Intermountain West Climate Summary

by The Western Water Assessment

Issued July 26, 2006

July 2006 Climate Summary

Hydrologic Conditions: Consistent with precipitation anomalies, all of Colorado and most of Wyoming are in drought status, and most of Utah is not. Colorado counties have been declared drought disaster areas due to long term deficits, and recent rains have only improved the drought status slightly.

Temperature: Temperatures were above average for much of the region for June.

Precipitation/Snowpack: Precipitation was below average in June for most of Colorado and Wyoming, and parts of Utah, with the only areas of above average in southern Utah and the San Juan Mountains.

ENSO: ENSO-neutral conditions are favored to prevail throughout 2006 with an 80% chance of continuing through June-August ; In the absence of ENSO anomalies in SST, climate impacts related to El Niño or La Niña will be negligible for the next few months.

Climate Forecasts: CPC outlooks project above average temperatures for all or most of the Intermountain West region through December forecast periods, and equal chances of above, around normal, or below normal precipitation for all but northern Wyoming in August.

Need for Drought Impacts reports and a new WGA report on Water

The National Drought Mitigation Center (NDMC) needs help from across the region to collect information on drought impacts. They introduced a new Drought Impact Reporter last summer with the goal to collect, quantify, and map reported drought impacts for the United States and provide access to the reports through interactive search tools. But this summer, in spite of drought conditions in many parts of the Intermountain West, few reports have been submitted. Users can submit their own drought impact reports through the tool's easy web interface at: http://droughtreporter.unl.edu/.

Last month, the Western Governor's Association issued a new report, *Water Needs and Strategies for a Sustainable Future*. According to a press release on June 12th, 2006, the Governors approved recommendations in the report for managing limited water in face of growth and drought in the West, among them describing potential ramifications of climate change on Western water resources and developing recommendations to assist states in preparing for these impacts, including drought preparedness, flood control and data collection. The report and the press release are available at: http://www.westgov.org.

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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.

Brad Udall – WWA Director
Andrea Ray – Editor/writer
Bobbie Klein – Assistant Editor/Writer
Eileen McKim - Assistant Editor/Writer
Christina Alvord - Writer
Barb DeLuisi - Graphic Designer

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Municipal Water Demand and Conservation: Western Water Assessment Studies

By Bobbie Klein and Christina Alvord, Western Water Assessment

This article summarizes some of the significant findings of recent WWA studies on municipal responses to drought in Colorado, including a publication in the Journal of the American Water Resources Association and a new report issued by WWA, both available on the WWA webpage (see the end of this article).

Introduction

Since the 2002 drought municipal water providers in Colorado's Front Range have utilized a variety of mechanisms to cope with water shortages, including short-term outdoor watering restrictions, formal drought plans, and longer-term water conservation planning. Water availability will be an ongoing concern throughout the region as the population continues to increase. Further, drought has been more common in past centuries than the past 100 years, and coupled with population growth, suggests that water shortages may be exacerbated in the future (see Woodhouse and Overpeck 1998). Consequently, these coping mechanisms are important components of water management and planning. As part of its mission to "identify and characterize regional vulnerabilities to climate variability and change" the Western Water Assessment (WWA) has undertaken several studies of the municipal response to drought.

2002 Municipal Response to Drought

The severity of the 2002 drought exposed the vulnerabilities of many water supply systems under extreme drought conditions within the state of Colorado. WWA examined drought response strategies of eight municipal water providers including Aurora, Boulder, Denver, Fort Collins, Lafayette, Louisville, Thornton, and Westminster (Kenney et al. 2004). Four of the eight surveyed municipal water providers restricted lawn watering to once every three days, whereas three water providers limited lawn watering to twice a week. Finally, Lafayette implemented the most severe restrictions, limiting lawn watering to only once a week.

Daily water use for the study period May 1 – August 31, 2002 was compared to water use from 2000 and 2001 as well as to the "expected use" of water in summer of 2002 absent any water restrictions. The first method compares daily water use (i.e. deliveries) during periods of water restrictions to that of water use during the same time period from previous years. The second method compares daily water use under imposed water restrictions to what researchers expected use would be without water restrictions, given the same precipitation and temperature conditions. Savings were also computed on a per capita basis to account for the impact of population growth.

This study found that during mandatory water restrictions, water use savings measured in expected use per capita ranged from 18-56%, about 4-6% greater than using direct comparison of water use between years. Mandatory water restrictions were far more effective than voluntary water restrictions that only saw a reduction of 4-12%. Consistent with previous drought management case studies it was also found that the tougher water restrictions were, the higher the water use savings.

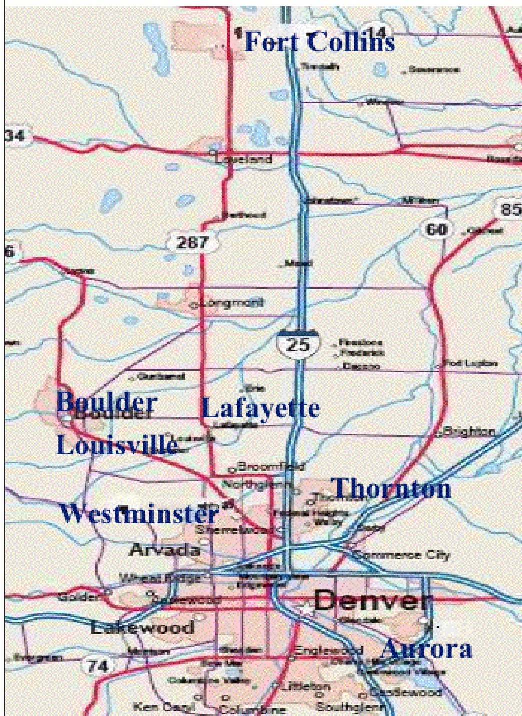
It is evident from this study that mandatory outdoor water restrictions can be an effective short-term drought coping mechanism. However, the success of the 2002 water restrictions might have been partly attributed to the urgent, emergency nature of the situation. Nevertheless, the discussion of short-term restrictions serves as an appropriate background to transition into how municipal drought planning incorporates climate information to shape management strategies.

Drought Management: The Incorporation of Climate Information

Drought planning at the municipal level is becoming more common since the onset of drought conditions in 2002. In a recently released report, WWA conducted a follow-up study of the eight municipal water providers featured in the 2002 drought effectiveness study along with twenty-one other major Front Range providers to determine the prevalence of formal drought planning as contrasted to the more ad-hoc watering restrictions imposed in 2002 (Klein and Kenney 2005). The study found that 13 out of the 29 water providers had a drought plan defined as a document that describes an agreed upon process to assess periodically water supply conditions and the options for responding to emerging drought based on pre-defined deficiencies or triggers. Eight of these 13 plans included drought indicators and/or triggers.

