Intermountain West Climate Summary

by The Western Water Assessment

Issued September 29, 2006

September 2006 Climate Summary

Hydrologic Conditions: The recent snow in the mountains benefits soil moisture, but will be melted out soon in all but the most sheltered locales, so will have little effect on winter snowpack. All of Wyoming and much of Colorado remains in drought status.

Temperature: Record temperatures were set in many areas in July and August, and temperatures in August were above average for much of the region.

Precipitation: Record summer monsoon and abundant rains in the first half of September brought drought relief to the Southwest and many parts of the Intermountain West.

ENSO: An El Niño event has developed in the equatorial Pacific, and is likely to continue into early 2007, although it is not yet strong enough to influence the October 2006 forecasts

Climate Forecasts: If the El Niño event strengthens further – as many models suggest – that would favor a wet fall from northeastern Colorado into southeastern Wyoming.

Drought and climate change is an active topic at meetings, in the press

Last week, scientists and resource managers from around the country met in Longmont, Colorado for a workshop *Managing Drought and Water Scarcity in Vulnerable Environments*, sponsored by the Geologic Society of America. The goal of the meeting was to create an integrated, interactive, future-oriented forum for understanding and improving our management of drought and water scarcity in the U.S. Although drought is a normal part of climate for virtually all U.S. regions, recent episodes have highlighted the increasing vulnerability of all regions to drought-induced water shortages. Several scientists affiliated with the Western Water Assessment were involved, including Connie Woodhouse, Roger Pulwarty, and Marty Hoerling, who discussed his new study on global warming, drought, and impacts on water supplies in the Interior West, which was covered in the Boulder Daily Camera, see http://tinyurl.com/kkh6o. More information and all the talks from the meeting will be available at the GSA website: http://www.geosociety.org/meetings/06drought/.

The Salt Lake City Tribune did a week-long series on climate change impacts on the West, including drought, see the first article in the series at: http://www.sltrib.com/ci_4142345, with links to the other articles.

WWA is a co-sponsor of two upcoming workshops. On Thursday, October 5th, the University of Wyoming is sponsoring a workshop on *Water, Drought, and Wyoming's Climate*, for more information see the Wyoming Water Availability page (p. 10) and http://www.uwyo.edu/enr/WyomingWater.asp. And on October 11-12, WWA, the Mountain Studies Institute, Fort Lewis College, the Univ. of Arizona Climate Assessment for the Southwest (CLIMAS), and San Juan Public Lands are hosting a collaborative workshop on climate variability and change in the San Juan Mountain region – for more information, see: http://www.mountainstudies.org/conference/ .

In This Issue

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

Contact Us - Send questions or feedback, or to sign up for our summary e-mail announcement, please e-mail us at: WWASummary@wwa.colorado.edu.

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New Spatial Information in the National Drought Monitor

By Kelly C. Smith, NDMC and Christina Alvord, WWA

An enhanced version of the U.S. Drought Monitor went live this month with state-level breakdowns that include county lines, making it easier to use and interpret. The weekly product now includes information by region and state, along with summary statistics on changes in drought status affecting various areas, according to Mark Svoboda, a climatologist at the National Drought Mitigation Center (NDMC). Svoboda, one of the lead authors and developers of the U.S. Drought Monitor, said, "We've been talking about these changes with our partners at NOAA and USDA since we first launched the U.S. Drought Monitor back in 1999." In a statement to fellow authors and reviewers, he said, "I tip my cap to our GIS programmer Soren Scott here at the NDMC for helping make these features happen so quickly after coming aboard the center here." Scott joined the NDMC earlier this year. The NDMC's expanded capabilities are largely due to funding from the U.S. Department of Agriculture (USDA) Risk Management Agency.

In the near future NDMC hopes to add the capability to generate even more spatially fine-tuned images. The U.S. Drought Monitor, which was first launched in 1999, combines the expertise of 225 federal, state, and academic reviewers from across the country with that of sophisticated climate monitoring tools in attempt to provide a big-picture view of current drought conditions in the United States.

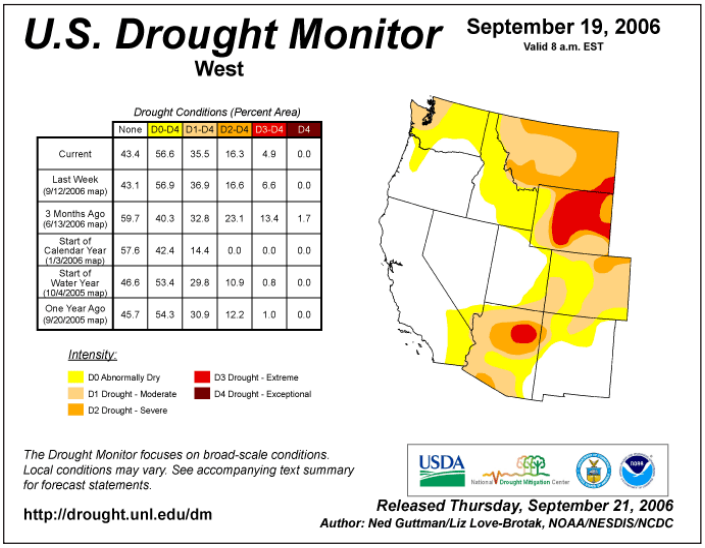

Figure 1a. Beginning last month, the U.S. Drought Monitor released new regional and state level breakdowns of drought conditions including changes in various areas over a given time-frame. As of September 21, the U.S. Drought Monitor reported that 4.9% of the area shown is assigned under the drought intensity category of D3 and D4, in comparison to last year's estimate of 1.0%.

U.S. Drought Monitor Applications: Use by USDA

The enhanced image resolutions were first released in a beta, i.e. test, version in July 2006 and are part of the first phase of turning the U.S. Drought Monitor into a more robust, interactive Decision Support System. The new enhancements came out at nearly the same time that Department of Agriculture officials announced endorsement of emergency assistance for ranchers residing in counties officially identified as being in extreme drought (D3) or exceptional drought (D4) conditions during the growing season. The federal announcement touched off a flurry of debate among U.S. Drought Monitor authors and reviewers as to whether the Drought Monitor is sufficiently accurate to allocate assistance at the local level. It illustrated the characteristic tension between scientists, who prefer very precise, highly qualified information, and policy makers, who need the best possible information and generally recognize that some uncertainty is inevitable. "I think it's great that USDA is using the Drought Monitor to make decisions. It simply is the best thing out there," said Mark Shafer, Director of Climate Information for the Oklahoma Climatological Survey. Shafer indicated that without the Drought Monitor, decisions such as emergency assistance were largely made without much objective information. Shafer and others also highlighted the need to combine the Drought Monitor's big-picture view with locally generated information – for example, by tapping into USDA county-level reports. "In making county-level designations from a national product, there are bound to be some areas that are imperfectly attributed," he said.

In another opinion, Brian Wolford, Executive Director of the Nebraska State Farm Service Agency, said the Drought Monitor is a good indicator of where to look for drought impacts, although it's often fruitful to include counties next to those that are officially in D3 or D4 drought." Whenever you draw a line, there's going to be people on one side that may not be in agreement with where it is," he said. Wolford emphasized that the U.S.

On the Web

- National Drought Mitigation Center: http://drought.unl.edu/
- Drought Monitor: http://drought.unl.edu/dm/monitor.html
- Drought Impact Reporter: http://droughtreporter.unl.edu

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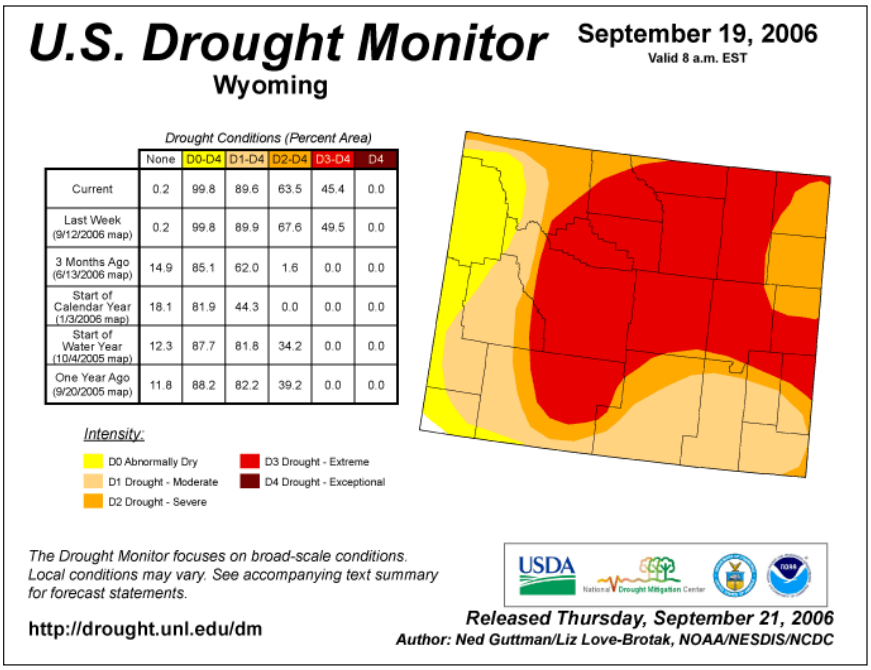


Figure 1b. State level drought condition product for Wyoming.

Drought Monitor brings an additional focus to the FSA's standard data collection methods, quantifying crop yields and losses on a county-by-county basis.

Wolford observed that in the past five years, "The USDA has begun using the Drought Monitor more in program administration." In addition to the newly announced Livestock Assistance Grant Program, the USDA has used the Drought Monitor to determine eligibility for emergency haying and grazing of Conservation Reserve Program land and to qualify producers in designated counties for the Cattle Feed Program and the Livestock Compensation Program. "We're trying to provide better tools to help producers make their case when these kinds of issues come up," Svoboda said. However, he cautioned, farmers and ranchers should assume that they bear the burden of proof in making the case that their specific circumstances warrant assistance.

