were conducted for each model. Figure 1 (middle panel) shows the multi-model ensemble mean precipitation anomaly (% of climatology) computed relative to control simulations that had used climatological global SSTs of 1971-2000. A dry signal emerges over much of the southern U.S.; the departures are about -10% in the 150-member average, compared to the -30% observed (contour interval of the GOGA run results is half that of OBS).

Did ENSO cause the U.S. droughts of 2007?

Additional simulations indicate this dry signal was very unlikely the result of ENSO variability. Lingering El Niño

* A full list of the Climate Attribution team members and other articles like this one is available at http://www.cdc.noaa.gov/CSI/.

conditions during winter/early spring 2007 were replaced by a La Niña event in late summer 2007. In a further suite of runs, SSTs were specified over the region 20°N-20°S, 160°E to the South American coast only, while climatological SSTs were specified elsewhere over the world oceans. For these so-called EPOGA (East Pacific Ocean-Global Atmosphere) runs, 50 separate realizations were again conducted for each model. A strong wet signal occurs over the Southwest (Fig. 1, bottom left), opposite to the drought conditions observed. The simulated wet signal is especially strong during winter/spring 2007 when El Niño conditions prevailed, and is also consistent with historical observations that reveal ENSO impacts to be largest during that time of year. Clearly, the expected wet signal failed to emerge during 2007; and it appears very unlikely that ENSO was a contributing factor to the droughts of 2007.



"CURTIS, I WANT YOU TO FIND A WAY TO BLAME ALL THIS ON EL NINO."

Did other ocean conditions contribute to U.S. droughts of 2007?

The principal anomalies in global SSTs during 2007, outside the ENSO region, were warmth in the tropical Indian and Atlantic Oceans, and warmth across much of the extratropical North Pacific and North Atlantic Oceans. We estimate the effect of the "non-ENSO region" SST forcing by constructing the differences "GOGA-EPOGA" (subsequently referred to as global/non-ENSO). To the extent that the U.S. response can be viewed as the linear superposition of signals from various ocean forcings, this analysis is one estimate for the SST forced signal from the ocean conditions outside of the tropical eastern Pacific.

The global/non-ENSO results (Fig. 1, bottom right) reveal a strong U.S. precipitation sensitivity to this non-ENSO region forcing. In particular, a dry signal occurs along the entire southern tier of states, having a maxmium percentage reduction in precipitation over the Southwest akin to the observed anomalies. Over the U.S. as a whole, this dry signal overwhelms the east Pacific induced wet signal. Thus, the modest U.S. drying emerging in response to the full global SST conditions of 2007 (Fig. 1, middle) appears to reflect the cancellation between between two different SST influences; a wet ENSO effect and a stronger drying effect due to non-ENSO SST conditions.

What was the changed liklihood of U.S. dryness given ocean conditions of 2007?

To quantify the extent to which the observed U.S. precipitation extremes were statistically consistent with SST forcing during 2007, Figure 1 also shows probability distribution functions (PDFs) of the individual 150-member annual precipitation anomalies for the Southwest (left panel; averages of California, Nevada, Utah, Arizona, Colorado, and New Mexico) and for the Southeast (right panel; averages of Arkansas, Alabama, Louisiana, Mississippi, Georgia, Tennesse, Florida, and the Carolinas). Two PDFs are compared, one drawn from the sampled population of runs forced by the ENSO-region 2007 SSTs only (blue curve), and the other drawn from the the sample population of runs forced with global/non-ENSO region 2007 SSTs (red curve). Consistent with the spatial plots, a distinct shift toward increasingly dry probabilities under the influence of global/non-ENSO SSTs occurs over the Southwest and Southeast U.S..

A simple ranking of all ENSO forced runs reveals that only 3% and 2% of runs were as dry as observed over the Southwest and Southeast, respectively. By comparison, for the effect of global/non-ENSO SSTs, 22% and 15% of runs were as dry as observed over the Southwest and Southeast, respectively. There is thus a 8-fold increase in the probability of drying having the severity observed over both the Southwest and Southeast during 2007 due to the effect of global/non-ENSO region SSTs versus the effect of ENSO region forcing alone.

Summary

The diagnosis presented above provides some attribution of key features of the observed 2007 U.S. climate conditions. The text uses subjective language to interpret the likelihood that certain conditions were caused by certain forcings, but at this point that should be viewed as a *qualitative*, expert assessment.

Regarding the anomalously low precipitation within the U.S. Southwest and Southeast regions, this assessment suggests the following:

- The extreme low precipitaiton was inconsistent with east tropical Pacific SST variability during 2007, and thus was very unlikely caused by the ENSO cycle occurring during January-December 2007. We estimate less than a 5% probability that the observed dryness was consistent with climate conditions driven from the tropical east Pacific in 2007.
- An SST-induced dry signal did exist in 2007, spanning much of the southern U.S., and orignated from SST conditions outside the tropical Pacific. This dry signal overwhelmed the ENSO wet signal, and we estimate a large increase in the probability of U.S. drying having intensities as large as observed in 2007 due to such a global SST influence.

Temperature 02/01/08 – 02/29/08

Monthly average temperature for February 2008 in the Intermountain West region ranged from 10-40°F (Figure 2a). The warmest areas (above 30°F) were across most of **Utah** and eastern and southwestern **Colorado**. Temperatures were -2°F to +2°F from average for most of the region (Figure 2b), except for areas in south-central **Colorado** that were 4-8°F below average and areas in north central **Utah** that were 4-6°F above average. No temperature records were set in February 2008.

Temperatures in February 2007 were higher than temperatures in February 2008 throughout most of the IMW region (Figure 2c). Northeastern **Wyoming** and eastern **Colorado** were 2-10°F below average in February 2007, but most of the region was 0-8°F above average.

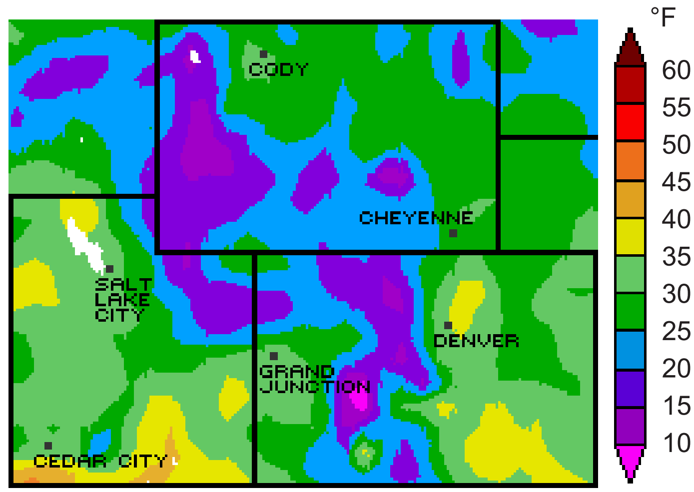


Figure 2a. Average temperature for the month of February 2008 in °F.

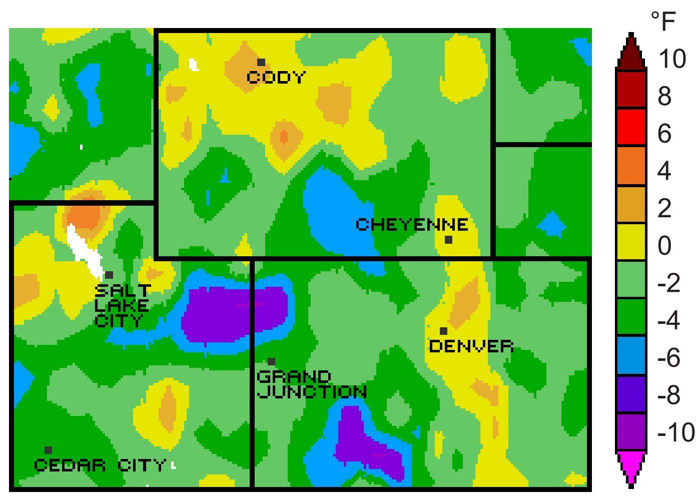


Figure 2b. Departure from average temperature for the month of February 2008 in °F.

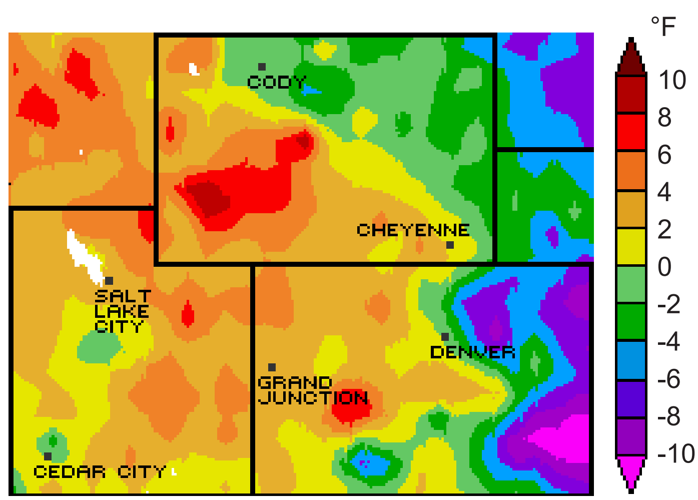


Figure 2c. Departure from average temperature in °F for last year, February 2007.

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.

On the Web

- For the most recent versions of these and maps of other climate variables including individual station data, visit: http://www.hprcc.unl.edu/products/current.html.
- 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.

Precipitation 02/01/08 – 02/29/08

Total precipitation for February 2008 in the Intermountain West region ranged from 0 - 3+ inches (Figure 3a). **Utah**, central and western **Colorado**, and western **Wyoming** received the highest totals (3+ inches). Eastern **Colorado** and eastern **Wyoming** received the least amount of precipitation (<0 – 0.50 inch). Alamosa, **Colorado**, set a record on February 5th for maximum precipitation and snowfall. Precipitation totaled 0.33 inch, breaking the old record of 0.18 inch set in 1967. A new record of 6.7 inches of snowfall broke the previous record of 3 inches also set in 1967.