Klein and Kenney found that many of these eight drought plans used climate information as a key component in assessing the severity of a drought. The types or sources of climate information used include: streamflow reports, streamflow forecasts, snowpack reports, weather reports, climate forecasts, drought

Water Savings from 2002 Lawn Watering Restrictions



Municipal Water Provider	*Actual Savings Over the Entire Study Period (acre feet)	Lawn Watering Restrictions Mandatory (M) & Voluntary (V)
Aurora	2,842 to 5,522	M: Every 3 days
Boulder	2,805 to 3,287	M: Twice a week
Denver	9,528 to 18,768	M: Every 3 days
Fort Collins	1,254 to 2,933	M: Twice a week
Lafayette	1,198 to 1,393	M: Once a week
Louisville	1,031 to 1,141	M: Twice a week
Thornton	-855 to 1,112	V: Every 3 days
Westminster	460 to 1,844	M: Every 3 days

*Variation in water use savings is due to different methods of calculation

indices such as Palmer Drought Severity Index (PDSI) and the Surface Water Supply Index (SWSI), and soil moisture reports, most of which water providers find on the internet. Municipal water providers use this information to assist them in determining whether to implement drought restrictions and, if so, at what level of severity.

However, climate sensitive drought triggers and indicators only represent a portion of the water management puzzle. Professional judgment and experience is imperative in translating indicators and triggers into drought management action. As one water manager explained, professional judgment is necessary because a simplified trigger cannot capture all of the elements water managers may evaluate and weigh when projecting water supply. (Klein and Kenney, p. 9) The incorporation of accessible climate information with professional judgment is an ideal partnership when enacting a successful drought management plan.

Aurora Water Demand Management Study

Aurora Water has implemented a variety of demand management strategies over the past four years that collectively have produced a significant reduction in municipal water demand. In an effort to better understand this trend WWA researchers teamed up with Aurora Water last year to analyze the effectiveness of these and other policies using household water use data from the past eight years. To date, this analysis has focused on the residential sector which showed the highest level of response. Some of the questions the study is addressing include:

1. Aurora has implemented a variety of pricing structures and mandatory watering restrictions over the past four years to curb demand. How have these policies impacted monthly household water demand? Is there an interaction between price and non-price policies? Are certain types of customers more responsive to different drought policies than others?

The preliminary results suggest that the magnitude of the response of each household to both price changes and outdoor restrictions was highly dependent on the “type” of user. As could be expected, “high-end” users – those with a high outdoor water demand - were more responsive to outdoor watering restrictions than “low-end” water users who were primarily indoor water users. On average, restrictions reduced the demand of high-end water users by over 51% while reducing the demand of low-end users by less than 8%. Similarly, high end water users were more than twice as responsive to price increases in the absence of restrictions. However, low-end users were more responsive to price increases when restrictions were in place, presumably because high end users had already cut back their use in response to restrictions.

These results indicate that the future effectiveness of demand management policies is dependent on whether small lots with low intensity water demands dominate new growth, in which case we can expect those consumers to behave more in line with "low-end" consumers.

2. Aurora has distributed devices (Water Smart Readers) that permit individual households to track their real-time water use, providing an unprecedented opportunity to evaluate the relationship between that kind of information and customer demand. How does having a Water Smart Reader (WSR) impact monthly household water demand?

Preliminary findings suggest a modest increase in water usage by households with a WSR. Despite an increase in use, these households were less likely to consume in the highest price block once they were able to track their use with the WSR. Together, these two points suggest that households are better able to modify their use to match the goals established by their water budgets when they can monitor their water use on a daily basis. However, it should be noted that this was not a random sample since it includes only households that chose to purchase Water Smart Readers.

3. Aurora has provided rebates for purchases of items such as low flow toilets and certain irrigation technologies. Have these rebates had an impact on residential water demand?

On average rebates for low-flow toilets reduced demand by 10-17%. Estimating the effect of the irrigation technology rebate program on household demand is more complex. This is because the installation of, for example, a new sprinkler system is often accompanied by other changes that may increase water use, such as the installation of a new lawn[1]. Thus, participation in the irrigation technology rebate program led to slight increases in use in some cases and slight decreases in others. This does not suggest that these programs will lead to an increase in residential demand but rather that the available data do not allow us to control for those other changes that might accompany participation in the irrigation technology rebate program. This is thus an area that requires more research[2].

Potential expansion of the study may include surveys of individual households about their decision making processes regarding outdoor water use. Researchers hope to include additional municipalities in their future work.

References:

Kenney, D., R. Klein, and M. Clark, 2004. Use and Effectiveness of Municipal Water Restrictions During Drought in Colorado. Journal of the American Water Resources Association, February 2004, 77-87. http://wwa.colorado.edu/admin/publication_files/resource-296-water_restrictions_jawra.pdf

Klein, R. and D. Kenney, 2005. Use of Climate Information in Municipal Drought Planning in Colorado. Western Water Assessment Report. http://wwa.colorado.edu/admin/publication_files/resource-2401-drought_planning_report.pdf

Woodhouse, C.A. and J.T. Overpeck, 1998. 2000 Years of Drought Variability in the Central United States. Bull. Amer. Met. Soc. 79(12), 2693 – 2714, December.

1 This is less likely to be the case for participation in the low-flow toilet program where households can only apply for a rebate if the new toilet they purchased is used to replace a pre-existing toilet.

2 These are the preliminary findings of researchers and should not be construed as the official position of the City of Aurora.

On the Web

- Western Water Assessment Home Page: http://wwa.colorado.edu

Temperature through 6/30/06

Source: High Plains Regional Climate Center

Average temperatures for June 2006 in the Intermountain West regions ranged from the lower 50s in the mountains of central **Colorado** and northwestern **Wyoming** to the lower 80s in southeastern **Utah** (Figure 2a). Across the region, temperatures were above average by 2° to 8 °, with the largest departure from average along the **Colorado** Front Range, southeast **Wyoming**, and sections of southeast **Utah** (Figure 2b). June 2006 was warmer across the region than June 2005 (Figure 2c), with the greatest differences in **Utah,** western **Colorado**, and southeast **Wyoming**, which were all below average by 2° to 6° in 2005.

According to the NWS Weather Forecast Office (WFO) Denver/Boulder, many temperature records were set or tied during the month of June 2006 for Denver and the surrounding area. A record number of days with 90° or above was set in Denver at 19 days. The previous record was 17 days in 2002. Temperatures ranged from a record setting 102° on June 14th to a low of 44° on the 1st. The 102° reading is significant because it is the earliest June date that registered a 100° reading. Five daily maximum temperature highs were set or tied and one minimum high of 61° tied the records for June. Three high temperatures in the 70s and several lows in the 40s lowered the average to make June 2006 the 3rd warmest June on record with an average temperature of 72.8. The warmest June on record occurred in 1994 with a 73.5 average. The NWS/WFO Salt Lake City reports that three record high temperatures also occurred in **Utah**, all breaking previous records set in 2000. According to the **Utah** Center for Climate and Weather, average June temperatures were above the (1901-2000) average by 4.6° F, making it the 9th warmest June in 112 years.

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.