Drought Impact Reporter

Recognizing the need for impacts information to complement the data on physical systems, the NDMC is also working to improve the Drought Impact Reporter. The Reporter went live in July 2005, relying mainly on collected media reports and other submitted impacts. Mike Hayes, NDMC Associate Director, said, "In our workshops and interactions with producers, we tell them that one of the best mitigation strategies a producer can take -- in other words, an action taken before a drought occurs -- is great record keeping. That might include historical yield data, planting data, climate data, and pictures. If a producer has documentation, and then can get supplemental information from their Regional Climate Centers, State Climatologists, local county extension agents, and local National Weather Service offices, they are going to be well-prepared to offer an argument for an exception."

Temperature through 8/31/06

Monthly average temperatures for August 2006 for the Intermountain West region ranged from lows in the mid-50s in western **Wyoming** and north central **Colorado** mountains to highs in the low 80s in southeast **Utah** (Figure 2a). Northeast and southeast **Wyoming** had the highest departure from average with temperatures ranging 2-3°F above average, while northeastern **Utah** recorded the lowest departure from average of 2-3°F below average (Figure 2b). Of the tri-state area, **Colorado** had temperatures closest to average, except for north central areas, where temperatures were 2-3° F above average.

In comparison to August 2005 (Figure 2c) temperatures for August 2006 were, on average, higher for most of the Intermountain West region. **Wyoming** has the largest difference between years, with above average temperatures for most of the state in 2006, whereas in 2005, the state recorded 0-4° F below average throughout most of the state.

According to NWS, Boulder, there were twelve 90° or above days recorded for the Denver area in August, which is 3 above the 1971-2000 average of 9. Seasonal total for 90° days is now at 54 which puts 2006 into 5th place for most days above 90°. The average through August is only 31. The current record of sixty-one days 90° or greater was set in 2000. In 2005 there were fifty-five 90° days, the 4th most recorded.

According to the NWS Salt Lake City, 9 daily temperature records were set or tied in July. July 22 set the records for both maximum and minimum temperature records. The average monthly maximum temperature of 83.1° made July 2006 the second warmest July and the second warmest month ever. The warmest July and warmest month occurred in 2003 with an average monthly temperature of 83.4°. The average monthly minimum temperature of 69.6° set a record for the warmest all time average monthly minimum temperature. The previous record was 68.8° in July 2003.

Notes

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.

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 aberrant values in data- sparse regions. For maps with individual station data, please see web sites listed below.

Figures 2a-c are experimental products from the High Plains Regional Climate Center. These data are considered experimental because they utilize the newest data available, which are not always quality controlled.

On the Web

- For the most recent versions 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.

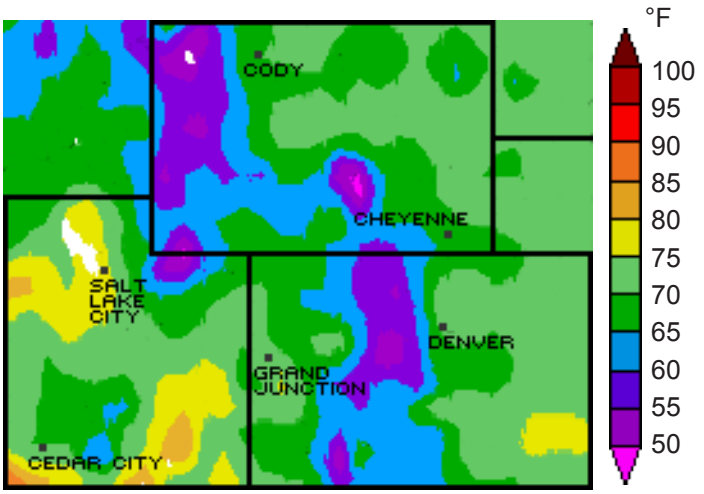


Figure 2a. Average temperature for the month of August 2006 in °F.

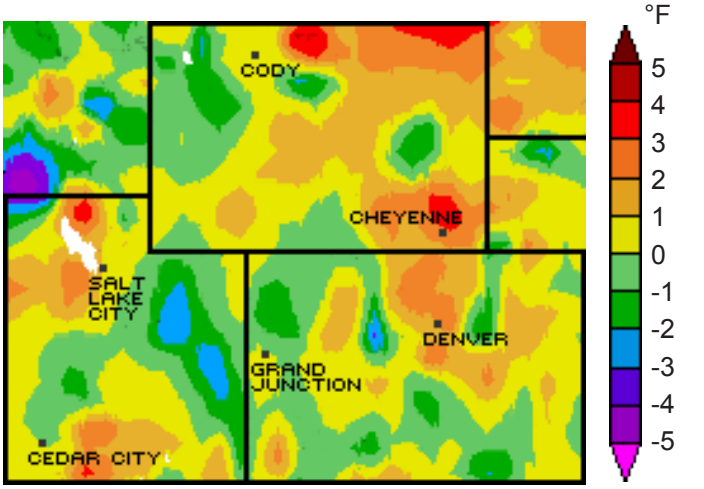


Figure 2b. Departure from average temperature for the month of August 2006 in °F.

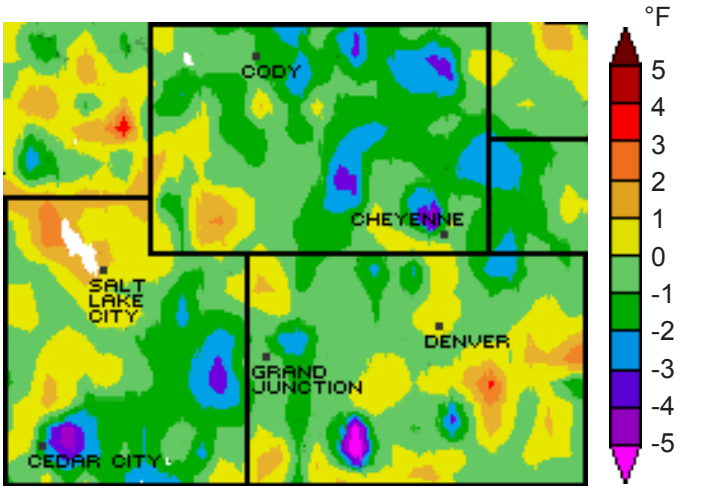


Figure 2c. Departure from average temperature in °F for last year, August 2005.

Precipitation through 8/31/06

Total precipitation for August 2006 in the Intermountain West region ranged from 0 to 4+ inches (Figure 3a). Southeast **Colorado** received the highest totals, with much of the southern half recording 4 - 6 inches. In contrast, north central **Wyoming** and western **Utah** received little precipitation in August, with some areas receiving less than 0.25 inches for the month. The significant precipitation received in southeastern **Colorado** appears to be related to the high monsoon precipitation amounts that fell in New Mexico and eastern Arizona this summer (some areas of central and northeast New Mexico received up to 10-20 inches of rain in August).

Due to significant summer storms, percent of average precipitation for the month of August (Figure 3b) is now at 120% - 200% of average for much of southern **Colorado**, southeastern **Wyoming**, and portions of southeast and north central **Utah**, while western **Utah** and north central **Wyoming** are still at less than 40% - 80% of average.

Percent of average precipitation since the start of the water year (Figure 3c) is near average for most of **Colorado** and **Utah**, except for northern **Utah** and southwest **Colorado** where precipitation values are about 120% of average. The deficit of water received in **Wyoming** since the start of the water year is reflected in percent of average values of 40% -80% of average, especially the north central region.

According to the Community Collaborative Rain, Hail & Snow Network (CoCoRaHS) update on September 2, several areas of **Wyoming** have had less than 1 inch of rain since June 1. Riverton, Lander, Cody, Powell and Pinedale have all been far below average. Director Nolan Doesken reports that the driest of all CoCoRaHS weather stations are in Washakie County in north central **Wyoming** where faithful observers in Worland and near Ten Sleep are reporting below 0.25" for the entire summer.

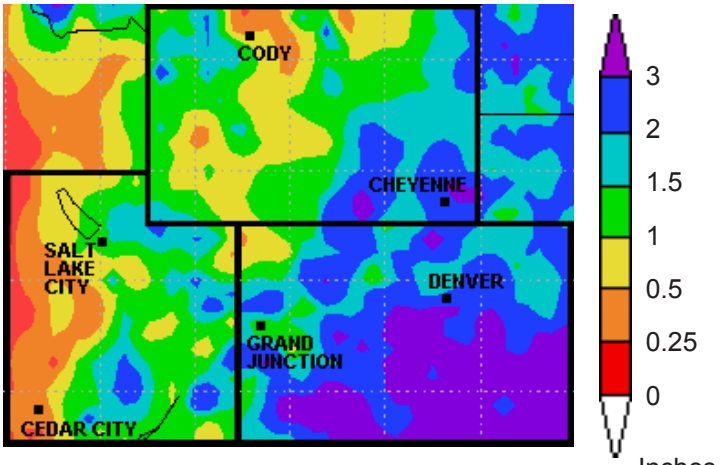


Figure 3a. Total precipitation in inches for the month of August 2006.

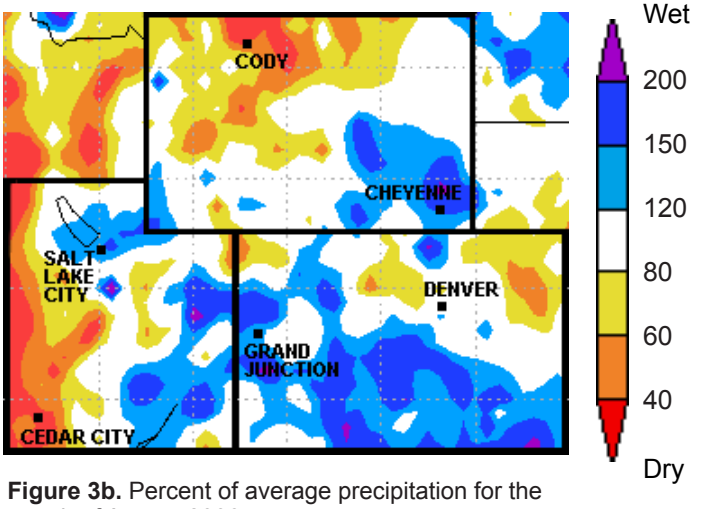


Figure 3b. Percent of average precipitation for the month of August 2006.