Most of the region had near or above average precipitation for February (Figure 3b). Parts of central **Colorado**, southern **Wyoming**, and central and eastern **Utah** reported above average precipitation (110-150%+). Areas in northern **Wyoming** and northeastern **Colorado** reported the lowest percent of average (<40 – 80%). One location with a high percent of normal was Alta, **Utah**. Alta received 9.63 inches of precipitation, which is 164% of normal.

Precipitation since the start of the water year is near or above average for most of the region (Figure 3c). Areas that are below average include northeast **Wyoming** and eastern **Colorado** (<50% - 70%). Areas with the highest percent of average are in western **Colorado**, eastern **Utah**, and southeast **Wyoming** (130 – 150%+).

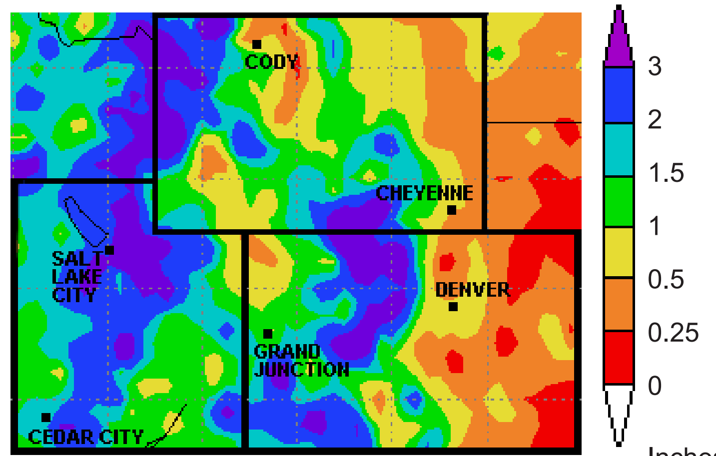


Figure 3a. Total precipitation in inches for the month of February 2008.

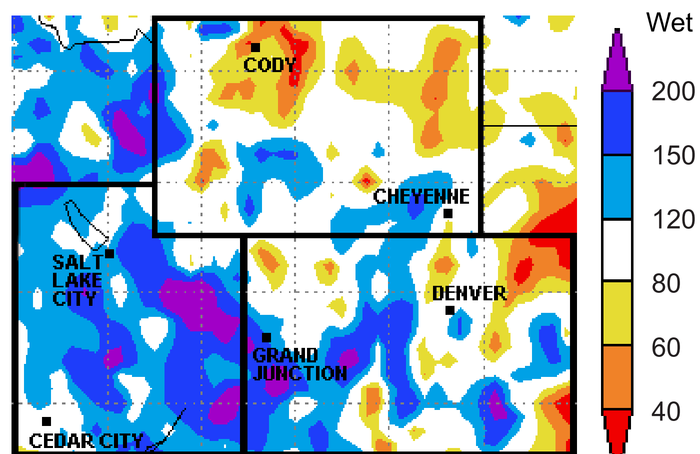


Figure 3b. Percent of average precipitation for the month of February 2008.

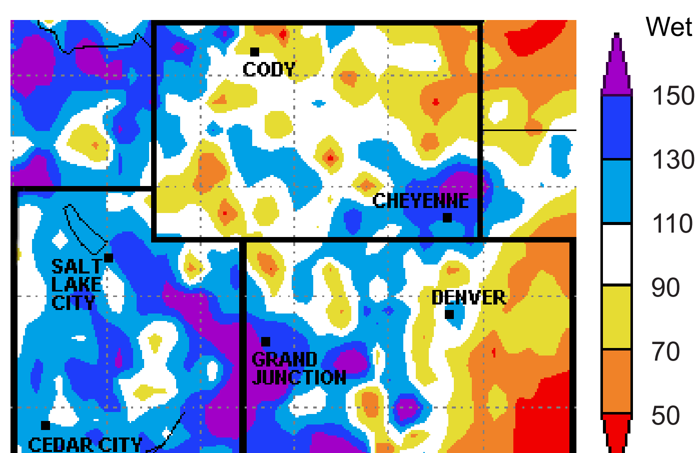


Figure 3c. Percent of average precipitation accumulation since the start of the water year 2008 (Oct. 1, 2007 – Feb. 29, 2008).

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 the most recent versions of these and maps of other climate variables including individual station data, visit: http://www.hprcc.unl.edu/products/current.html.
- For precipitation maps like these and those in the previous summaries, which are updated daily visit: http://www.cdc.noaa.gov/Drought/.
- 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.

U.S. Drought Monitor conditions as of 3/18/08

The U.S. Drought Monitor (Figure 4) shows the highest drought intensity in the IMW region is in western **Wyoming** and northwest **Utah**; areas in the severe drought category (D2). Above average precipitation in **Utah** in February helped decrease the drought status in the rest of **Utah** since mid-January (see inset). Lower drought intensity extends through western **Utah**, along the Colorado River in **Utah**, central and eastern **Wyoming**, and eastern **Colorado**.

This month's feature article "Diagnosis of Cause(s) for 2007 U.S. Precipitation Extremes" shows how the drought in the southwestern U.S. in 2007 was attributed to non-ENSO sea surface temperature (SST) anomalies. There was a strong El Niño during the winter/spring of 2007, and climate forecasts expected above average precipitation associated with that. However, the article's authors show that this "wet signal" was overwhelmed by a "dry signal" from other SST anomalies outside the Tropical Pacific (ENSO region-see page 2).

Notes

The U. S. Drought Monitor (Figure 4) 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.

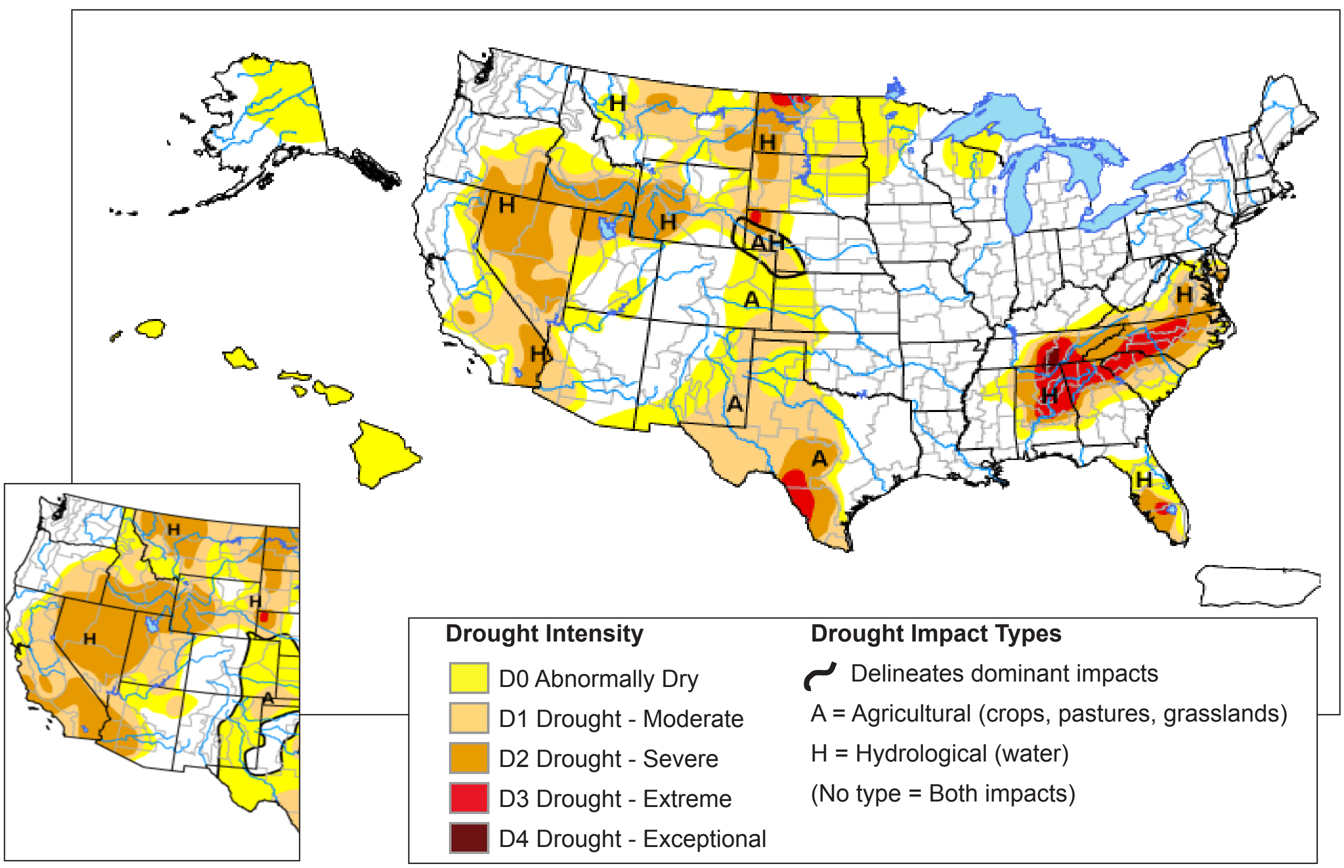


Figure 4. Drought Monitor from March 18, 2007 (full size) and the last summary, January 15, 2008 (inset, lower left) for comparison.

On the Web

- For the most recent Drought Monitor, 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.

Intermountain West Snowpack data through 2/29/08

March 1 snowpack conditions are at or above average for most of the Intermountain West Region, with the exception of several basins in central **Wyoming** (Figure 5). Above average snowfall in January and February lead to increases in snowpack in many basins across the region. In **Colorado**, SWE increased in every basin except the Rio Grande (south-central). However, the Rio Grande Basin still has the highest percentage in the state with 169% of average SWE (NRCS). In **Utah**, the lowest SWE is 98% of average in the Bear River basin in the north, but most of the state is above average. The highest SWE in **Utah** is 142% in the southwest basins. **Wyoming's** basins all have higher SWE as a percent of averages than last year at this time. The Little Snake River Basin in southeast **Wyoming** has the highest SWE (120% of average). The lowest value reported was 78% of average SWE on the Big Sandy-Eden Valley Basin in the west.