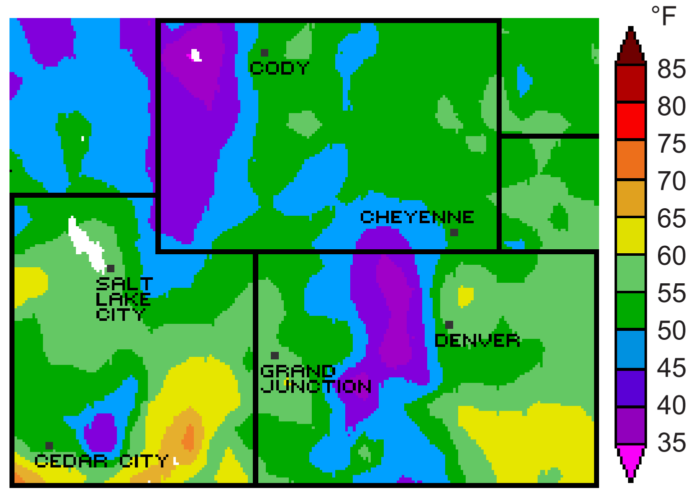


Figure 2a. Average temperature for the month of June 2006 in °F.

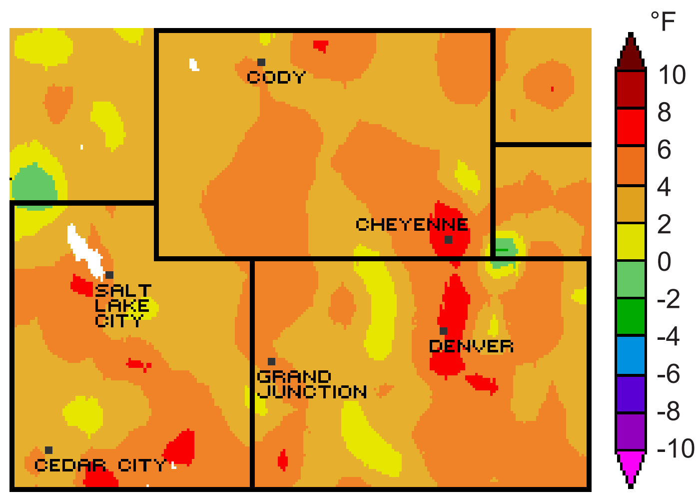


Figure 2b. Departure from average temperature for the month of June 2006 in °F.

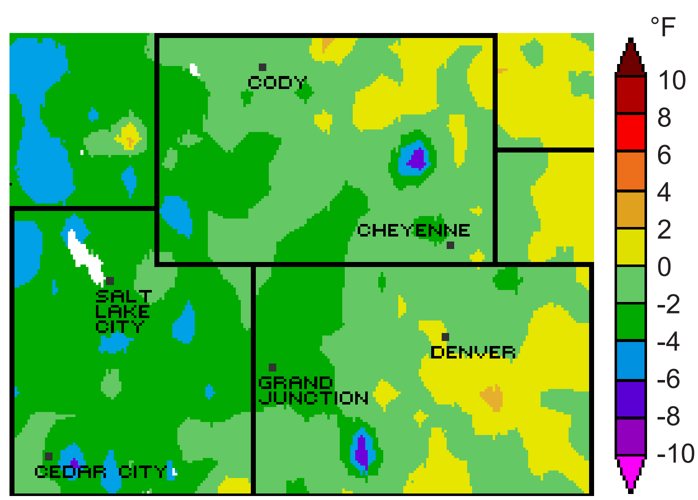


Figure 2c. Departure from average temperature in °F for last year, June 2005.

Precipitation through 6/30/06

Source: NOAA/ESRL/PSD Climate Diagnostics Branch, NOAA Climate Prediction Center

In June 2006, the greatest amounts of precipitation were received along the eastern **Colorado** border and northwest corner of **Wyoming** (Figure 3a). Southern and eastern **Utah**, northwestern **Colorado**, and south central **Wyoming** remain extremely dry, receiving less than .50 inches of rainfall for the month of June.

Except for portions of **Utah**, precipitation in the region as a percent of average was below average in most of the region, including **Wyoming** and much of northern **Colorado** and the Front Range. Large areas had less than 40% of average (Figure 3b). Only portions of northern and south central **Utah** and the southwest corner of **Colorado** are around average (80-120% average category). **Utah's** northwest corner and central **Colorado** mountains have the greatest percent average precipitation since the start of the water year (Figure 3c), and central **Wyoming** and eastern Colorado Front Range have received the lowest water year precipitation.

The NWS/WFO Denver/Boulder, reports that June 2006 tied June 1952 as the 4th driest June since records started in 1872. June finished with only 0.12 inch of precipitation for the Denver area. In comparison, June 2005 finished with a total of 3.99 inches for the month, which is 2.43 inches above normal. The Utah Center for Climate and Weather reports that **Utah** had the 9th wettest June on record, receiving 4.57 inches more than the 1901-2000 average.

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 run-off 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 Climate Diagnostics Center, 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.

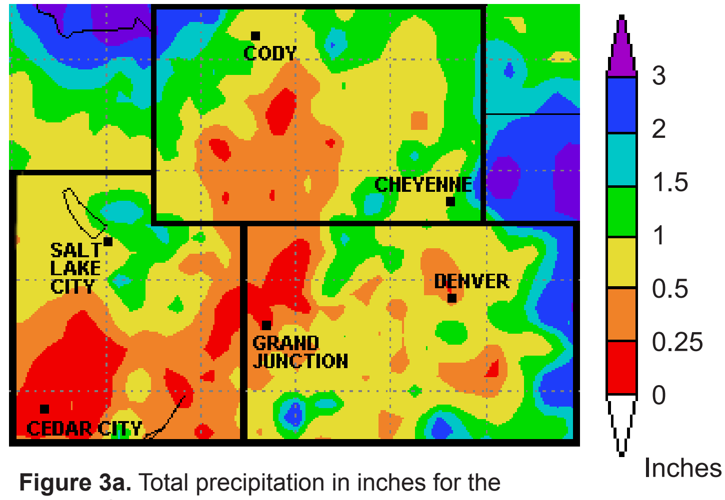


Figure 3a. Total precipitation in inches for the month of June 2006.

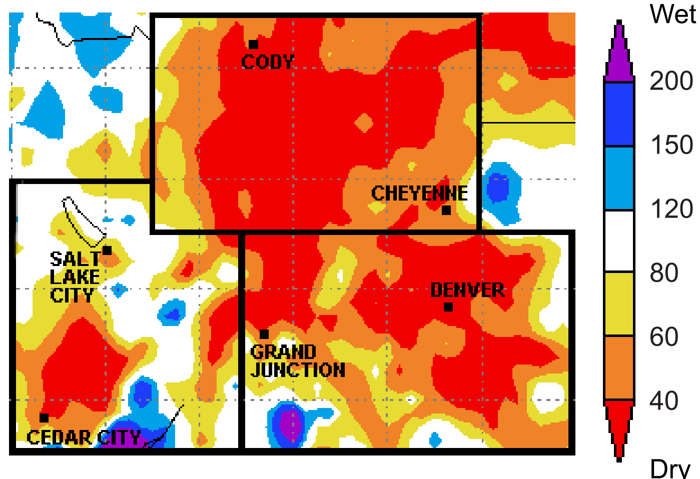


Figure 3b. Percent of average precipitation for the month of June 2006.