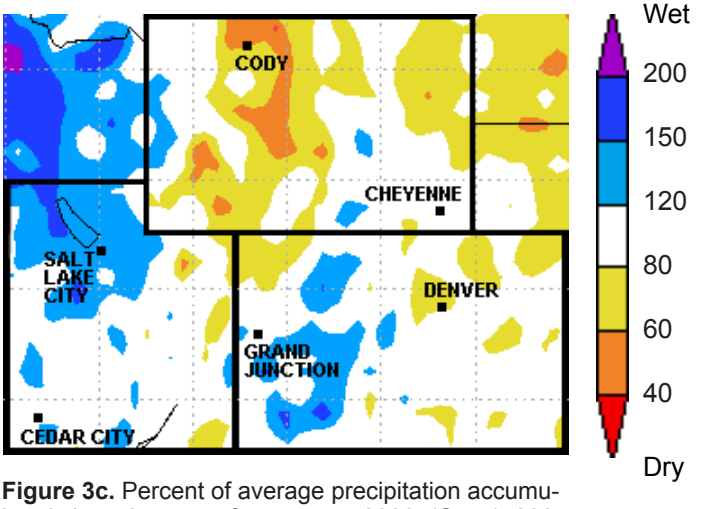


Figure 3c. Percent of average precipitation accumulated since the start of water year 2006. (Oct. 1, 2005 to August 31, 2006).

Notes

The water year runs from October 1 to September 30 of the following year. As of October 1, 2005, we are in the 2006 water year. The water year is more representative of climate and hydrological activity than the standard calendar year. It reflects the natural cycle of accumulation of snow in the winter and runoff and use of water in the spring and summer.

Average refers to the arithmetic mean of annual data from 1996-2005. This period of record is only ten years long because it includes SNOTEL data, which have a continuous record beginning in 1996. Percent of average precipitation is calculated by taking the ratio of current to average precipitation and multiplying by 100.

The data in Figs. 3a-c come from NOAA's Climate Prediction Center. The maps are created by NOAA's Earth System Research Laboratory and are updated daily (see website below). These maps are derived by taking measurements at individual meteorological stations and interpolating (estimating) values between known data points to produce continuous categories.

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/2002/perspectives.html.
- For a list of weather stations in Colorado, Utah, and Wyoming, visit: http://www.wrcc.dri.edu/summary.

U.S. Drought Monitor conditions as of 9/19/06

According to the National Drought Monitor on September 19, 2006, drought intensity status has decreased for much of **Colorado**, with the drought category for the northeast section being lowered from D2 (severe) in August to D1 (moderate drought). The category for the northwest, southeast and central **Colorado** was also lowered from D1 (moderate) to DO (abnormally dry). The highest intensity drought in the Intermountain West is in northern and central **Wyoming** where the status was raised from from D2 (severe) in August to D3 (extreme) in September. However, the southeast section has been lowered to D1 (moderate) from D2 (severe), due to receiving some beneficial moisture in August. **Utah** conditions remain unchanged from August, with the southeast in moderate of abnormally dry conditions, the rest of **Utah** remains outside the designated drought area. The Nebraska panhandle remains in D3 (extreme) status.

According to the U. S. Drought Monitor Impacts Reporter, Park and Big Horn counties of **Wyoming**, (currently in D2 - D3 status) report impacts of the reduced water levels of Bighorn Lake, a large reservoir which stretches across the Montana-**Wyoming** border. It is reported that water level reductions are creating problems for lake recreation and trout fisheries, and animosity is growing between different water users on around the lake. Reports indicate fish populations in the lake have been reduced from 9,000 fish per mile to fewer than 500 fish per mile. Current inflow into the lake is the fourth lowest since 1967. In northern and central **Wyoming**, the dry summer has limited the forage for wildlife. Antelope and mule deer were especially affected, meaning fewer survived the summer due to poor nutrition. Johnson County reports agricultural and livestock impacts due to no water for grass and loss of bulls due to bad water.

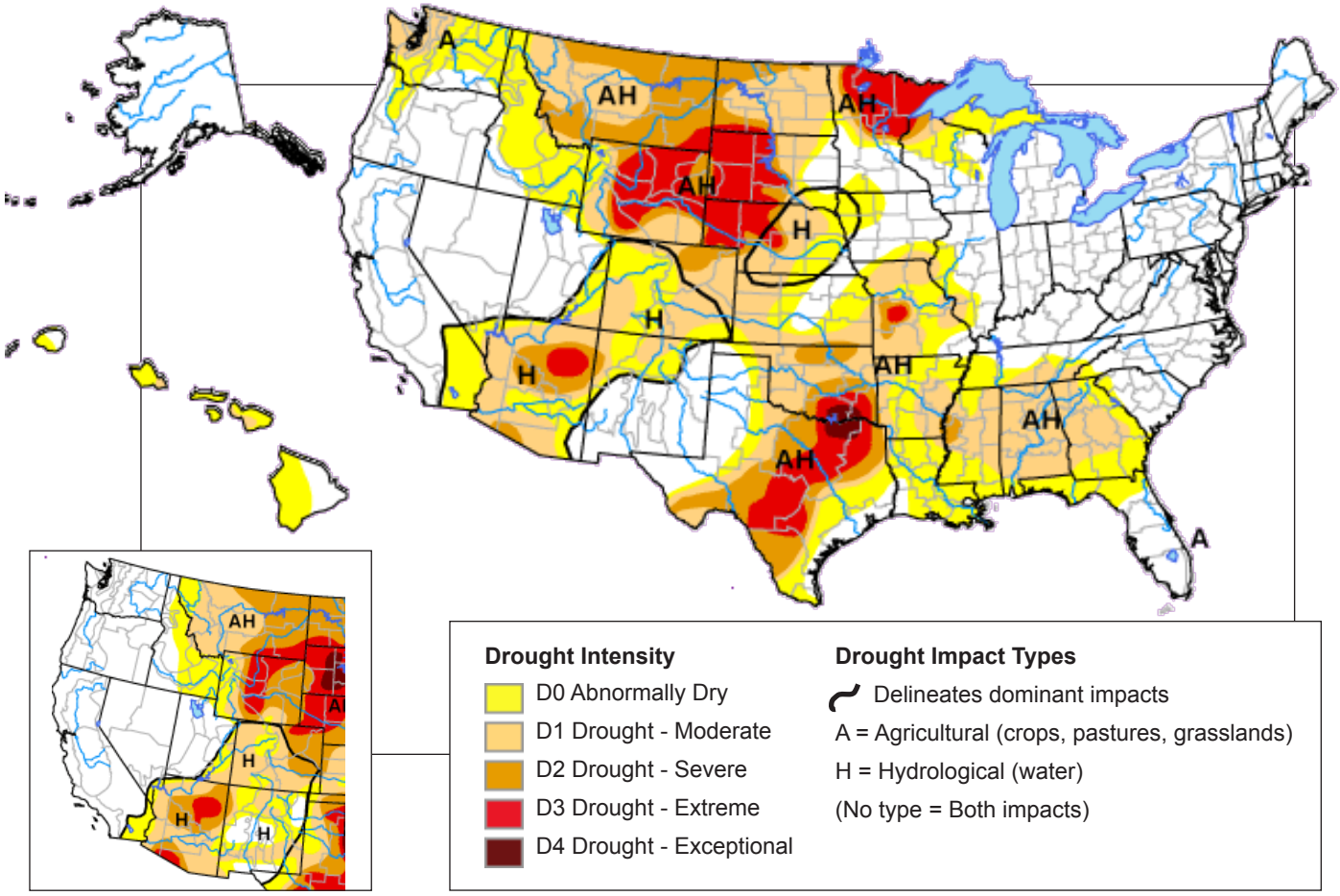


Figure 4. Drought Monitor released September 19, 2006 (full size) and last month August 22, 2006 (inset, lower left) for comparison.

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 month'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 the several agencies; the author of this monitor is Rich Tinker of the NOAA Climate Prediction Center.

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/

Reservoir Status

In the late summer and fall each year, reservoirs are past the springtime runoff that over April-July provides most of the supply for the rest of year, and are being drawn down to provide water for agricultural, municipal, and industrial uses. Some years, rain in the late summer increases storage, and this happened this year at Turquoise Lake in the Upper Arkansas River in **Colorado**, where storage levels increased over the summer, and capacity is currently at 83%. Lake Powell is at 49% of capacity, slightly up from 46% in May. The USBR is currently releasing 9,100 acre feet from Glen Canyon Dam, which remains consistent with releases in 2005. According to USBR, April through July unregulated inflow to Lake Powell was 5.32 maf, or 67 percent of the 30 year average. water surface elevation of Lake Powell will likely continue to decrease through the fall and winter until April 2007, when anticipated snowmelt runoff will cause the water surface level to increase once more.

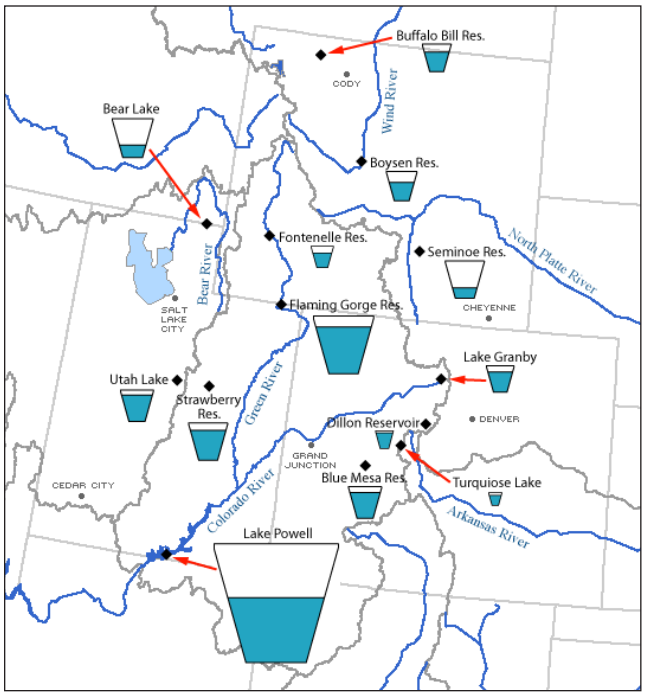
Colorado reservoirs saw an overall increase in storage since the beginning of the summer, but only Dillon Reservoir maintains near full capacity storage levels, currently at 98% capacity with 247,968 acre feet of storage; however all the reservoirs listed in **Colorado** reservoirs are near average for this time of year . Arkansas basin reservoirs in **Colorado**, including Twin Lakes, Pueblo, John Martin, and Turquoise reservoirs collectively totaled 76% of average at the end of August.