Notes

Snow water equivalent (SWE) or snow water content (SWC) refers to the depth of water that would result by melting the snowpack at the measurement site. Snowpack telemetry (SNOTEL) sites are automated stations operated by NRCS that measure snowpack. In addition, SWE is measured manually at other locations called snow courses. SWE is determined by measuring the weight of snow on a "pillow" (like a very large bathroom scale) at the SNOTEL site. Knowing the size of the pillow and the density of water, SWE is then calculated from the weight measurement. Given two snow samples of the same depth, heavy, wet snow will yield a greater SWE than light, powdery snow. SWE is important in predicting runoff and streamflow.

Figure 5 shows the SWE based on SNOTEL and snow course sites in the Intermountain West states, compared to the 1971-2000 average values. The number of SNOTEL or snow course sites varies by basin. Basins with no SNOTEL sites or incomplete data are designated in white on the map. To see the locations of individual SNOTEL sites, see each state's water availability page.

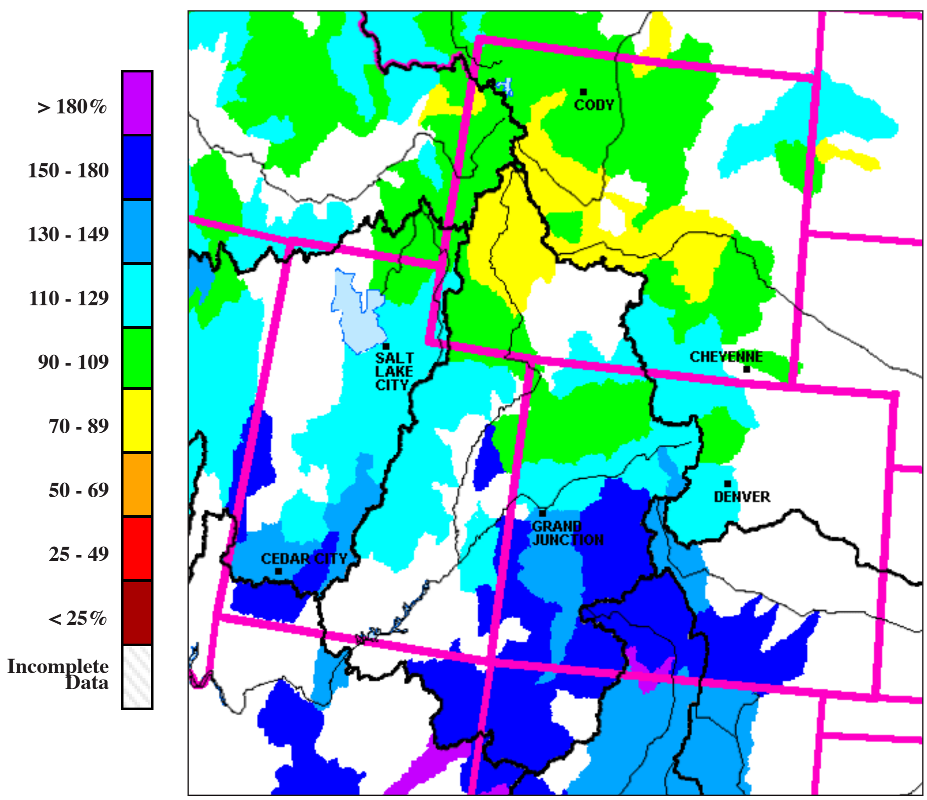


Figure 5. Snow water equivalent (SWE) as a percent of average for available monitoring sites in the Intermountain West as of March 1, 2008 (NRCS).

On the Web

- For graphs like this and snowpack graphs of other parts of the western U.S., visit: http://www.wcc.nrcs.usda.gov/snowcourse/snow_map.html.
- For snow course and SNOTEL data updated daily, please visit one of the following sites: River basin data of SWE and precipitation: http://www.wrcc.dri.edu/snotelanom/snotelbasin.
- Individual station data of SWE and precipitation for SNOTEL and snow course sites: http://www.wcc.nrcs.usda.gov/snowcourse/snow_rpt.html or http://www.wcc.nrcs.usda.gov/snotel/.
- Graphic representations of SWE and precipitation at individual SNOTEL sites: http://www.wcc.nrcs.usda.gov/snow/snotel-data.html.

Regional Standardized Precipitation Index data through 2/29/08

The Standardized Precipitation Index 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. 3- and 6-month SPIs are useful in short-term agricultural applications. Longer-term SPIs (12 months and longer) are useful in hydrological applications. This month, we will describe the 3-month and the 12-month SPI maps.

Due to above average precipitation in December, January, and February, the 3-month SPI map shows wet categories across most of the region (Figure 6a). No climate divisions on the map are in dry categories. The wettest categories (extremely wet) are the Lower Platte division in **Wyoming** and the Platte Drainage and Rio Grande Drainage divisions in **Colorado**.

The wet conditions for the past three months also affected the longer term 12-month SPI (Figure 6b). Five climate divisions in the IMW region moved into wetter categories between the end of December 2007 (available in the January 2008 IMW Climate Summary) and the end of February 2008. In **Utah**, the Western climate division changed categories from very dry to moderately dry and the north central climate division changed from the moderately dry category to the near normal category. In **Wyoming**, the Yellow Drainage and Snake Drainage climate divisions in the northwest both changed from the moderately dry category to the near normal category. In **Colorado**, the Rio Grande Drainage division changed from the near normal category to the moderately wet category.

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.

A 12-month SPI is used for the Intermountain West region (Figure 6b) and compares precipitation patterns for 12 consecutive months with the same 12 consecutive months during all the previous years of available data. The SPI at these time scales reflect long-term precipitation patterns. The 3-month SPI uses data for the last three months and represents short-term precipitation patterns (Figure 6a). Figures 6a and b come from the Western Regional Climate Center, which uses data from the NCDC and the NOAA Climate Prediction Center.

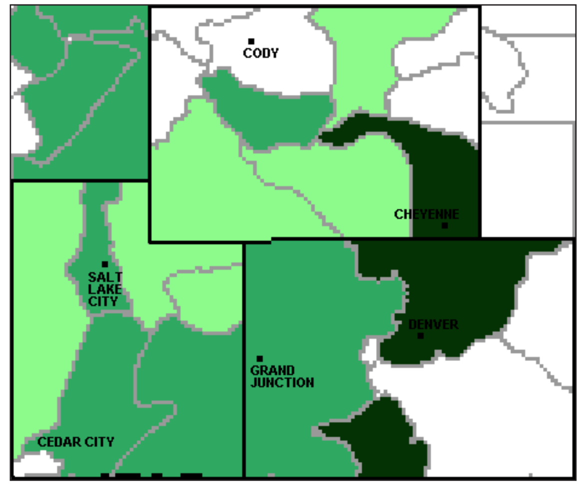


Figure 6a. 3-month Intermountain West regional Standardized Precipitation Index (data from 12/01/07 – 02/29/08).

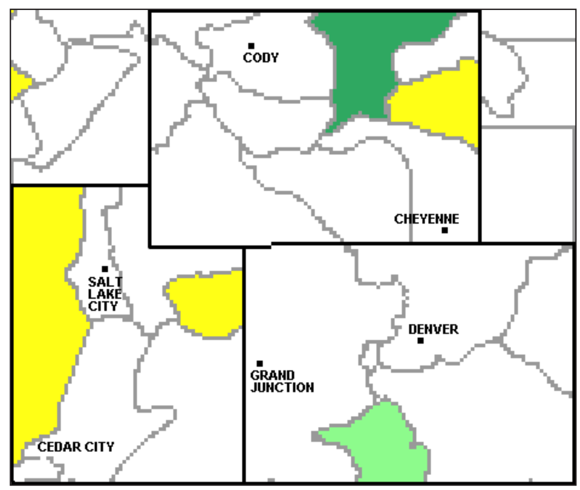


Figure 6b. 12-month Intermountain West regional Standardized Precipitation Index (data from 03/1/07 - 02/29/08).

+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 6a and 6b, but the categories are defined slightly differently.

Colorado Water Availability

On March 3, the majority of SNOTEL stations reported near or above average snowpack statewide, with most stations in the northern mountains at 100-149% of average and most stations in the southern mountains at 125%-200% of average (Figure 7a). Snowpack has increased in all basins from last month with the exception of the Rio Grande basin, according to the NRCS. March snowpack was 152% of average in the Arkansas River basin and is the highest March 1 snowpack since 1962 (Figure 7b). Precipitation in the eastern plains this winter was a sharp contrast to the mountains. Dry and windy midwinter conditions on the eastern plains are decreasing soil moisture levels, which could limit agricultural yield for the upcoming growing season, according to Colorado State Climatologist, Nolan Doesken.

Statewide reservoir storage is near average (data from USBR not shown), ranging from a low of 90% of average in the South Platte basin to a high of 111% of average in the Yampa, White, and North Platte basins (NRCS). Reservoir inflow projections are near or above average statewide, and water managers in southern basins have started releasing to prepare for above average spring and summer streamflows (USBR).

March 1 SWSI values are above or much above average (data from NRCS not shown), ranging from a low of 0.2 in the South Platte basin to a high of 3.9 in the Gunnison, San Juan, Miguel, Dolores, and Animas basins. SWSI values increased in all basins except the Yampa, White, and South Platte in comparison to last month's values.

Initial spring 2008 runoff forecasts released by the NWS River Forecast Centers project near or above average runoff forecast for all basins, for the exception of stations along the St. Vrain and Big Thompson Rivers in the South Platte Basin. The highest streamflow forecasts (135-150% of average) are in the San Juan, Animas, Dolores, Rio Grande, and Arkansas basins, and are identified as high flood risk areas by the Colorado Flood Task Force. For more information on spring and summer streamflow forecasts, see page 17.