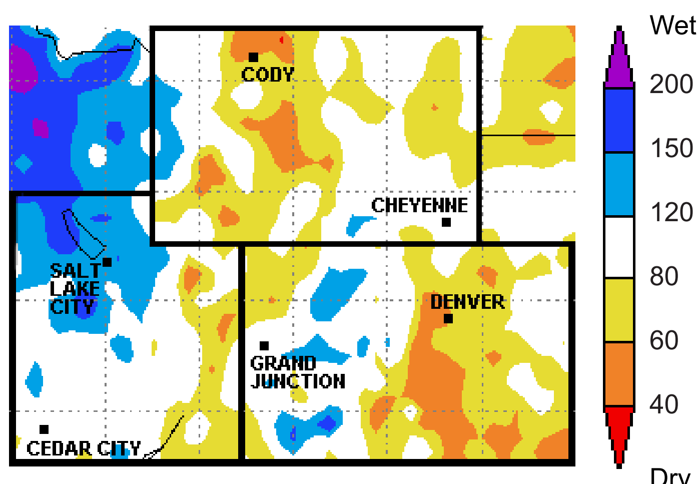


Figure 3c. Percent of average precipitation accumulated since the start of water year 2006. (Oct. 1, 2005 to June 30, 2006).

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 7/18/06

Source: U.S. Department of Agriculture, National Drought Mitigation Center, National Oceanic and Atmospheric Administration

According to the National Drought Monitor summary of July 18, 2006, the intensity of drought status has decreased for parts of eastern **Colorado**, with the southwest corner moving out of D3 status (extreme) to D1-D2 (dry to moderate). In the northwest however, drought status increased from DO to D1. Southwest Nebraska and western Kansas have also had a decrease in drought intensity. **Wyoming** had the greatest increase in drought status, with the southern half of the state moving from D1 to D2 (severe) and an area in south central **Wyoming** increasing to D3. Most of **Utah** remains outside a designated drought area, except for the southeast, which has had an increase in intensity from abnormally dry to moderate drought status.

According to the U.S. Drought Monitor Impacts Reporter, the U.S. Agriculture Secretary has designated fifty-nine of **Colorado's** 64 counties as disaster areas due to the ongoing drought, high winds, insect pests, and a late freeze. The disaster declaration certifies that these counties have suffered at least a 30 percent loss in one or more crop or livestock areas and provides affected producers with access to low-interest loans and other programs to help mitigate the impact of the drought. The hardest hit counties in **Colorado** are Weld, Morgan, and El Paso. On July 1 the Morgan county Brush city council approved water restrictions. The current level of the city's well fields has dropped 5-7 feet; the water has not been down this far since the 2002 drought. In El Paso County, area hay has been selling for twice its normal price of $70 per ton due to drought conditions.

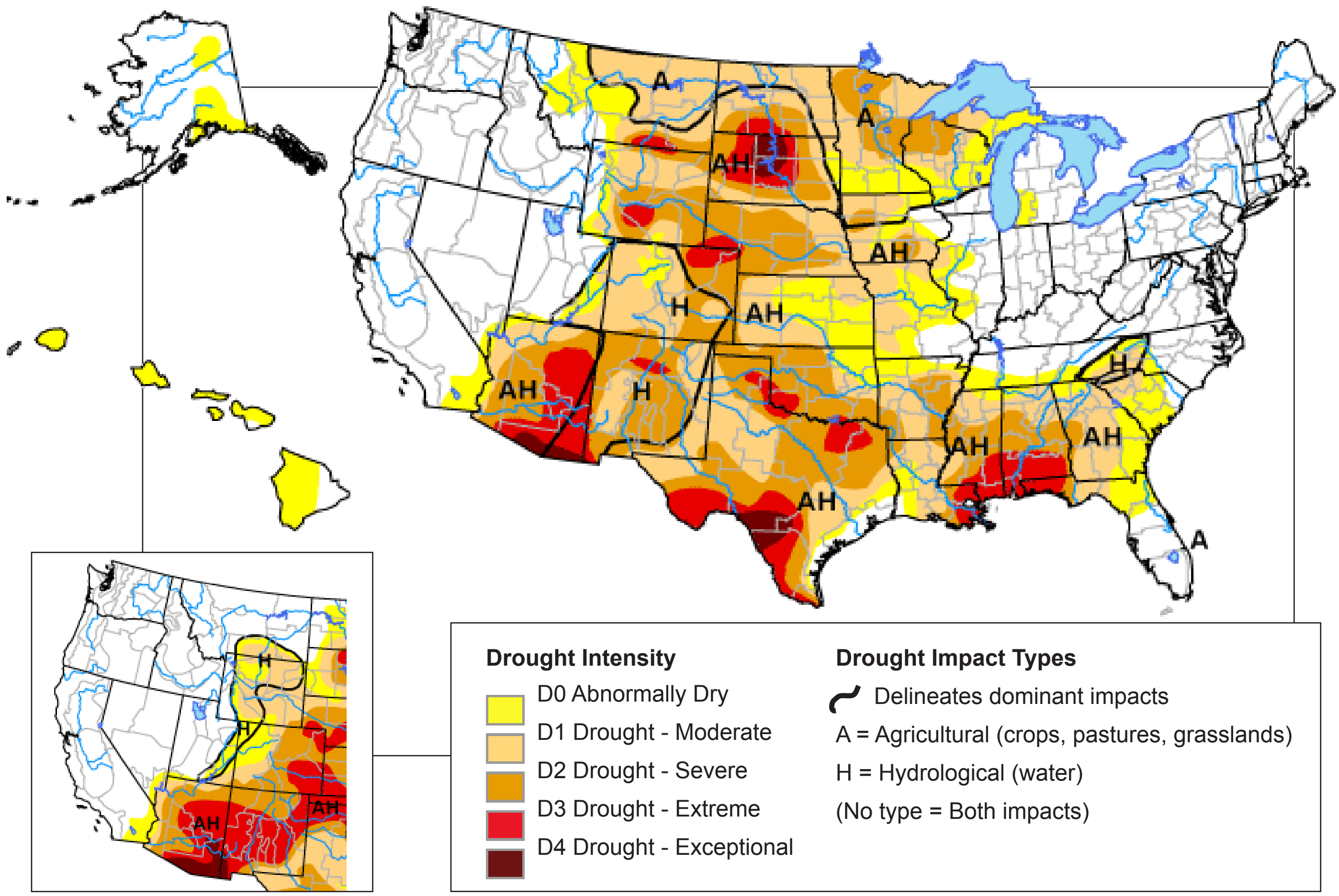


Figure 4. Drought Monitor released July 20, 2006 (full size) and last month June 22, 2006 (inset, lower left) for comparison.