Storage in **Wyoming** reservoirs Seminoe, Boysen, and Buffalo Bill also decreased as reservoir releases were made the late summer/early fall period. Storage of 27% capacity, down from 40% in May for Seminoe Reservoir can be partially attributed to below average inflows from the North Platte River above the Reservoir for August and continuing into September. August flows at USGS station above Seminoe Reservoir ranged from 200-300 cfs, a lower flow range than the 67-year average range of 300- 400 cfs for this period . Boysen Reservoir storage is now at 60% capacity.

Storage in **Utah** has declined since reservoir levels reached their annual highs in July. According to Central Utah Water Conservancy District, inflow into Strawberry reservoir on August 8 was 292 cfs, but dropped to 177 cfs on September 11 and to 4 cfs by September 13. While these decreases may be related to upstream management, they are typical of drops in flows from summer levels to fall and winter base. Flows at the USGS gage above Bear Lake (#10020100), dropped about 175 cfs in a 48-hour period.

Notes

The size of each "tea-cup" in Figure 5 is proportional to the size of the reservoir, as is the amount the tea-cup is filled. The first percentage shown in the table is the current contents divided by the total capacity. The second percentage shown is the percent of average water in the reservoir for this time of year. Reservoir status is updated at different times for individual reservoirs, so see the websites below for the most recent information.



Reservoir	Current Water (KAF)	Total Capacity (KAF)	% Full	% of Average
Colorado				
Blue Mesa Res.	692.1	829.5	83%	102%
Dillon Res.	248.0	254.0	98%	104%
Lake Granby	386.5	539.7	72%	96%
Turquiose Lake	112.2	129.4	87%	100%
Utah				
Bear Lake	409.3	1,302.0	31%	55%
Lake Powell	11,956.4	24,322.0	49%	59%
Strawberry Res.	931.3	1,106.5	84%	137%
Utah Lake	770.0	870.9	88%	106%
Wyoming				
Boysen Res.	444.6	741.6	60%	83%
Buffalo Bill Res.	460.9	644.1	72%	146%
Flaming Gorge Res.	3,137.0	3,749.0	84%	95%
Fontenelle Res.	248.9	344.8	72%	91%
Seminoe Res.	272.0	1,017.3	27%	43%

KAF = Thousands of Acre Feet

Figure 5. Tea-cup diagram of several large reservoirs in the Intermountain West Region. All reservoir content data is from between August 30 and July 5, 2006.

On the Web

- Dillon Reservoir, operated by Denver Water: http://www.water.denver.co.gov/indexmain.html.
- Turquoise Lake, Boysen Reservoir, Seminoe Reservoir, and Buffalo Bill Reservoir operated by the U.S. Bureau of Reclamation (USBR) Great Plains Region: http://www.usbr.gov/gp/hydromet/teacup_form.cfm.
- Lake Granby is part of the Colorado-Big Thompson project, operated by Northern Colorado Water Conservancy District and the USBR Great Plains Region: http://www.ncwcd.org/datareports/data_reports/cbt_wir.pdf.
- Blue Mesa Reservoir, Lake Powell, Flaming Gorge Reservoir, and Fontenelle Reservoir operated by the USBR – Upper Colorado Region: http://www.usbr.gov/uc/wcao/water/basin/tc_cr.html.
- Strawberry Reservoir, operated by the Central Utah Water Conservancy District: http://www.cuwcd.com/operations/currentdata.htm.
- Utah Lake, operated by the Utah Division of Water Rights, and Bear Lake, operated by Utah Power: http://www.wcc.nrcs.usda.gov/cgibin/resv_rpt.pl?state=utah

Regional Standardized Precipitation Index data through 8/31/06

Source: Western Regional Climate Center, using data from NOAA National Climatic Data Center and NOAA Climate Prediction Center

The Standardized Precipitation Index (SPI) can be used to monitor conditions on a variety of time scales. 3- and 6-month SPIs are useful in short-term agricultural applications and longer-term SPIs (12-month and longer) are useful in hydrological applications. The 12-month SPI for the Intermountain West region reflects precipitation patterns over the past 12 months (through the end of August 2006) compared to the average precipitation of the same 12 consecutive months during all the previous years of available data.

As of the end of August 2006, several climate divisions were downgraded by one category drier from the classification at the end of June, 2006. In **Wyoming** the Upper Platte River division moved from very dry to extremely dry, the Green & Bear division from moderately dry to very dry, and the Yellowstone and Powder, Little Missouri, Tongue River divisions from near normal to moderately dry. In **Colorado**, the Platte River division was upgraded by one category from extremely dry to very dry, while the Arkansas River division was upgraded by two categories from very dry to near average.

Notes

The Standardized Precipitation Index (SPI) is a simple statistic generated from accumulated precipitation totals for consecutive months compared to the historical data for that station. 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 out of 100 years would be expected to be drier. An index value of -2 means severe drought with only one year in 40 expected to be drier (courtesy of the Colorado Climate Center).

The SPI calculation for any location is based on the long-term precipitation record for a desired period. This long-term record is fitted to a probability distribution, which is then transformed into a normal distribution so that the mean SPI for the location and desired period is zero. Positive SPI values indicate greater than median precipitation, and negative values indicate less than median precipitation. Because the SPI is normalized, wetter and drier climates can be represented in the same way. The SPI is valuable in monitoring both wet and dry periods.

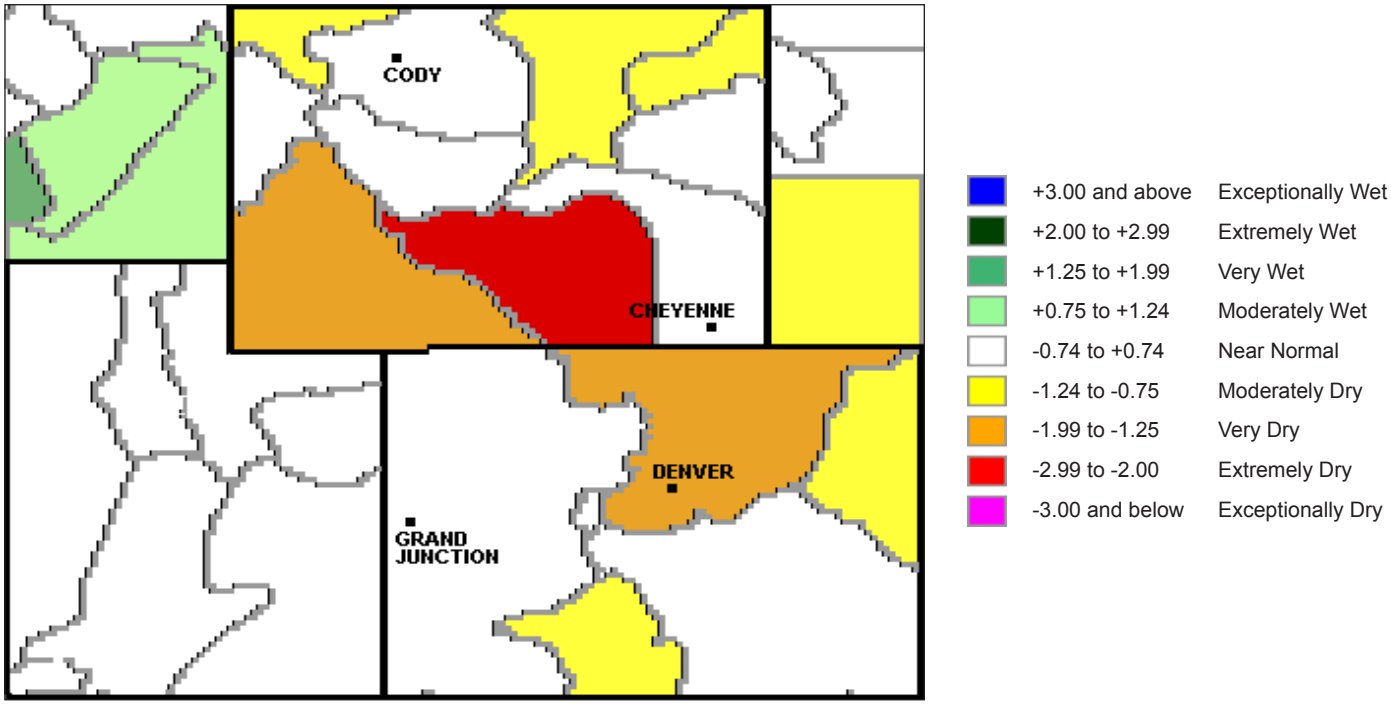


Figure 6. 12-month Intermountain West regional Standardized Precipitation Index. (data through 8/31/06)

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.

Colorado Water Availability September 2006

Source: Colorado Division of Water Resources, State Engineer; U.S. Geological Survey

In September, Colorado has higher SWSI indices and average to above average streamflows, a positive note for water availability considering that statewide snowpack on June 1 of this year was 26% of average, and in July Governor Bill Owens declared 25 out of 64 counties a disaster area due to severe drought conditions.

Most Colorado rivers are, flowing in the average and above average categories (25th-90th percentiles) for this time of year, with the highest flows in the Arkansas River Basin at Cherry Creek and Fountain Creek (Figure 7b). Low flows (>10th -24th percentiles) are located on the White River and the Upper Colorado River area surrounding Grandby.