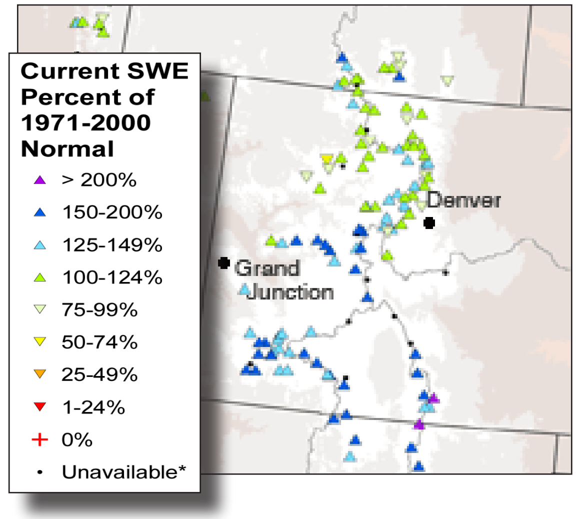


Figure 7a. Current snow water equivalent (SWE) as a percent of normal for SNOTEL sites in Colorado as of March 3, 2008, (NRCS).

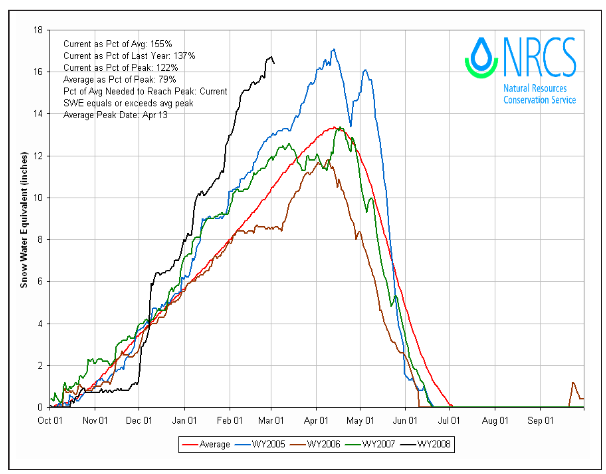


Figure 7b. Accumulated SWE for WY2008 (black line) increased over four inches during February in the Arkansas River Basin, bringing snowpack to 155% of average (NRCS).

Notes

Figure 7a (NRCS), shows the SWE as a percent of average for each of the major river basins in Colorado. Figure 7b shows accumulated SWE amounts (inches) based on provision SNOTEL data as of March 3, 2008 for WY2005 (blue line), WY2006 (brown line), WY2007 (green line), WY2008 (black line) plotted against the historical average (red line). The Surface Water Supply Index (SWSI) developed by the Colorado Office of the State Engineer and the NRCS is used as an indicator of mountain-based water supply conditions in the major river basins of the state. The Colorado SWSI is based on snowpack, reservoir storage, and precipitation for the winter period (November-April). This differs from summer calculations that use streamflows as well. SWSI values in were computed for each of the seven major basins in Colorado on the first of each month, and reflect conditions through the end of the previous month.

On the Web

- For current maps of SWE as a percent of normal (Figure 7a), visit: http://www.wcc.nrcs.usda.gov/gis/snow.html.
- For monthly reports on water supply conditions & forecasts for major CO river basins, visit: http://www.co.nrcs.usda.gov/snow/snow/snow_all.html and click on "Basin Outlook Reports."
- Information on regional weather forecasts and information, visit NWS Denver/Boulder Weather Forecast Office at http://www.crh.noaa.gov/bou/.
- 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.
- NRCS SWE line graphs by basin like in Figure 7b available at: http://www.co.nrcs.usda.gov/snow/snow/watershed/current/daily/maps_graphs/swe_time.html.
- 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.

Wyoming Water Availability

Water supply conditions are largely based on snowpack at this time of year. Warm temperatures and/or snow accumulation events during the spring (March, April, May) can result in rapid changes to basin snowpack amounts. Wyoming snowpack is near or below average in western basins, ranging from 75-99% of average in most areas, and near or above average in eastern basins, with the majority of stations ranging from 100-124% of average (Figure 8a). The areas with highest increases in snowpack since early January were in the Wind and Upper Bear River drainages, increasing approximately ten percentage points (NOAA).

Statewide reservoir storage (data from NRCS not shown) ranges from a low of 46% of average in the North Platte basin to a high of 102% of average in the Green River basin. Reservoir storage in Boysen, Flaming Gorge, Buffalo Bill, Seminoe, and Fontenelle reservoirs are 76%, 103%, 142%, 39%, and 73% of average, respectively.

March 1 SWSI values range from a low of -2.76 in the Upper Green basin to a high of 3.12 in northwestern Wyoming (Figure 8b). SWSI values have increased in all basins except the Upper and Lower Green river basins since January 1. SWSI values indicate above average water supply conditions in the southeast and northwest basins while conditions in central and southwest basins are below average. Wyoming drought intensity has decreased statewide in comparison to this time last year according to the U.S. Drought Monitor (USDM, see page 6).

According to March streamflow projections released by the CBRFC, statewide spring and summer streamflows are expected to be near or below average ranging from a low 71% and 77% of average in the Green and Wind River basins to a high of 124% of average in the Little Snake basin. Projected April-July inflow into Fontenelle and Flaming Gorge reservoirs are 77% and 71% of average, respectively.

Notes

Figure 8a, (NRCS), shows the SWE as a percent of average for each of the major river basins in Wyoming. According to the WY NRCS, "The Surface Water Supply Index" (SWSI, Figure 8b) is computed using only surface water supplies for each drainage basin. The computation includes reservoir storage, if applicable, plus the runoff forecast. The index is purposely created to resemble the Palmer Drought Index, with normal conditions centered near zero. Adequate and excessive supply has a positive number and deficit water supply has a negative value. The SWSI does not use soil moisture and precipitation forecast, but the runoff forecast may include these values."

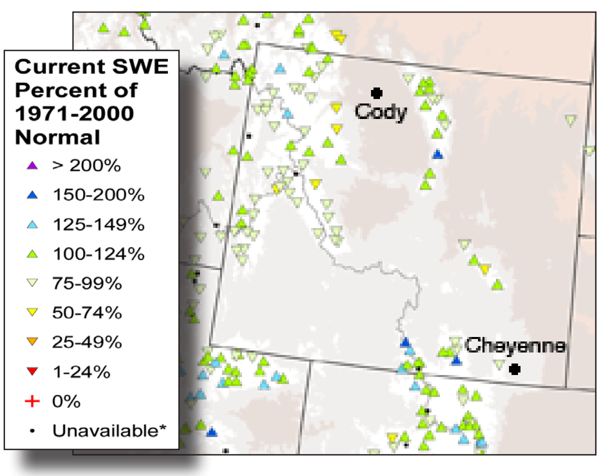


Figure 8a. Current snow water equivalent (SWE) as a percent of normal for SNOTEL sites in Wyoming as of March 3, 2008 (NRCS).

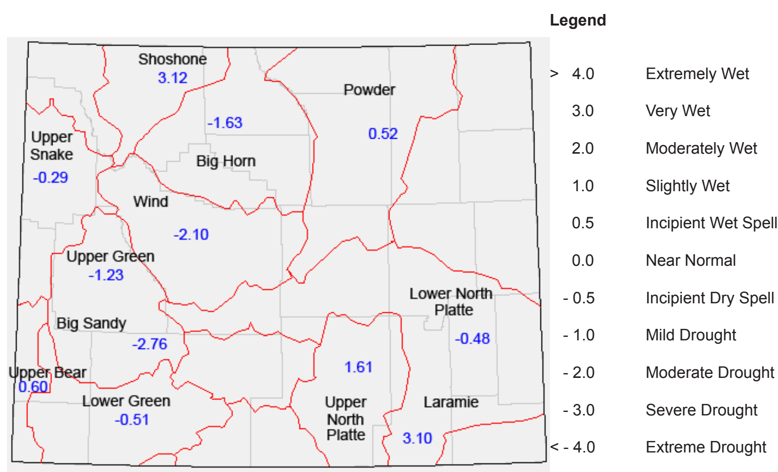


Figure 8b. Wyoming Surface Water Supply Index as of March 3, 2008 (Wyoming NRCS).

On the Web

- For current maps of SWE as a percent of normal (Figure 8a), visit: http://www.wcc.nrcs.usda.gov/gis/snow.html.
- For current SNOTEL data and plots of specific sites, visit: http://www.wcc.nrcs.usda.gov/snotel/.
- The Wyoming SWSI (Figure 8b), along with more data about current water supply conditions for the state can be found at: http://www.wrds.uwyo.edu/wrds/nrcs/nrcs.html.
- For monthly State Basin Outlook Reports on water supply conditions and forecasts for WY river basins, visit: http://www.wcc.nrcs.usda.gov/cgibin/bor.pl.
- Wyoming Water Resource Data system's drought page is located at: http://www.wrds.uwyo.edu/wrds/wsc/dtf/drought.html.

Utah Water Availability

Water supply conditions are largely based on snowpack at this time of year. Warm temperatures and/or snow accumulation events during the spring (March, April, May) can result in rapid changes to basin snowpack amounts. Utah snowpack is near or above average, ranging from a low of 75-99% of average in Uintah and Bear basins to a high of 125-200% of average in the Virgin basin. La Nina has continued to strengthen in the Equatorial Pacific, and is expected to continue through spring. Historically, below average snowfall in southern basins and near or above average snowfall in northern basins is associated with La Nina conditions in the winter and spring. However, current snowfall patterns in Utah are not characteristic of past La Nina years, according to the NRCS.

Starting on March 4, the USBR conducted a high flow test on the Colorado River, releasing up to 41,500 cfs for 60 hours to determine the effectiveness of rebuilding sandbar deposits and backwaters in Marble and Grand Canyons. March releases from Glen Canyon Dam will increase to 830,000 acre-feet, however annual (WY2008) release volume and Lake Powell surface elevation will not be affected by the experiment (USBR). Reservoir levels are near or below average, ranging from a low of 22% of average in the Bear River basin to a high of 78% of average in the Provo and Duchesne basins. Reservoir storage is in part indicative of water supply conditions in previous years. So although current snowpack is near average in most basins, reservoir storage statewide has declined 13 percentage points since this time last year due to below average streamflows in WY2007.