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

Source: Denver Water, U. S. Bureau of Reclamation, Northern Colorado Water Conservancy District, Natural Resources Conservation Service, and Central Utah Water Conservancy District

Reservoir storage increased overall during the month of July for the systems reported here (Figure 5). In most areas of the Intermountain West, 70% or more of the annual reservoir inflow occurs during the April-July period. Peak flows have already occurred, so concerns about flood control are lowered, and superceeded by the goal to maintain or exceed current reservoir levels. For example, according to the USBR in Wyoming, in July of 2006, Flaming Gorge reservoir, part of the Colorado River Storage Project, is 84% of capacity in comparison to June of 2006 when it was 80% full. This is an encouraging increase in reservoir storage considering the anomalous warm and dry conditions that persisted throughout the Intermountain West during the month of June. During the summer period, reservoirs are allowed to exceed 100% capacity due to the minimal threat of flood during the latter portion of the summer season. For instance, at 102% of capacity, Utah Lake, operated by Utah Division of Water Rights (http://www.wcc.nrcs.usda.gov/cgi-bin/resv_rpt.pl?state=utah) was permitted to exceed the 870.9 kaf total capacity, currently housing 888.0 kaf of water.

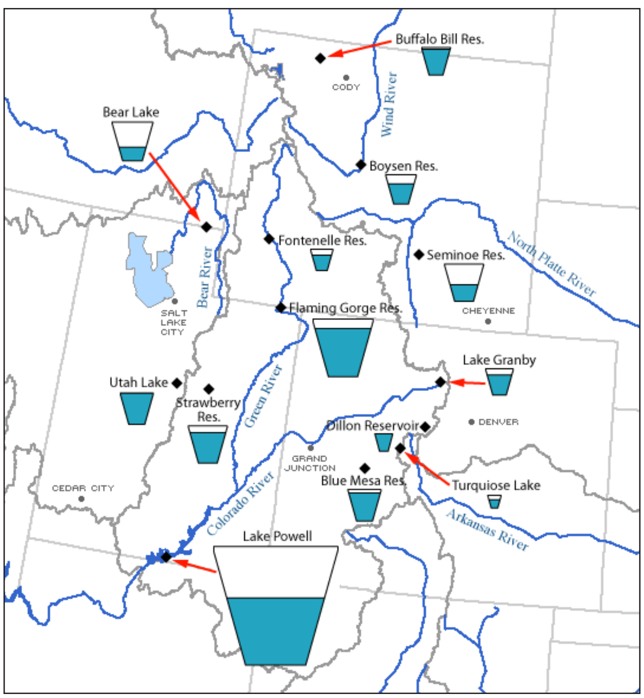
According to Denver Water, (http://www.water.denver.co.gov/indexmain.html) Lake Dillon reached 100% of capacity this month holding 3,131.9 kaf of water. Above average precipitation at Dillon reservoir during July of 2006 (3.52 inches vs average 1.33 inches for the month) contributed to filling of the reservoir.

Due to persistent below average inflows into Lake Powell, storage hovers around 53% of capacity, up slightly from 51% in June. According to the NWS Colorado Basin River Forecast Center in Salt Lake City, Utah, (http://www.cbrfc.noaa.gov/wsup/water/uc/2006/uc_ju.pdf) July forecast inflows for Lake Powell are notably lower this year in comparison to July 2005 forecast inflows. With inflows forecast for Lake Powell less than 1,000 thousant acre-feet (Kaf), this is a considerable drop from July of 2005 when forecast inflows were approximately 1,500 Kaf. Such low forecast inflows further jeopardize the chance for significant increase in storage at Lake Powell.

Last month we adopted a new method for calculating storage compared to long-term average. Instead of computing averages based on the period of record of the given reservoir, storage as a percent of average is calculated by the NRCS (http://www.wcc.nrcs.usda.gov/wsf/reservoir/resv_rpt.html) and is now compared to the 1971-2000 average storage for Lake Powell, Blue Mesa, Fontenelle, and Flaming Gorge.

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.	807.4	829.5	97%	116%
Dillon Res.	254.2	254.0	100%	103%
Lake Granby	436.1	539.7	81%	103%
Turquiose Lake	119.7	129.4	92%	106%
Utah				
Bear Lake	498.8	1,302.0	38%	59%
Lake Powell	12,748.4	24,322.0	52%	61%
Strawberry Res.	938.0	1,106.5	85%	132%
Utah Lake	888.0	870.9	102%	102%
Wyoming				
Boysen Res.	539.0	741.6	73%	87%
Buffalo Bill Res.	636.4	644.1	99%	136%
Flaming Gorge Res.	3,131.9	3,749.0	84%	97%
Fontenelle Res.	287.5	344.8	83%	106%
Seminoe Res.	426.5	1,017.3	42%	59%

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 June 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 6/30/06

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 the previous month, in this case June 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 June 2006, the SPI around the Intermountain West region ranges from near normal for **Utah**, western **Colorado**, and north and southeast **Wyoming** to extremely dry in northern **Colorado** (Figure 6).

As of the end of June, several climate divisions were downgraded by one category drier from the classification at the end of May: the Arkansas and Kansas River divisions of **Colorado**; the Snake and Belle Fourche River divisions in **Wyoming**; and the north central division of **Utah**. The Platte River division of **Colorado** was downgraded by two categories to extremely dry, and is the largest climate division in this category in the U. S. In contrast, the Wind River division of **Wyoming** was upgraded one category from moderately dry to near normal.

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.

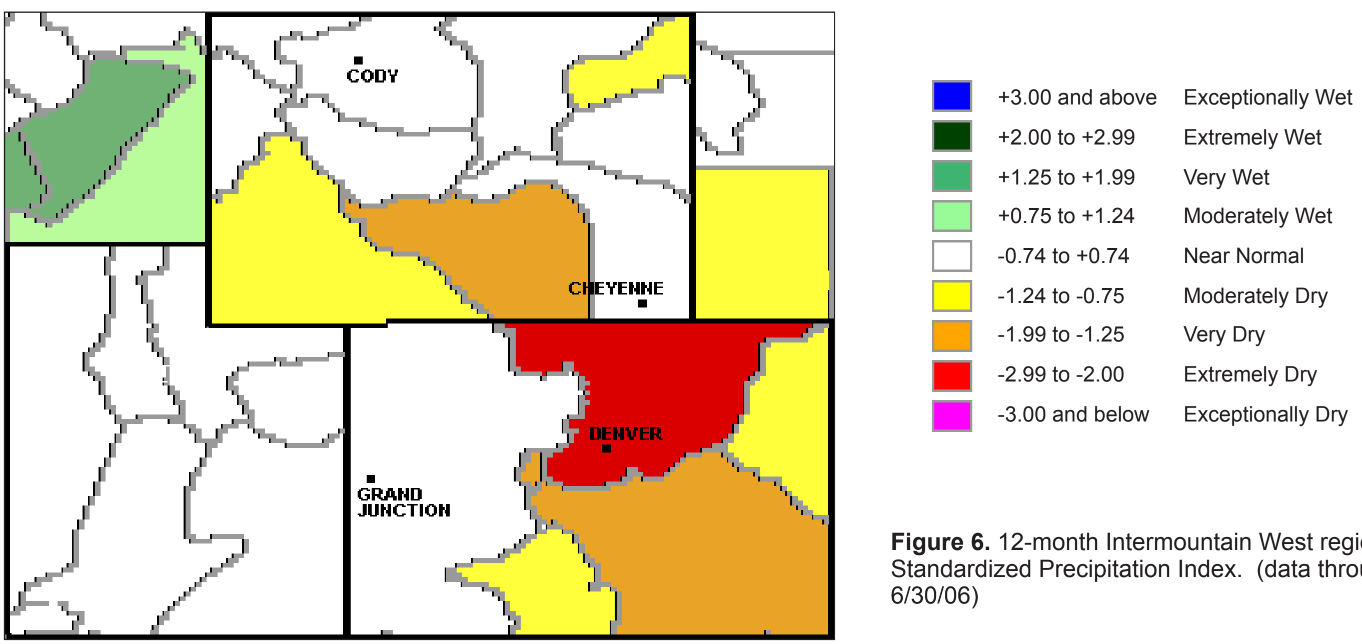


Figure 6. 12-month Intermountain West regional Standardized Precipitation Index. (data through 6/30/06)