Surface Water Supply Index for August 2006 (SWSI) values have increased in four of seven basins compared to July 2006 (Figure 7a). Ranging from a low value of -0.9 in the Gunnison Basin to a high value of +1.0 in the San Juan/Dolores Basin, September 1 SWSI values reflect conditions during the month of August. Rainfall in the Rio Grande Basin has improved streamflow conditions, represented in +2.5 change in value from the previous month. According to the Colorado Office of the State Engineer, monsoon weather in the San Juan/Dolores Basin contributed to low maximum temperatures and high minimum temperatures, and to +2.9 change in SWSI for that basin since July. For example, the daytime high temperatures in Durango were 1.2 degree below its 30-year average high and nighttime lows were 3.8 degrees above 30-year average lows.

Below average flows in August for the South Platte Basin contributes to a –0.6 decline in SWSI values from last month, but the Basin still remains at above average supply conditions with a value of +0.8. The Colorado River Basin stands at +1.1, average to above average supply conditions. Detailed information on each basin is available from a monthly report from the Colorado Division of Water Resources updated the first week of each month and available at http://www.water.state.co.us/pubs/swsi.asp.

The Colorado Water Availability Task Force of the Office of Water Conservation & Drought Planning met on September 21st but does not plan to meet again until December. Information can be found on the web at http://cwcb.state.co.us/Conservation/Drought/waterAvailability.htm.

Surface Water Supply Index

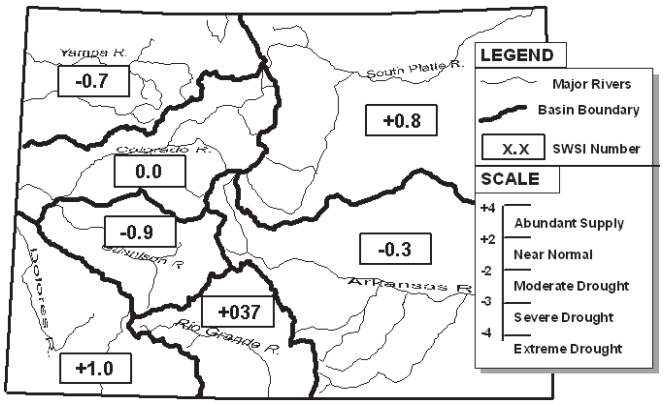


Figure 7a. Colorado Surface Water Supply Index. The map is an indicator of mountain-based water supply conditions in the major river basins of the state as of July 1, 2006.

7-Day Average Streamflows

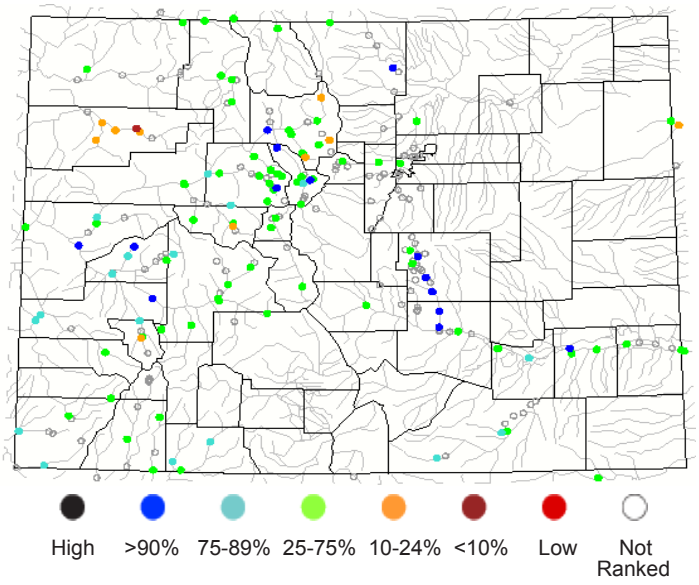


Figure 7b. Seven-day average streamflow conditions for points in Colorado as of September 13, 2006, computed at USGS gauging stations. The colors represent 7-day average streamflow compared to percentiles of 7-day average streamflow for 9/13/06.

Notes

The Surface Water Supply Index (SWSI), developed by the Colorado Office of the State Engineer and the USDA Natural Resources Conservation Service, 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 streamflow, reservoir storage, and precipitation for the summer period (May - October). This differs from winter calculations that use snowpack as well. During the summer period, streamflow is the primary component in all basins except the South Platte Basin, where reservoir storage is given the most weight. SWSI values in Figure 7a 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.

The "7-day average streamflow" map (Figure 7b) shows the average streamflow conditions for the past 7 days compared to the same period in past years. By averaging over the past 7 days, the values on the map are more indicative of longer-term streamflow conditions than either the "Real-time streamflow" or the "Daily streamflow" maps. If a station is categorized in "near normal" or 25th – 75th percentile class, it means that the streamflows 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. Areas containing no dots indicate locations where flow data for the current day are temporarily unavailable. The data used to produce this map are provisional and have not been reviewed or edited. They may be subject to significant change.

On the Web

- For current streamflow information from USGS as in Figure 7b, visit: http://water.usgs.gov/waterwatch/.
- For the current SWSI map, go to: http://www.water.state.co.us/pubs/swsi.asp
- 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."
- The Colorado Water Availability Task Force's Aug meeting had not yet been scheduled at press time. Agendas & minutes of upcoming & previous meetings are available at: http://cwcb.state.co.us/Conservation/Drought/taskForceAgendaMinPres.htm.

Wyoming Water Availability September 2006

Source: Wyoming Water Resources Data System and USDA Natural Resources Conservation Service

The University of Wyoming is sponsoring a one-day workshop in Laramie for water and other natural resource managers, scientists, and others who are interested in understanding the influence of climate on water resources. The ***Water, Drought, and Wyoming's Climate*** workshop will be held on Thursday October 5, 2006, and is a follow-up to the WWA Wyoming Climate workshop in December 2005.

The workshop will communicate current understanding of climate variability and climate change as it relates to Wyoming's water; discuss needs of water resource managers and other stakeholders; and facilitate discussion between water managers and researchers to develop future collaborations among participants to find answers, suggest solutions and address anticipated needs. For meeting information see: http://www.uwyo.edu/enr/WyomingWater.asp.

According to NWS of Western and Central Wyoming, July 2006 was the 2nd hottest July on record since 1892 as four new daily record highs were set and one tied in Landers. The NWS in Riverton reports that July 2006 ended up as the hottest July on record since 1918, with three daily record highs set. July was also the 4th driest July on record with only 0.03 of a inch of rainfall recorded or about 4% of normal. Casper set or tied five daily high temperature records in July 2006, ending with the second hottest July on record since 1940. Precipitation in Casper for the month of August was above average for the first time this year. Although this area is indrought warning, with significant water supply deficit, the monthly total to 199% of average, making it the 8th wettest August in the record book.

The most recent drought status update for Wyoming indicates drought conditions for much of Wyoming have been downgraded one to two classifications from July 2006 for most of the state (Figure 8a). The west has changed from wet-normal to drought watch and most of the rest of the state from watch to warning. Areas of central and northern Wyoming have been downgraded to extreme drought conditions.

The USGS reports that many streamflow gauges (Figure 8b) in northern and central Wyoming are below average with many low reports. Average streamflow conditions in southern and western Wyoming are mostly in the average category (25-75% percentile).

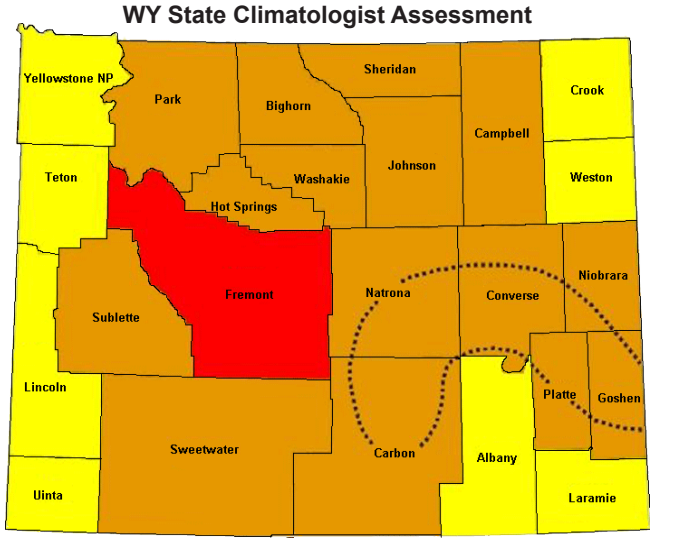


Figure 8a. Wyoming drought status. This map shows the Wyoming State Climatologist's assessment of the status of the drought throughout the state as of September 21, 2006.

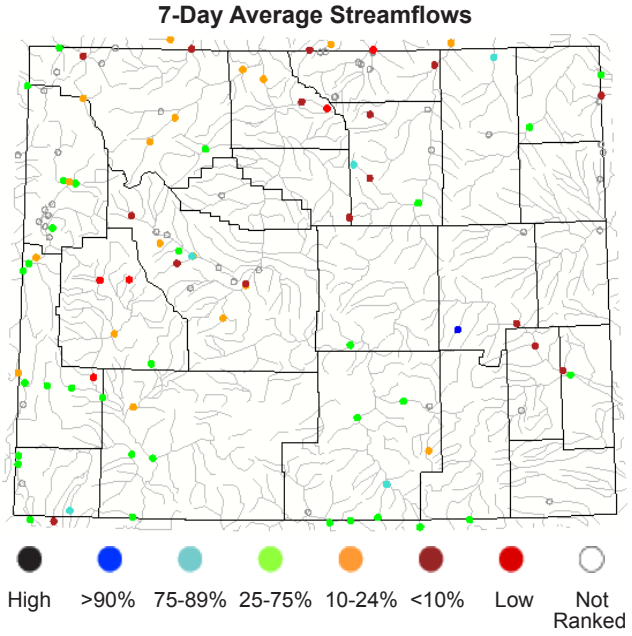


Figure 8b. Seven-day average streamflow conditions for points in Wyoming as of September 13, 2006, computed at USGS gauging stations. The colors represent 7-day average streamflow compared to percentiles of 7-day average streamflow for 9/13/06.