SWSI values are near or above average statewide, ranging from a low of -3.15 in the Bear River basin to a high of 2.83 in the West Uintah basin (Figure 9b). All basins except the Bear and Weber River basins are reporting positive SWSI values.

April-July inflow projections into Lake Powell are 120% of average. Statewide streamflow projections range from a low of 68% of average on the Bear River to 203% of average on South Creek near Monticello (NRCS). The majority of streamflow projections across the state are near or above average, ranging from 90-130% of average. For additional information on spring and summer streamflow forecasts, see page 17.

Notes

Figure 9a shows the SWE as a percent of normal (average) for SNOTEL sites in Utah, courtesy NRCS. According to the UT NRCS, "The Surface Water Supply Index (SWSI, Figure 9b) is a predictive indicator of total surface water availability within a watershed for the spring and summer water use seasons. The index is calculated by combining pre-runoff reservoir storage (carryover) with forecasts of spring and summer streamflow, which are based on current Snowpack and other hydrologic variables. SWSI values are scaled from +4.1 (abundant supply) to -4.1 (extremely dry) with a value of zero (0) indicating median water supply as compared to historical analysis. SWSI's are calculated in this fashion to be consistent with other hydroclimatic indicators such as the Palmer Drought Index and the [Standardized] Precipitation Index." See page 9 for the SPI.

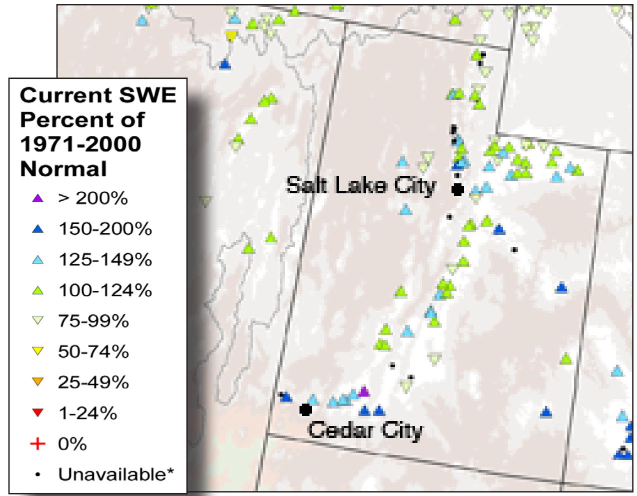


Figure 9a. Current snow water equivalent (SWE) as a percent of normal for SNOTEL sites in Utah as of March 3, 2008 (NRCS).

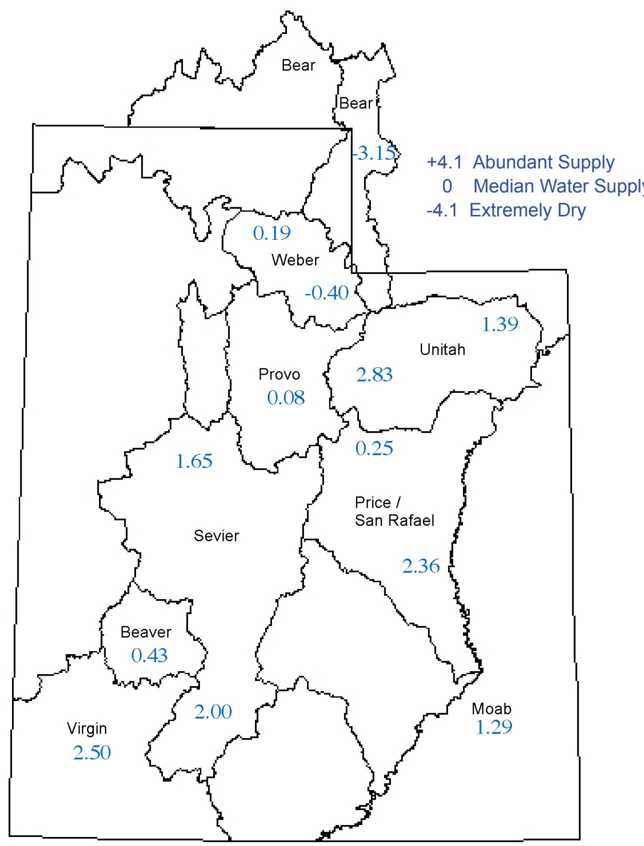


Figure 9b. Utah Surface Water Supply Index as of March 1, 2008 (Utah NRCS).

On the Web

- For current maps of SWE as a percent of normal as shown in Figure 9a, go to http://wcc.nrcs.usda.gov/gis/.
- The Utah SWSI, along with more data about current water supply status for the state, can be found at:
- http://www.ut.nrcs.usda.gov/snow/watersupply/.
- The Palmer Drought Index is found on NOAA's drought page: www.drought.noaa.gov.
- The Utah January Water Supply Outlook is available by state and basin at: http://www.ut.nrcs.usda.gov/snow/watersupply/wsor.html.
- The Lake Powell Status Summary is updated at the first of each month and is available at http://www.usbr.gov/uc/.
- Utah Water Supply Outlook Report provided by the NRCS is available at: http://www.ut.nrcs.usda.gov/snow/watersupply/wsor/2008/wsor_0308.pdf

Temperature Outlook April – August 2008

The temperature outlook for April indicates an enhanced probability of above average temperatures across most of the southern U.S, from Arizona eastward across the southern and central plains the entire southeast (Figure 10a). The temperature forecast for April is based on both long-term trends and composites of observations from previous strong La Niña episodes. In the April – June forecast period, the area with increased probability for above average temperatures includes **Colorado** and most of **Utah** as well (Figure 10b). The probability of above average temperatures is 50% or more for much of **Utah** and the western part of the Intermountain region for the May-July season (Figure 10c), the June-August season (Figure 10d), and through the July-Sept season (not shown).

The temperature outlook for all lead times are based on the consolidation forecast, a skill-weighted and calibrated objective blend of several forecast tools, including Optimal Climate Normals (OCN). The OCN is a forecast based on persisting the average of the last 10 years for temperature and the last 15 years for precipitation, and is an indicator of trends. Trends dominate the temperature consolidation forecast for all periods beginning with April-June 2008.

An updated temperature forecast for April 2008 will be released on March 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. *The next issue date for the seasonal Outlooks is April 17th.*

Notes

The seasonal temperature outlooks predict the likelihood (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 CPC outlooks are 3-category forecasts based on climate models in which the skill 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 indicates the likelihood of the temperature being in the *above-average* (A, orange shading) or *below-average* (B) 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) indicates areas for which the models do not have sufficient skill to predict the temperature with any confidence, representing equal chances or a 33.3% probability for each tercile. For a detailed description, see notes on the precipitation outlook page.

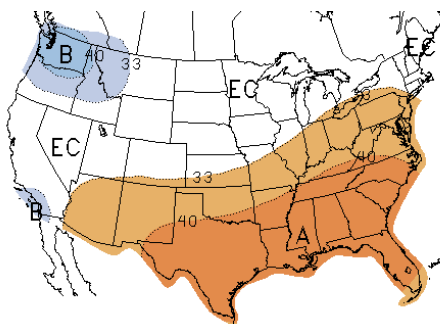


Figure 10a. Long-lead national temperature forecast for April 2008 (released March 20, 2008).

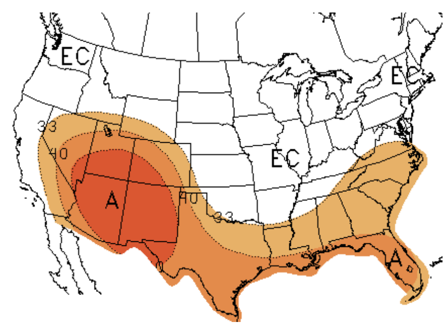


Figure 10b. Long-lead national temperature forecast for Apr. – Jun. 2008 (released March 20, 2008).

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

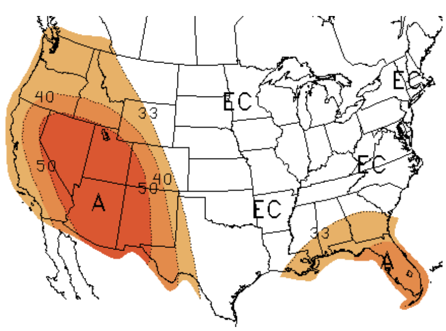


Figure 10c. Long-lead national temperature forecast for May – Jul. 2008 (released March 20, 2008).

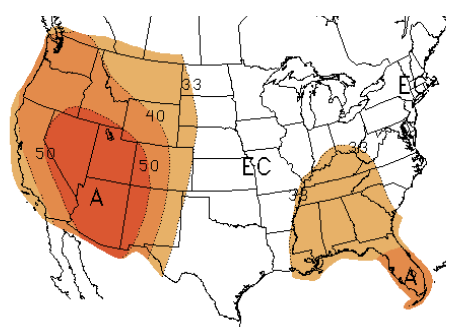


Figure 10d. Long-lead national temperature forecast for Jun. – Aug. 2008 (released March 20, 2008).

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 April – August 2008

Consistent with the typical springtime La Niña signal, the CPC monthly and seasonal outlooks call for an increased probability of below-average precipitation across the southern tier of the U.S., including southernmost **Utah** in April, and **Utah**, most of **Colorado** and parts of **Wyoming** for the April-June 2008 season (Figure 11a-b). The forecast for May-July in the IMW region calls for equal chances (EC) of above, near and below average precipitation (Figure 11c). In June-Aug (Figure 11d) and July-Sep (not shown), the forecast for much of the region is for increased risk of below average precipitation again.

The precipitation outlooks for April-June through August-October 2008 are based on La Niña composites and also weak trends as indicated by the Optimal Climate Normals (OCN) tool (see the temperature page for a discussion of this tool).