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 July 2006

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

The Surface Water Supply Index (SWSI) measures water availability related to stream flow, reservoir storage, and precipitation for the period May through October. The Colorado SWSI from the Colorado State Engineer indicates that the Gunnison was the only basin with near normal conditions (Figure 7a). The San Juan/Dolores is experiencing between moderate and severe drought conditions. All of the remaining basins had SWSI values in below normal categories (the Arkansas was close to moderate drought conditions at -1.6). All SWSI values have decreased from those last month and one year ago. The largest declines are in the Yampa/White, Colorado, and San Juan/Dolores basins. Overall, SWSI values in the state are in below normal categories.

Most of Colorado's rivers are running in the normal category (25th – 75th percentile) for this time of year, according to 7-day average streamflow observations from the USGS (Figure 7b). About a dozen or so stations in southeastern Colorado, mainly on Fountain Creek and the Arkansas River, are running in the above normal to much above normal category, while a number of stations scattered throughout the western slope are below normal.

The first few weeks of June saw record-breaking temperatures in Colorado. According to Denver Channel 7 news, in mid-June Colorado Governor Bill Owens asked federal officials to declare 25 of Colorado's 64 southern counties a disaster area because of drought, fire, high winds and heat. Owens also banned open burning and fireworks on all state lands. The hot dry spell in the Front Range was dramatically broken on June 24 when large hail and very heavy rain fell from Boulder south through Lakewood and into western Douglas County. A highly unusual slow and steady, low intensity, continuous rain fell over much of Colorado from late July 7 through July 9. According to the Niwot Ridge Long-Term Ecological Research Site it is more typical to see thunderstorms, with high intensity, short duration precipitation events this time of year.

Surface Water Supply Index

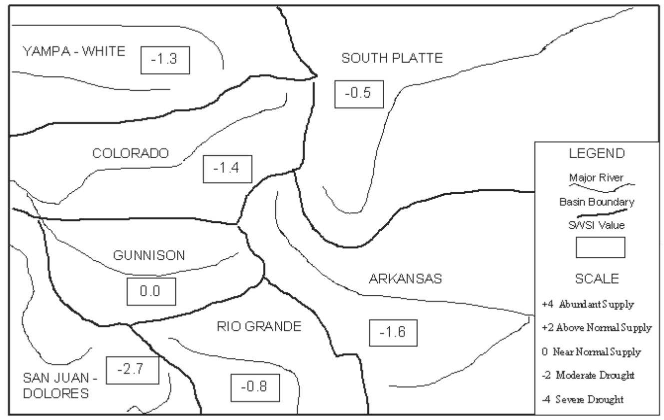


Figure 7a. Colorado Surface Water Supply Index. The map is an indicator of mountain-based water supply conditions in the major river basins of the state as of July 1, 2006.

7-Day Average Streamflows

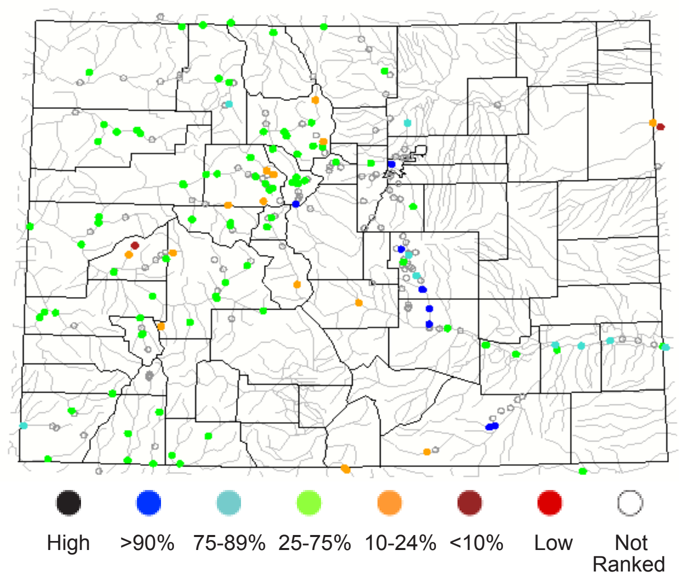


Figure 7b. Seven-day average streamflow conditions for points in Colorado as of July 16, 2006, computed at USGS gauging stations. The colors represent 7-day average streamflow compared to percentiles of 7-day average streamflow for 7/16/06.

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.

Notes

Each state calculates their SWSI a little differently.

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. The SWSI values in Figure 7a were computed for each of the seven major basins in Colorado for July 1, 2006, and reflect conditions through the month of June 2006.

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.

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 July 2006

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

The Wyoming State Climatologist reports that while fall and winter snowfall brought some drought relief to most of Wyoming, below-average spring precipitation and above-average temperatures have contributed to a general drying trend in recent months. Most of the state is under 'drought watch' status (Figure 8a). Abnormally dry to moderate drought conditions now exist in all but the westernmost portions of the state. Without substantial summer moisture, some parts of the state could increase to "Drought Warning" status before the end of August.

The current NOAA/CPC outlook is for above-average temperatures to continue throughout the summer in Wyoming. Decreasing soil moisture over large parts of southern and eastern Wyoming is also a growing concern. With estimated soil moisture values now ranging from 20-30% of normal in several counties, adverse effects on livestock production and agriculture are expected.

The USGS reports that streamflow gauges (Figure 8b) in western Wyoming are mostly in the average (25th to 75th) percentile. However, stream flows in north central Wyoming, particularly the Bighorn Mountains area, are generally below-average for this time of year, with several low stream flow conditions reported. The State Climatologist reports that, in many cases, the high-elevation snowpack that feeds these streams had melted by the end of May so relatively low flows are expected throughout the summer. It is reported that, historically, late winter and spring produce a large percentage of total annual precipitation across Wyoming, and the months of April - June are usually the wettest time of year on the eastern plains. This year, however, April - June has been markedly dry in all but the northwest and, to some degree, northeast corners of Wyoming.