Notes

The Drought Status (Figure 8a) is calculated by the Wyoming state climatologist, based on snow water equivalent and other data.

The "7-day average streamflow" map (Figure 8b) shows the average streamflow conditions for the past 7 days compared to the same period in past years. By averaging over the past 7 days, the values on the map are more indicative of longer-term streamflow conditions than either the "Real-time streamflow" or the "Daily streamflow" maps. If a station is categorized in "near normal" or 25th – 75th percentile class, it means that the streamflows 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. Areas containing no dots indicate locations where flow data for the current day are temporarily unavailable. The data used to produce this map are provisional and have not been reviewed or edited. They may be subject to significant change.

On the Web

- Information on current Wyoming snowpack, SWE, and SWSI, along with more data about current water supply status for the state, can be found at: http://www.wrds.uwyo.edu/wrds/nrcs/nrcs.html.
- The Palmer Drought Index is found on NOAA's drought page: www.drought.noaa.gov.
- For current streamflow information from USGS, visit: http://water.usgs.gov/waterwatch/
- For current maps of SWE as a percent of normal like in Figure 8a, go to: http://www.wcc.nrcs.usda.gov/gis/snow.html.

Utah Water Availability September 2006

Source: USDA Natural Resources Conservation Service and the Colorado Basin River Forecast Center

Although there were numerous reports by the NWS of heavy thunderstorms and flash flooding, precipitation for July for northern Utah was below average with the monthly total at 0.26 of an inch or 36% of normal. According to NWS Salt Lake City, in one surge of moisture on July 30-31st, heavy rain and flash flooding hit parts of southern Utah as subtropical moisture moved northward into the state. Heavy rain west of Price caused a wall of water to wash down Garley Wash canyon, trapping a family and ultimately resulting in two fatalities.

The NWS reports that in early August, severe thunderstorms caused major damage and widespread power outages from Provo to Salt Lake City, with damage estimates in the tens of millions of dollars in Provo and Millcreek. Wind gusts reached 92 mph at the Provo Airport, where planes were flipped, hangers damaged, and hundreds of trees blown down. In late August, monsoonal moisture interacting with a cold storm system brought microburst winds and large hail, some up to 1.75" in diameter, to areas in northern Utah. August also brought some more record warm minimum temperatures on 22-23rd.

As of September 13, 2006 a majority of streamflow sites on the USGS "7-day average streamflow map" (Figure 9a) had flow values in the average category (25th – 75th percentile), with a few streams in north central Utah running above average (75th to >90th percentile). However several sites in northeast and central Utah recorded below-average flows within the (10th -24th percentile).

By using new soil moisture sensors, soil moisture charts are now available for Utah, which compile monthly averages of soil moisture statewide (Figure 9b) and from various locations and watershed basins. For more information on this network see the focus page in the June 2006 IMW Climate Summary. These data are being used to improve the water supply outlooks by incorporating information on soil moisture deficits.

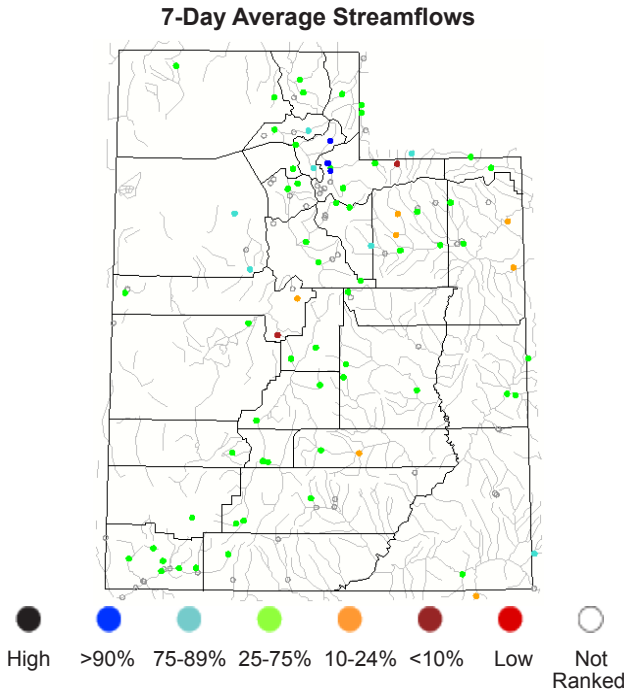


Figure 9a. Seven-day average streamflow conditions for points in Utah as of September 13, 2006, computed at USGS gauging stations. The colors represent 7-day average streamflow compared to percentiles of 7-day average streamflow for 9/13/06

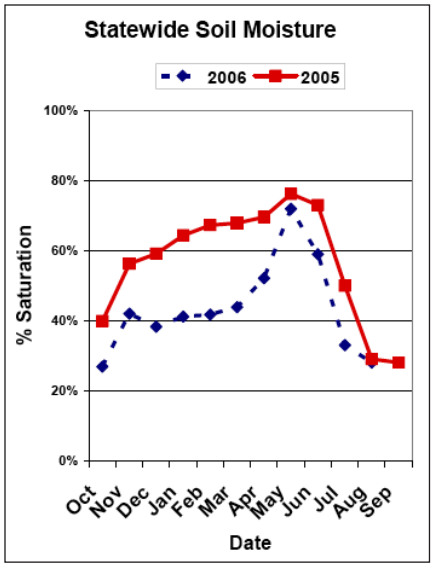


Figure 9b. Soil moisture chart for Utah for 2005 and 2006 to date; soil moisture for individual basins is available on the Utah NRCS webpage.

Notes

The "7-day average streamflow" map (Figure 9a) shows the average streamflow conditions for the past 7 days compared to the same period in past years. By averaging over the past 7 days, the values on the map are more indicative of longer-term streamflow conditions than either the "Real-time streamflow" or the "Daily streamflow" maps. If a station is categorized in "near normal" or 25th – 75th percentile class, it means that the streamflows 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. Areas containing no dots indicate locations where flow data for the current day are temporarily unavailable. The data used to produce this map are provisional and have not been reviewed or edited. They may be subject to significant change.

On the Web

- 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
- For current streamflow information from USGS, visit: http://water.usgs.gov/waterwatch/
- Utah NRCS Soil Moisture plots can be found at: http://www.ut.nrcs.usda.gov/snow/climate/

Temperature Outlook October 2006 - February 2007

According to the NOAA/CPC monthly outlook issued September 21st, there are equal chances of above, below or around average temperatures across most of the U.S. for the month of October 2006. Most indications from Forecast tools were either weak or mixed, so the only confident forecast that can be made is for above average temperatures in New England. Although El Niño conditions have developed in the tropical Pacific (see page 16), according to CPC the typical patterns of temperature (and precipitation) that accompany an El Niño tend to materialize further into the cold season, and are not much of a factor in the October forecasts.

However, the CPC seasonal forecasts for the October- December (OND) season and through the winter show an increased risk of above average temperatures for the Intermountain West as well as the West as a whole. This increased temperature is both due to long-term trends and due to a tendency for the West to be warmer than average during El Niño. For Nov-Jan 2006 the gray shading in the southeast indicates an increased chance of around average temperatures.

The temperature forecast for October 2006 will be updated on September 30th. Updated monthly forecast maps tend to feature more confident details than the regular mid-month forecast maps.

Notes

The seasonal temperature outlooks in Figures 10a-d predict the likelihood (chance) of *above-average, near-average,* and *below-average* temperature, but not the magnitude of such variation. The numbers on the maps refer to the percent chance that temperatures will be in one of these three categories, they do not refer to actual temperature values.

The NOAA-CPC outlooks are a 3-category forecast based largely on the status of El Niño and recent trends. As a starting point, the 1971-2000 climate record for each particular 1 or 3 month period is divided into 3 categories or terciles, each with a 33.3 % chance of occurring. The middle tercile is considered the *near-average* (or normal) temperature range. The forecast indicates the likelihood of the temperature being in one of the warmer or cooler terciles--*above-average* (A) or *below-average* (B)--with a corresponding adjustment to the opposite category; the near-average category is preserved at 33.3% likelihood, unless the anomaly forecast probability is very high. For a detailed description of how this works, see notes on the following page.

Equal Chances (EC) indicates areas for which the models cannot predict the temperature with any confidence. EC is used as a "default option" representing equal chances or a 33.3% probability for each tercile, indicating areas where the reliability (i.e., 'skill') of the forecast is poor.

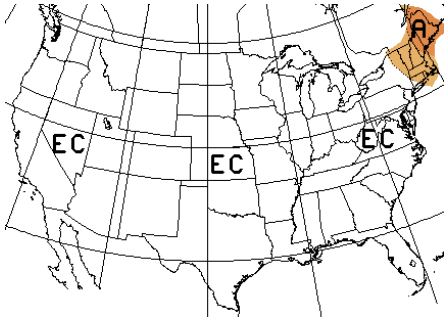


Figure 10a. Long-lead national temperature forecast for October 2006. (released Sep. 21, 2006)

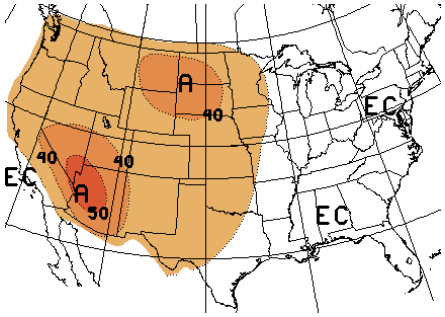


Figure 10b. Long-lead national temperature forecast for Oct. - Dec. 2006. (released Sep. 21, 2006)

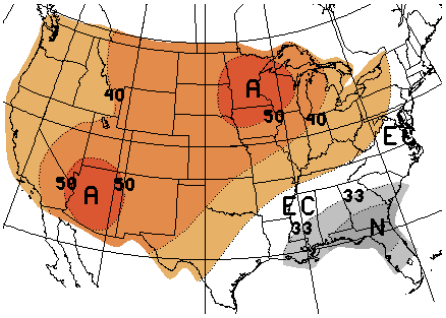


Figure 10c. Long-lead national temperature forecast for Nov. 2006 - Jan. 2007. (released Sep. 21, 2006)