An updated precipitation forecast for April 2008 will be released on March 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. *The next issue date for the seasonal Outlooks is April 17th.*

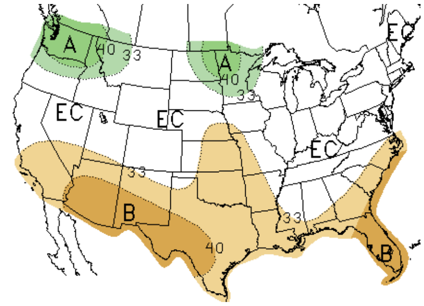


Figure 11a. Long-lead national precipitation forecast for April 2008 (released March 20, 2008).

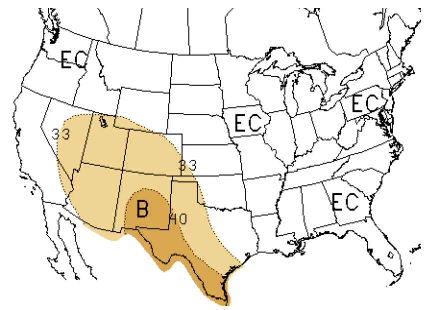


Figure 11b. Long-lead national precipitation forecast for Apr. – Jun. 2008 (released March 20, 2008).

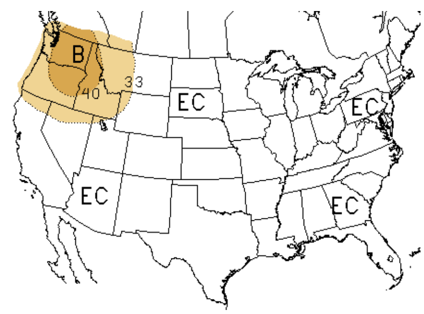


Figure 11c. Long-lead national precipitation forecast for May – Jul. 2008 (released March 20, 2008).

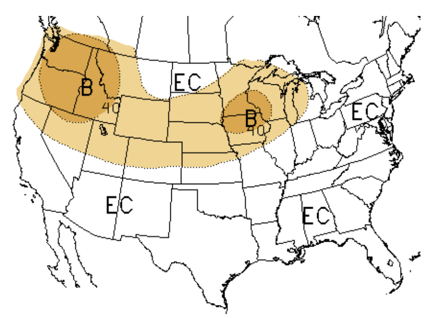


Figure 11d. Long-lead national precipitation forecast for Jun. – Aug. 2008 (released March 20, 2008).

EC = Equal Chances	A = Above	B = Below
	40.0–49.9%	50.0–59.9%
	33.3–39.9%	40.0–49.9%
		33.3–39.9%

Notes

The seasonal precipitation outlooks predict the likelihood (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 CPC outlooks are 3-category forecasts based on climate models in which the skill 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 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. Green shading indicate areas with a greater chance of above average precipitation. Equal Chances (EC) indicates areas for which the models cannot predict the precipitation with any confidence, representing equal chances or a 33.3% probability for each tercile, indicating areas where the reliability (i.e., ‘skill’) of the forecast is poor. “N” indicates an increased chance of near-average conditions, but is not forecasted 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.

Precipitation Outlook cont.

The Experimental Guidance product from the NOAA Earth System Research Lab shows a 10% shift in the probability towards above average precipitation in eastern **Colorado**, and a 10% shift in the probability towards below average precipitation in southern New Mexico (Figure 11e). Most other regions with good verification skill (such as southwestern and northeastern **Colorado**) have essentially no tilt towards wet or dry right now.

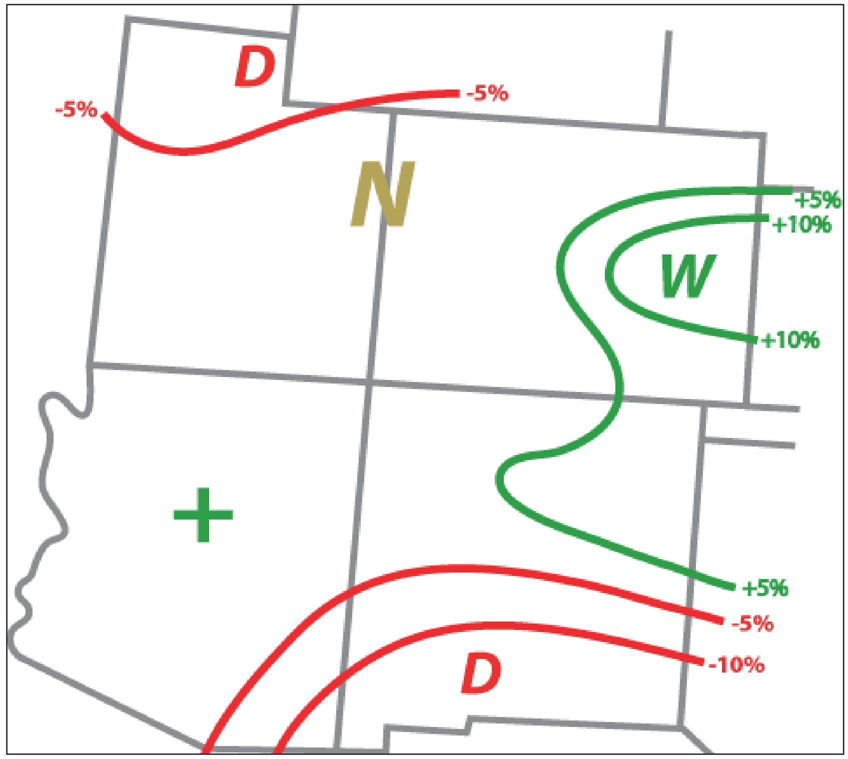


Figure 11e. Experimental Precipitation Forecast Guidance. Forecasted shifts in tercile probabilities for April – June 2008 (released March 13, 2008).

Notes

The experimental guidance for seasonal future precipitation in Figure 11e shows most recent forecast of shifts in tercile probabilities for April – June 2008. In order to be shown on this map, a forecast tilt in the odds has to reach at least 3% either towards wet (above-average), dry (below-average), or near-normal (average). Shifts towards the wettest (driest) tercile are indicated in green (red), and are contoured in 5% increments, while near-normal tilts of at least 3% are indicated by the letter "N". Shifts over 10% considered significant. Positive (negative) shifts between three and five percent are indicated by a green (red) plus (minus) sign, while minor shifts of one or two percent are left blank in this display.

On the Web

- 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 April 2008

Since December, a series of winter storms have resulted in drought improvement across the west, especially in the central Rockies, including **Wyoming** (Figure 12). SWE values are at or above normal in northern **Utah**, and parts of **Colorado**. Despite below normal precipitation forecasted in the CPC seasonal outlook, the combination of the upcoming spring snowmelt and a few more expected storms in the short to medium range should bring improvement to much of the northern Great Basin. However, drought associated with hydrological impacts persists (See U.S. Drought Monitor, page 6).

Tools used in the Drought Outlook include the following CPC products: official long-lead precipitation outlook for April - June 2008; four-month drought termination and amelioration probabilities; various medium and short-range forecasts and models (e.g. 6-10 day and 8-14 day forecasts); the soil moisture tools based on the NOAA GFS model and the constructed analogues of soil moisture; the CFS seasonal precipitation forecasts, and La Niña composites.

The next DO will be issued in two weeks, on April 3rd.

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 (Figure 11) are defined subjectively based on expert assessment of numerous indicators, 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: 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.

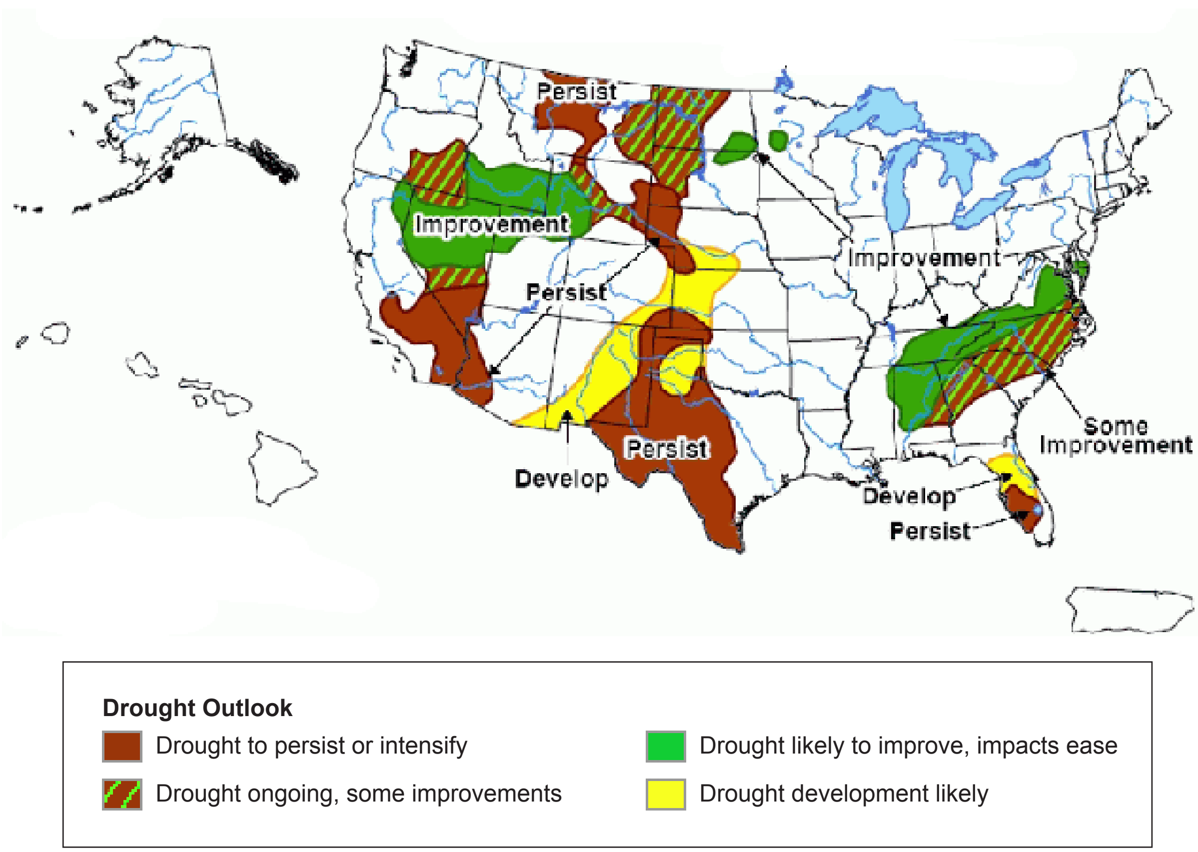


Figure 12. Long-lead national precipitation forecast for March – June 2008 (released March 20, 2008).