WY State Climatologist Assessment

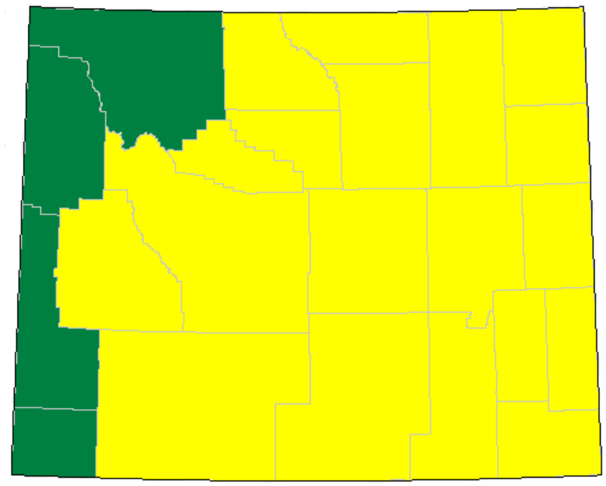


Figure 8a. Wyoming drought status. This map shows the Wyoming State Climatologist's assessment of the status of the drought throughout the state for the period Jul. 1 - Aug. 31, 2006.

Normal
Watch
Warning
Disaster

7-Day Average Streamflows

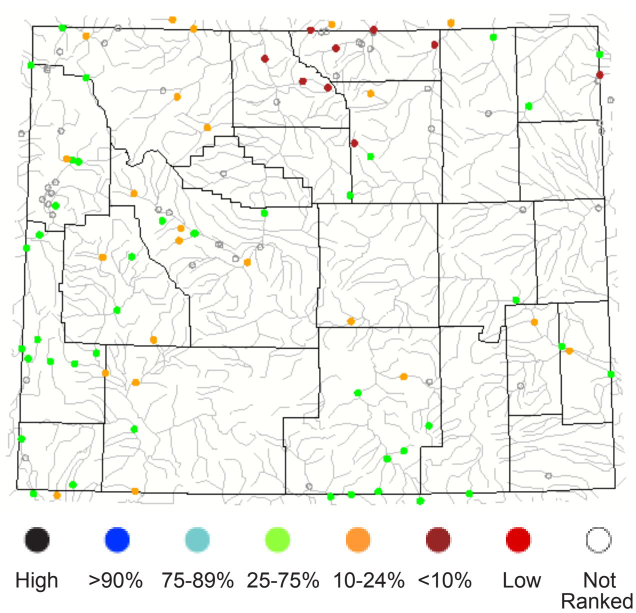


Figure 8b. Seven-day average streamflow conditions for points in Wyoming as of July 16, 2006, computed at USGS gauging stations. The colors represent 7-day average streamflow compared to percentiles of 7-day average streamflow for 7/16/06.

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 July 2006

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

According to the NWS/WFO Salt Lake City, and the Utah Center for Climate and Weather, June 2006 was warm with near average to above average precipitation. As of July 11, 2006 a majority of the streamflow sites on the USGS "7-day average streamflow map" (Figure 9) had average flow values (25th – 75th percentile), with a few streams the north central and southwestern Utah running above average (75th to > 90th percentile). However, some sites in the northeastern section of the state recorded below-average flows within the (10th -24th percentile).

The NWS/WFO Salt Lake City, reports that record high temperatures were recorded across northern Utah the first week of June. A surge of subtropical moisture moved into Utah June 6th-9th bringing severe storms with high winds, large hail and flash flooding to some areas. On June 6th strong microbursts reached 50 MPH in Spanish Fork and on the 7th wind gusts reached 71 MPH in Tooele County and 68 MPH in Stockton, which also reported 1 inch diameter hail. Strong microbursts blew over three semi trucks on I-80 near Grantsville. On June 8th, flash flooding occurred in Capital Reef and Big Cottonwood Canyon from torrential cloudbursts. Roads were closed due to water and debris at both locations. Centerville and Bountiful reported receiving 1.57 inches of precipitation in about one hour. June 9th brought more high winds and large hail, with several locations reporting 1 – 1.25 inch hail and wind gusts up to 76 MPH. A semi truck was blown over on I-80 near milepost 64. Lightning was also a problem, injuring a child in Kearns. On June 13th, more strong microburst blew across portions of Utah, with a top speed of 93 MPH reported near Callao, Utah. June 30th brought very heavy rainfall resulting in flash flooding and mudslides in Diamond Fork Canyon near Spanish Fork resulting in the evacuation of campers.

7-Day Average Streamflows

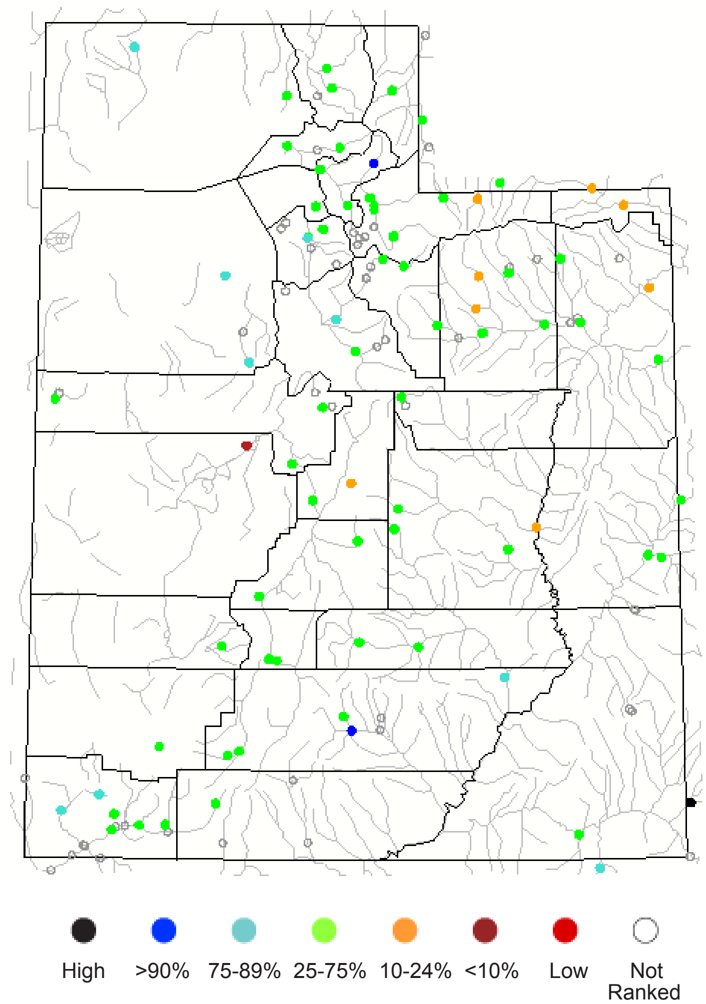


Figure 9. Seven-day average streamflow conditions for points in Utah as of July 16, 2006, computed at USGS gauging stations. The colors represent 7-day average streamflow compared to percentiles of 7-day average streamflow for 7/16/06

Notes

The "7-day average streamflow" map (Figure 9) 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/

Temperature Outlook **August - December 2006** Source: NOAA Climate Prediction Center

According to the NOAA/CPC monthly and seasonal forecasts issued July 20th, above median temperatures are predicted across much of the U.S. for August 2006, including most of the intermountain West, but not parts of **Wyoming** (Figure 10a).