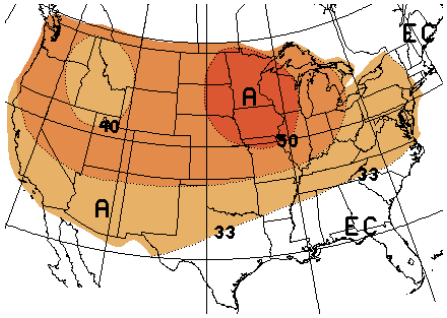


Figure 10d. Long-lead national temperature forecast for Dec. 2006 - Feb. 2007. (released Sep. 21, 2006)

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

N = Normal

On the Web

- For more information and the most recent forecast images, visit: http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html. 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 October 2006 - February 2007

According to the NOAA/CPC monthly forecast for October 2006, issued September 21st, there are equal chances of above, below or around average temperatures across most of the U.S. As with the monthly temperature forecast, this forecast is based on a synthesis of weak or mixed signals from forecast tools, so the only confident forecast that can be made is for above average precipitation in southern Florida. Although El Niño conditions have developed in the tropical Pacific (see page 16), according to CPC the typical patterns of temperature (and precipitation) that typically accompany an El Niño tend to materialize further into the cold season, and are not much of a factor in the October forecasts

The CPC seasonal forecasts, also provide little information, until the January-March (JFM) 2006 forecast period, in which there is an increased risk of above average precipitation in the southwest, which is consistent with an El Niño conditions. One of the typical patterns associated with El Niño is wetter than average precipitation in the southwest and drier than average precipitation in the northwestern U.S.

The precipitation forecast for October 2006 will be updated on September 30th. Updated monthly forecast maps tend to feature more confident details than the regular mid-month forecast maps.

Notes

The seasonal precipitation outlook in Figures 11a-b predicts the likelihood (chance) of above-average, near-average, and below-average precipitation, but not the magnitude of such variation. The numbers on the maps refer to the percent chance that precipitation will be in one of these three categories, they do not refer to inches of precipitation.

The NOAA-CPC outlooks are a 3-category forecast based largely on the status of El Niño and recent trends. As a starting point, the 1971-2000 climate record for each particular 1 or 3 month period is divided into 3 categories or terciles, 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 being in one of the wetter or cooler terciles--above-average (A) or below-average (B)--with a corresponding adjustment to the opposite category; the near-average category is preserved at 33.3% likelihood, unless the anomaly forecast probability is very high.

Thus, using the NOAA-CPC temperature outlook, areas with light brown shading display a 33.3-39.9% chance of above-average, a 33.3% chance of near-average, and a 26.7-33.3% chance of below-average temperature. A shade darker brown indicates a 40.0-50.0% chance of above-average, a 33.3% chance of near-average, and a 16.7-26.6% chance of below-average temperature, and so on.

Equal Chances (EC) indicates areas for which the models cannot predict the temperature with any confidence. EC is used as a "default option" representing equal chances or a 33.3% probability for each tercile indicating areas where the reliability (i.e., 'skill') of the forecast is poor.

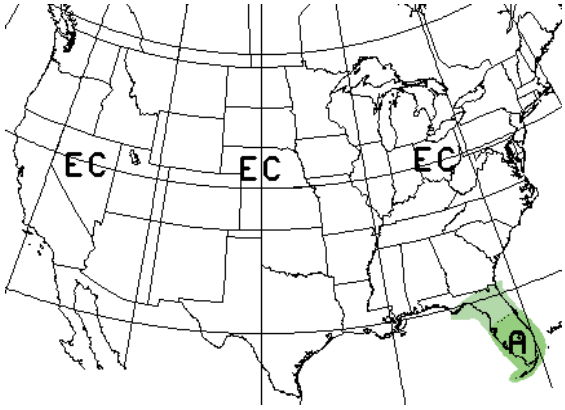


Figure 11a. Long-lead national precipitation forecast for October 2006. (released Sep. 21, 2006)

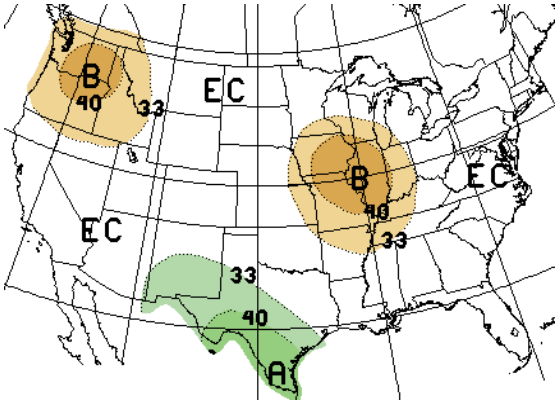


Figure 11b. Long-lead national precipitation forecast for Oct. - Dec 2006. (released Sep. 21, 2006)

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

On the Web

- For more information and the most recent CPC forecast images, visit: http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html. 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 continued

The experimental interior southwest forecast guidance for the upcoming October-December shows a shift in the odds towards dry conditions from southern **Utah** into all of New Mexico, while eastern **Colorado** features the opposite outlook ("wet"). Unfortunately, according to Dr. Wolter, fall seasons are difficult to predict, although a stronger-than-present El Niño event would favor a wet fall from northeastern Colorado into southeastern **Wyoming**, as well as for New Mexico. His first outlook for January-March 2007 (not shown, available on the webpage) favors New Mexico with the best odds for a wet late winter, while Arizona, Utah, and northeast Colorado face an increased likelihood for a dry late winter. Most of these regional forecasts are backed up by good verification skill during the last seven years.

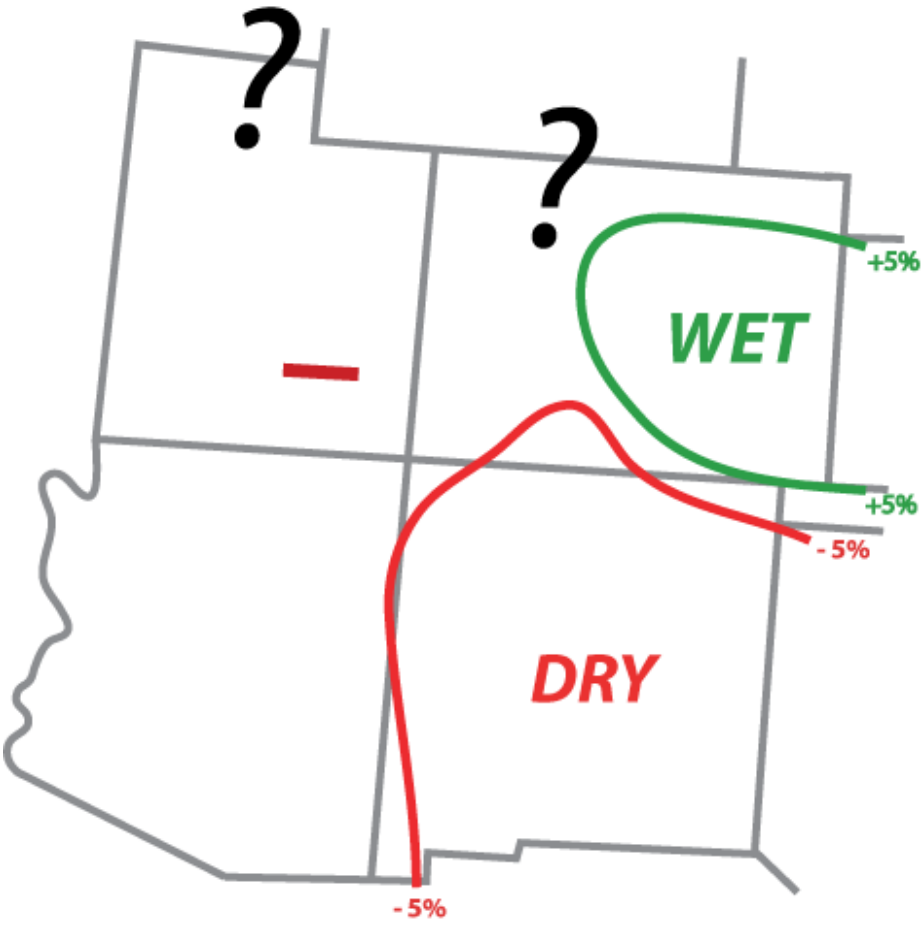


Figure 11c. Experimental guidance for seasonal precipitation in the southwest for October - December (issued September 19, 2006).

Notes

The experimental guidance for seasonal future precipitation in Figure 11c shows most recent forecast of shifts in tercile probabilities for July - September 2006. 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 CDC 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 December 2006 Source: NOAA Climate Prediction Center

The latest U.S. Seasonal Drought Outlook through December 2006, released Sept 21st by NOAA/CPC, reports that abundant rains in the first half of September brought drought relief to many parts of the country, including the Southwest and southwestern **Colorado**, the southern Plains, the Rockies, and portions of the central and northern Plains and the Southeast. CPC sees indications that further improvement will take place over many remaining drought areas in the Great Plains, including parts of Nebraska, **Wyoming**, and northern **Colorado**. A record summer monsoon in the southwest ended drought over New Mexico and parts of Arizona. Through December, some limited additional improvement is anticipated over remaining drought areas in Arizona, northwestern New Mexico, and southwestern **Colorado**. If recently-developed El Niño conditions persist through the end of the calendar year (as expected), it is very unlikely the upcoming snow season will be as low as that observed last winter across the Southwest, and that should benefit water supplies in the Southwest.

The next Seasonal Drought Outlook will be issued on October 19th.

Notes

The delineated areas in the Seasonal Drought Outlook (Figure 12) are defined subjectively and are based on expert assessment of numerous indicators, including outputs of short- and long-term forecasting models. "Ongoing" drought areas 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.