On the Web

- For more 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

According to the NOAA Climate Prediction Center's monthly "ENSO Diagnostic Discussion," atmospheric and oceanic conditions during February 2008 continued to reflect a strong La Niña (Figure 13a). Sea surface temperatures (SST) were well below average across the central and east-central equatorial Pacific, and the low level equatorial easterly winds have been stronger than average across the central equatorial Pacific. In contrast, SST in the far eastern equatorial Pacific were above average during February 2008, as expected during a La Niña. These conditions are similar to those during the last strong La Niña episode in 1998-2000.

The most recent dynamical and statistical SST forecasts for the ENSO region continue to indicate a moderate-to-strong La Niña through March 2008, and a weaker La Niña during April- June 2008 (Figure 13b). Thereafter, there is considerable spread in the forecasts, with about half indicating that La Niña could continue into the fall. According to the International Research Institute (IRI) for Climate and Society, a NOAA partner, there is a 85% probability of maintaining La Niña conditions over the March-May 2008 season, and a 40% probability that it will continue through the July-September season. The probability of an El Niño developing by July-Sep is about 20%.

La Niña impacts over the United States in spring are typically less pronounced than its impacts in the winter. The primary springtime signal for the contiguous United States is an increased probability of below-average precipitation across the South, particularly in the Southeast.

The ENSO Diagnostic Discussion is a consolidated effort of the several parts of NOAA, including the National Weather Service, research labs, the IRI, and other institutions funded by NOAA. The CPC ENSO Diagnostic Discussion will be updated next on April 10th, and the IRI ENSO "Quick Look" on April 17th.

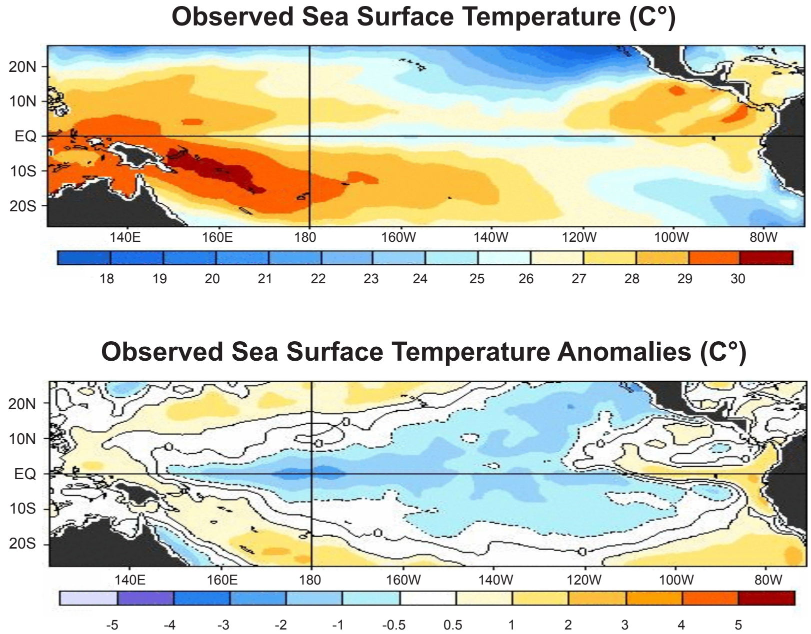


Figure 13a. Observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. The Niño 3.4 region encompasses the area between 120°W-170°W and 5°N-5°S. The graphics represent the 7-day average centered on March 12, 2008.

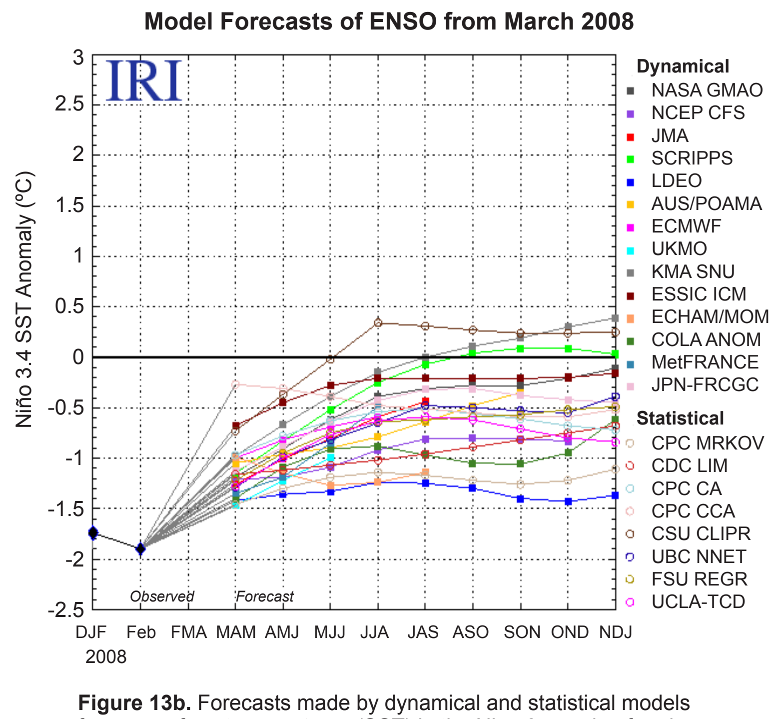


Figure 13b. Forecasts made by dynamical and statistical models for sea surface temperatures (SST) in the Niño 3.4 region for nine overlapping 3-month periods from March 2008 through January 2009 (released March 20, 2008). Forecast graphic is from the International Research Institute (IRI) for Climate and Society.

Notes

Two NOAA graphics in Figure 13a show observed SST (upper) and SST anomalies (lower) in the Pacific Ocean, averaged over a recent 5-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 in the Niño 3.4 region for nine overlapping 3-month periods. "Niño 3.4" refers to the region of the equatorial 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 the system, e.g., forecasts made between June and December are generally better than those made between February and May. Differences among forecasts reflect both differences in model design and actual uncertainty in the forecast of the possible future SST scenario.

On the Web

- For a technical discussion of current El Niño conditions, visit: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/.
- For updated graphics of SST and SST anomalies, 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, visit: http://portal.iri.columbia.edu/climate/ENSO/.

Spring and Summer Streamflow Forecasts for the 2008 Runoff Season

Most basins in **Colorado** and **Utah** are projected to have above average streamflow this spring, and half of **Wyoming** basins are projected to get near or above average streamflows as well (Figure 14). Due to above average snowfall in January and February across the higher elevation areas in the region, this month's forecast is in sharp contrast to streamflow forecasts shown in the January IMW Climate Summary, where most basins were in the below average range.

In **Colorado**, streamflow projections increased in almost all basins since the last summary. All basins show above average streamflow forecasts, except the St. Vrain and Big Thompson basins in the Front Range (NRCS). The highest projections are for the southern basins, which are at more than 150% of average. The NRCS expects 2008 to have the highest statewide runoff in more than a decade.

Utah also has higher streamflow forecasts this month and almost all basins are in the above average range. The highest forecasts are in the southern and southwestern basins (140-200% of average). The NRCS cautions that these regions should make adequate preparations for very high spring flows, especially if snowpacks continue to increase in March.

Streamflow forecasts vary widely across **Wyoming**, more so than the other two states. While there are some basins in the southeast and northwest that have above average forecasts, water supply is expected to be below average in the rest of the state (NRCS). The highest forecast are for the Upper and North Platte Rivers (120% and 117% of average, respectively), and the lowest forecasts are in the Green, Wind and Big Horn Rivers (71%, 77%, and 80% of average, respectively).

Notes

Forecasts of natural runoff are based principally on measurements of precipitation, snow water equivalent, and antecedent runoff, influenced by precipitation in the fall before winter snowfall (Figure 14). Forecasts become more accurate as more of the data affecting runoff are measured (i.e. accuracy increases from January to May). In addition, these forecasts assume that climatic factors during the remainder of the snow accumulation and melt season will have an average affect on runoff. Early season forecasts are, therefore, subject to a greater change than those made on later dates.

The graphic shown here is from the NRCS, but the forecast is a collaborative effort between the NRCS and the NOAA River Basin Forecast Centers. You can see the official NOAA streamflow forecasts on the individual river basin forecast centers' websites. (See On the Web box below for links to the official NOAA forecasts.)

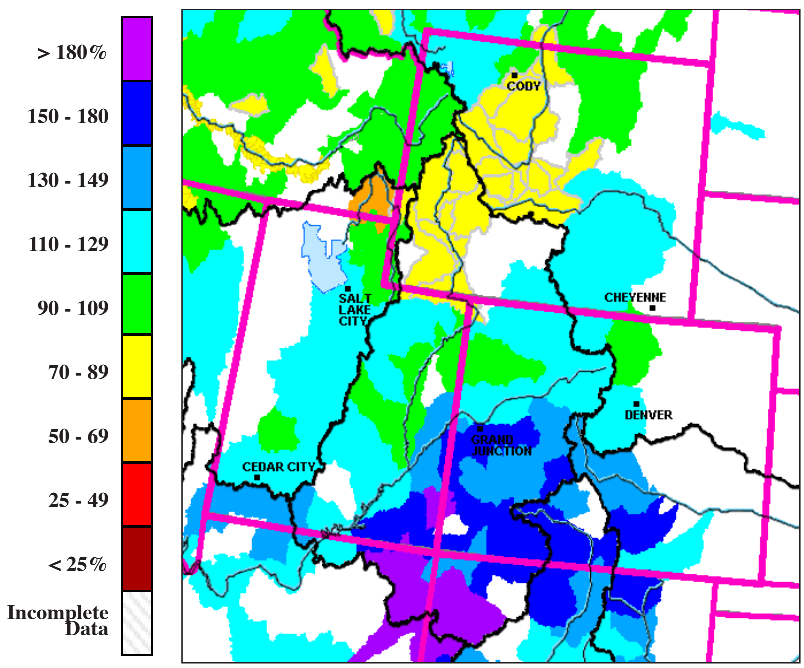


Figure 14. NRCS outlook for natural streamflows for spring and summer in the Intermountain West region as a percent of average streamflows (data through March 1, 2008).

On the Web

For more information about NRCS water supply forecasts based on snow accumulation and access to the graph on this page, visit: http://www.wcc.nrcs.usda.gov/wsf/.

The official NOAA streamflow forecasts are available through the following websites of individual River Forecast Centers:

- Colorado Basin (includes Great Basin): http://www.cbrfc.noaa.gov/.
- Missouri Basin (includes South Platte and North Plate: http://www.crh.noaa.gov/mbrfc/.
- West Gulf (includes Rio Grande): http://www.srh.noaa.gov/wgrfc/.
- Arkansas Basin: http://www.srh.noaa.gov/abrfc/.
- The NOAA CBRFC has a new interactive website that shows streamflow forecasts as inputs to reservoirs: http://www.cbrfc.noaa.gov/westernwater/.

Climate Service Activities in the National Weather Service Central Region

By Doug Kluck, NWS Central Region - Climate Services Program Manager, Eileen McKim and Jessica Lowrey, WWA

In an effort to raise the level of climate services provided by its offices, the NOAA National Weather Service is developing climate services programs through each of its regional offices. Climate Services Program Manager (CSPM, Doug Kluck) manages the climate-related activities of the NWS Central Region Headquarters, which provides leadership, management and support to 38 weather forecast offices (WFOs), two river forecast offices, and five center weather service units (NWS aviation support offices for the FAA) within the 14-state region. The Regional headquarters is in Kansas City, Missouri, and manages NWS activities in Wyoming, Colorado, North Dakota, South Dakota, Nebraska, Kansas, Wisconsin, Iowa, Missouri, Minnesota, Illinois, Indiana, Michigan, Kentucky (Figure 15a).

Figure 15a. Map of NWS Central Region showing locations of weather forecast offices (WFOs).

The CSPM in each region helps disseminate information from the national headquarters of the National Weather Services to the field units and vice versa related to climate services and facilitate partnerships with the Regional Climate Centers, State Climatologists, RISAs (of which WWA is one) and stakeholders. He also manages quality assurance of the climate data record from observations across the region, and he is responsible for feedback and dissemination of climate outlooks from the Climate Prediction Center (CPC) and providing material on climate change.

The NWS Central Region climate services program has developed a web page to provide its customers with useful resources to access climate information pertaining to the central part of the U.S. (http://www.crh.noaa.gov/climate/). This climate resource page is a gateway to access the many activities of and information from NOAA and other climate information providers. It provides up-to-date, reliable, and usable information through links, graphics, maps, and tables from local and national NWS offices, as well as their partners.

The web page is divided into four units: climate information, climate outlooks, science and education, and climate resources. The climate information unit provides data sources for observations, average conditions, and extreme weather events. It also has maps of climatological averages for temperature, precipitation, and snowfall for the region. The climate outlook unit has two-week outlooks for hazardous and severe weather (published every week) and drought for the next three-month period (published every month). Other outlooks available include the the Spring Water Resources Outlook (March and April) and the Winter Outlook (October-January). The science and education unit includes educational resources for teachers, and a "kid's corner," as well as links to a publication archive. Finally, the climate resources unit provides contacts to local WFOs, state climatologists, regional climate centers, and other climate information providers.

Another new on-line service provided by the NWS Central Region WFOs is the Weather Story. Links to Weather Stories are at: http://www.crh.noaa.gov/crh/graphicasts.php, or you can access them from a link in the top-right corner of the WFO homepages. The Weather Story provides a graphical presentation of the most significant weather feature expected to impact the local area for the following seven days. It also highlights natural hazards such as severe thunderstorms, heavy rainfall, strong winds, fire danger and excessive heat (Figure 15b).

In striving to provide timely and relevant climate services to its users, the NWS Central Region continues to improve the accessibility of drought information. The WFOs issue drought statements once a month when any part of a forecast area is in the severe drought category (D2), according to the U.S. Drought Monitor (see page 7). These statements describe the drought status, potential impacts climate outlooks and river forecasts. These statements are written by the Drought Focal Point at each WFO, who often collaborates with state climate offices and other federal agencies (USDA, USGS) for information. At the bottom of the statement are links for further drought information. To access current drought statements, visit http://www.weather.gov/hic/current/drought/index.shtml.

Finally, the NWS Central Region is committed to maintaining the accessibility, quality control, and quality assurance of weather information collected at thousands of sites. In 2007, NWS Central Region conducted three Data Stewardship Meetings across the region focusing on issues that relate directly to data collection and storage. These meetings provided information on various aspects of the data program within NOAA, and key stakeholders both internal and external to NWS were invited to all meetings to expand awareness and answer questions. Key findings include the need for quality assurance standards and a policy statement on best practices for quality control so NWS Central Region can continue to deliver the most accurate and timely information to the public. Two more are scheduled for 2008: Madison, WI (May 21-22) and Kansas City, MO (July 29-30).

NWS is always looking for feedback from users. A customer survey link is provided on each forecast office site to collect user thoughts and comments.

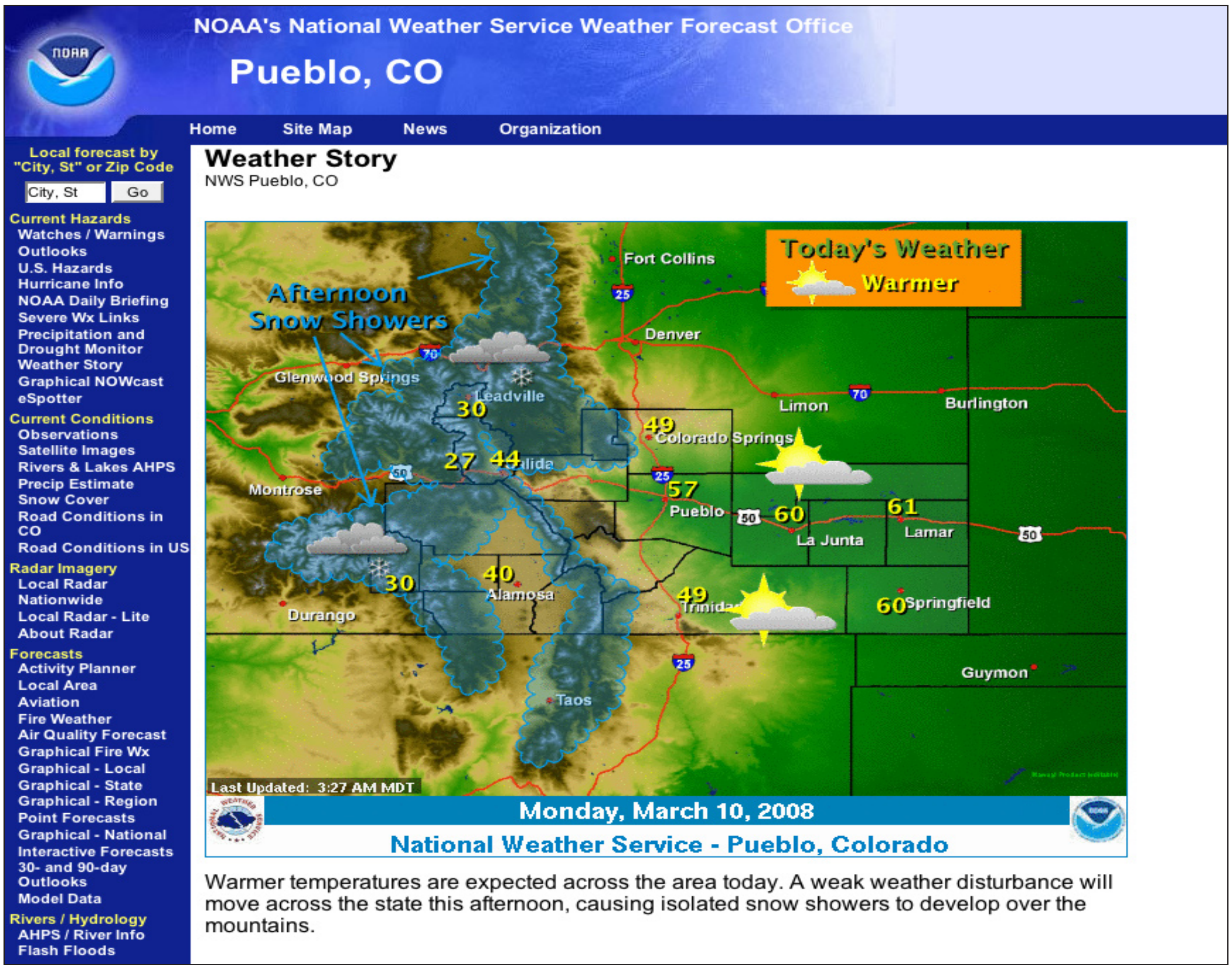


Figure 15b. Example of a Weather Story web page from the WFO in Pueblo, Colorado.

On the Web

- NWS Central Region climate resource page: http://www.crh.noaa.gov/climate/.
- Current drought statements for the whole U.S.: http://www.weather.gov/hic/current/drought/index.shtml.
- Weather stories for the NWS Central Region: http://www.crh.noaa.gov/crh/graphicasts.php.
- Local weather forecast office web sites accessed either from the NWS Central Region: http://www.crh.noaa.gov/ or from the National Weather Service homepage: http://www.weather.gov (click on desired location).