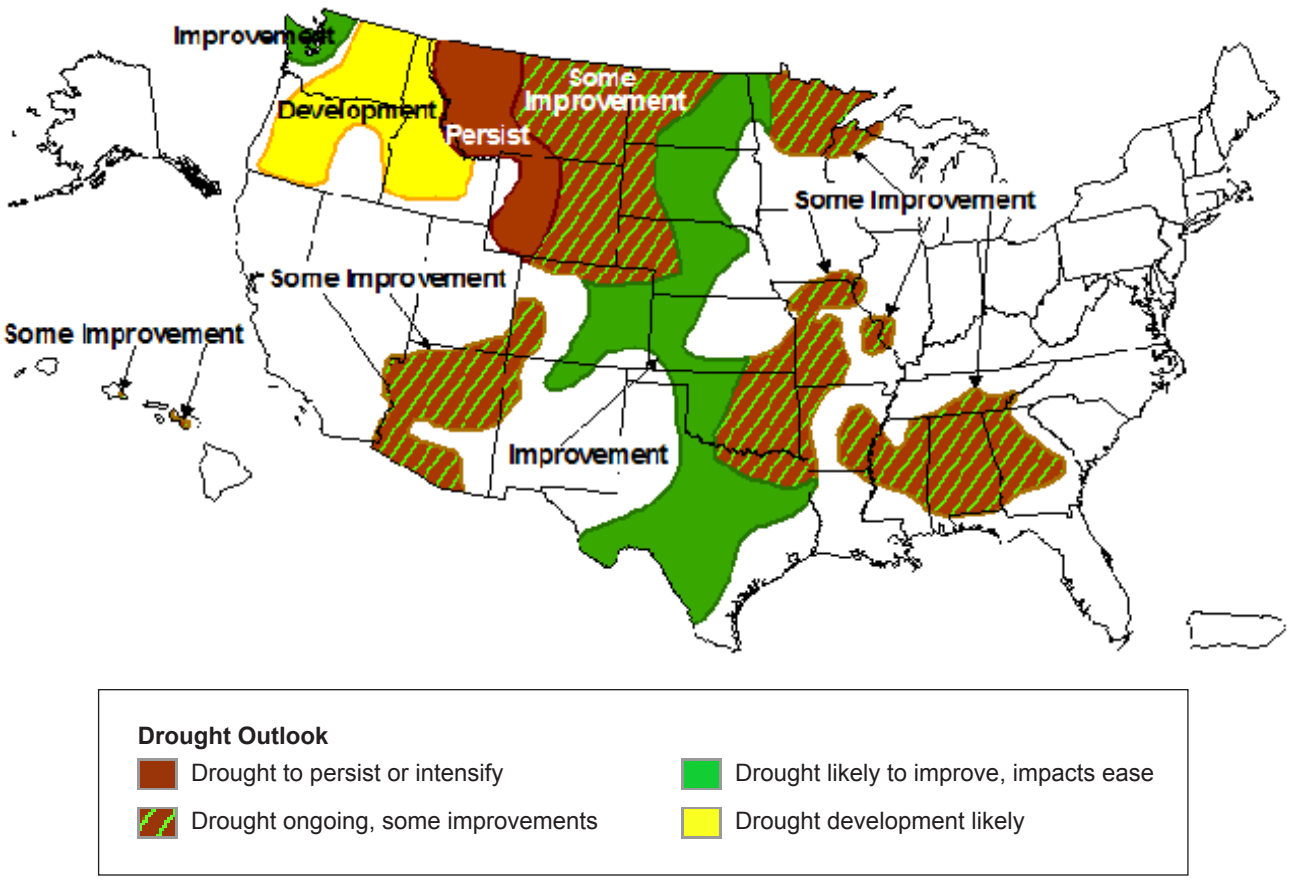


Figure 12. Seasonal Drought Outlook through December 2006 (release date September 20, 2006).

On the Web

- For more information, visit: http://www.drought.noaa.gov/.
- Drought termination probabilities: http://www.ncdc.noaa.gov/oa/climate/research/drought/current.html

El Niño Status and Forecast

Source: NOAA Climate Prediction Center, International Research Institute For Climate and Society

Thresholds for El Niño conditions, in terms of tropical Pacific SST anomalies, have been crossed recently, according to the ENSO Diagnostic Discussion issued by the NOAA Climate Prediction Center (CPC) on September 13th and the NOAA-funded International Research Institute (IRI). El Niño conditions are likely to continue into early 2007. By early September equatorial SST anomalies greater than +0.5ºC were observed in most of the equatorial Pacific, with anomalies exceeding +1.0ºC in the central Pacific (Figure 13a). There has been a build-up in heat content in the upper ocean, beginning in February 2006, and since early April positive anomalies have been observed.

According to CPC, over the past several months most of the models have forecasted El Niño conditions, and the latest NOAA coupled forecast system (CFS) predictions indicate El Niño conditions for the remainder of 2006 and into the Northern Hemisphere spring 2007. According to IRI, the probability of a La Niña is much less than the climatologically expected odds of 25%. In fact, none of the 20 international forecast models for the central tropical Pacific is now predicting negative SST anomalies during the next six months (Figure 13b).

El Niño events typically develop in late spring or early summer, so this year's event is a late starter. However, it appears on track for a moderate-sized peak during December-February. Most El Niño events last between six and twelve months, but have been known to persist through two winters (such as 1986-88). With respect to El Niño effects over North America, CPC notes that these effects are likely to develop during the upcoming winter season, but are not yet evident in the October 2006 forecasts. These effects include warmer-than-average temperatures over western and central Canada, and over the western and northern U.S. Wetter-than-average conditions are likely over portions of the U.S. Gulf Coast and Florida, while drier-than-average conditions can be expected in the Ohio Valley, the Pacific Northwest, and most of the U.S.-affiliated islands in the north tropical Pacific.

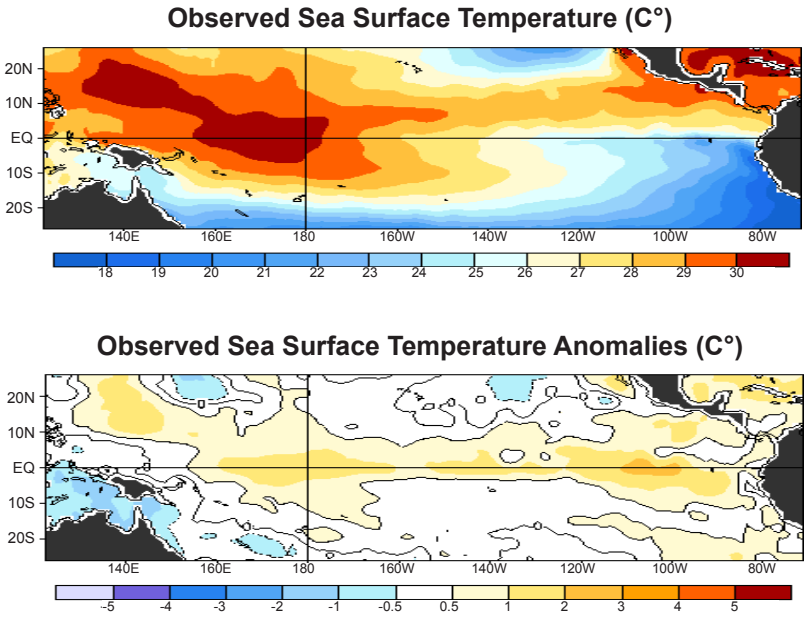


Figure 13a. Two graphics showing the observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. The Niño 3.4 region encompasses the area between 120ºW-170ºW and 5ºN-5ºS. The graphics represent the 7-day average centered on September 20, 2006.

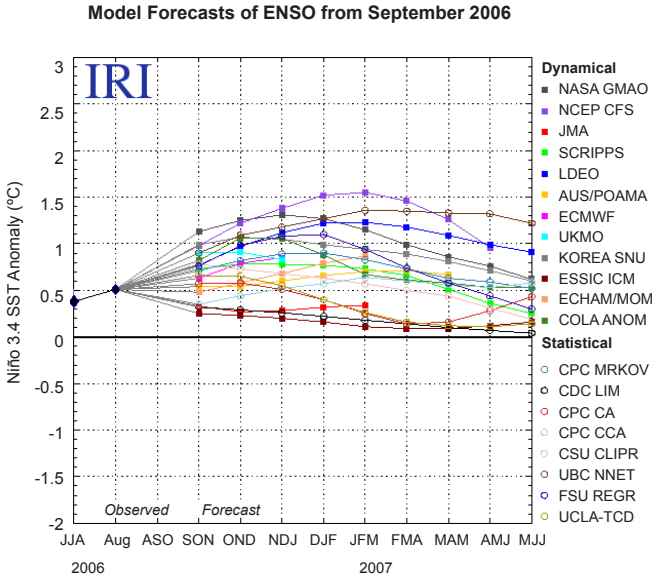


Figure 13b. Forecasts made by dynamical and statistical models for sea surface temperatures (SST) in the Niño 3.4 region for nine overlapping 3-month periods from September 2006 through July 2007 (released Sep. 20, 2006). Forecasts are courtesy of the International Research Institute (IRI) for Climate and Society.

Notes

Two graphics in Figure 13a produced by NOAA show the observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. This data is from the TOGA/TAO Array of 70 moored buoys spread out over the Pacific Ocean, centered on the equator. These buoys measure temperature, currents and winds in the Pacific equatorial band 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 multiple forecasts for SST in the Niño 3.4 region for nine overlapping 3-month periods from September 2005 to July 2006. "Niño 3.4" refers to the region of the equatorial Pacific from 120ºW to 170ºW and 5ºN to 5ºS, which is one basis for defining ENSO sea surface temperature anomalies. Initials at the bottom of the graph represent groups of three months (e.g. SON = Sept-Nov). The expected skills of the models, based on historical performance, are not equal to one another. The skills also generally decrease as the lead-time increases. Forecasts made at some times of the year generally have higher skill than forecasts made at other times of the year. They are better when made between June and December than between February and May. Differences among the forecasts of the models 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 Nino 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 Nino, including the most recent forecasts, visit: http://iri.columbia.edu/climate/ENSO/.