ENSO is expected to have little influence on temperatures in the upcoming few months, trends in temperature dominate the predictable signals. The seasonal (three-month) temperature outlooks continue to indicate increased risk for above average temperatures through the September-October-November (SON) forecast period (Figure 10 c). A large area of the southern and western U.S., including **Utah**, most of **Colorado**, and southern **Wyoming**, has a 40% or more increased risk of above average temperatures in August-October (ASO) 2006 (Figure 10b). Above average temperatures are likely through the late summer and early fall for all or most of the Intermountain west (Figure 10b-d). This forecast means that the average for the three month season is more likely to be above the climatological average for the 1971-2000 time period.

The forecast for August 2006 will be updated on July 31st. This forecast is available on the same CPC webpages as the regular mid-month forecasts.

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.

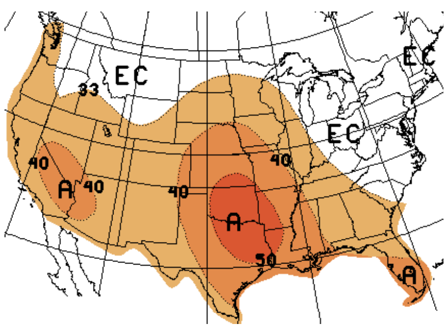


Figure 10a. Long-lead national temperature forecast for August 2006. (released July 20, 2006)

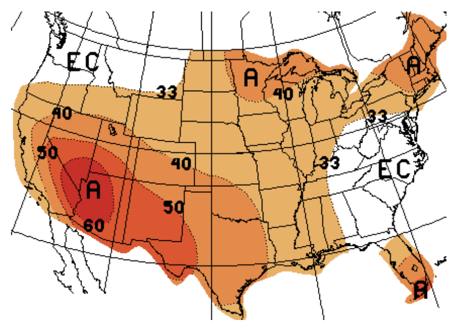


Figure 10b. Long-lead national temperature forecast for Aug. - Oct. 2006. (released July 20, 2006)

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

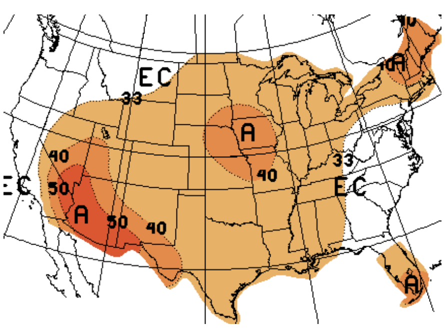


Figure 10c. Long-lead national temperature forecast for Sep. - Nov. 2006. (released July 20, 2006)

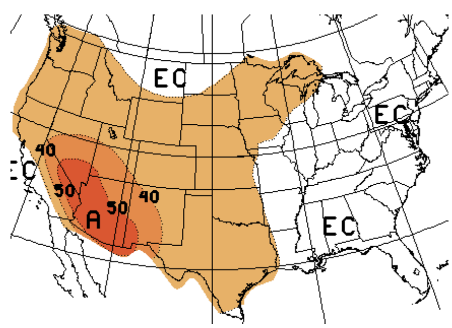


Figure 10d. Long-lead national temperature forecast for Oct. - Dec. 2006. (released July 20, 2006)

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 **August - October 2006** Source: NOAA Climate Prediction Center

Summer seasonal precipitation forecasts, issued July 20th by the NOAA Climate Prediction Center (CPC), have provided little information for the Intermountain West for several months. Most of the Intermountain West has "equal chances" of above-average, near-normal or below-average precipitation for the August 2006 forecast period (figure 11a) and August-October forecast period (Figure 11b). The exception is an outlook for above average precipitation for northern **Wyoming** for the month of August 2006.

According to CPC, at present there are no significant skillful indications from the forecast tools for precipitation anomalies for most of the intermountain West region. Therefore, the intermountain West – and much of the continental U.S. – has "equal chances" of above-average, near-normal or below-average precipitation for the August-October 2006 forecast period (Figure 11b) and forecast periods into the fall and winter (not shown).

The August precipitation forecast will be updated on July 31st and may provide more forecast information. Last year, CPC began updating the one month forecast on the last day of the previous month. This "zero-lead" forecast often can take advantage of long-lead weather forecasts and typically has increased skill over the forecast made mid month because of the shorter lead time. This forecast is available on the same CPC webpages as the regular mid-month forecasts.

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.

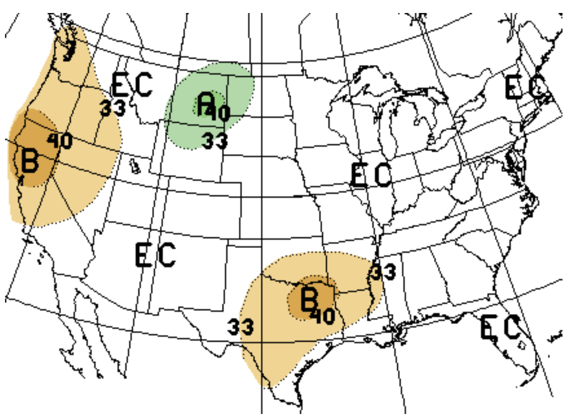


Figure 11a. Long-lead national precipitation forecast for August 2006. (released July 20, 2006)

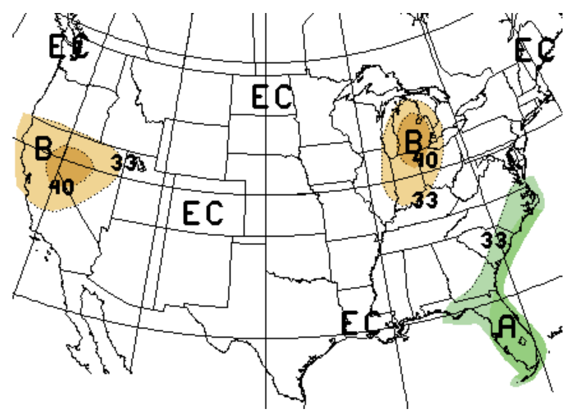


Figure 11b. Long-lead national precipitation forecast for Aug. - Oct. 2006. (released July 20 2006)

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

According to the experimental forecast guidance for July-September precipitation, large parts of **Colorado** and New Mexico have increased chance of above average precipition. While both Arizona and New Mexico summer monsoon seasons have been anticipated with some skill since 2000, the increased chance for above average precipitation in **Colorado** due to the monsoon is handicapped by poor skill performance for this forecast method in this region over the same period.

According to Klaus Wolter, who creates this forecast, the spring season was exceptionally hot and dry, which he thinks are only partially explained by lingering La Niña effects. The July-September monsoon has the potential to be above-average from southwestern New Mexico into eastern **Colorado** (despite some caveats about the forecast skill in **Colorado**). The monsoon season got off to an early start (late June) in most of the Interior Southwest. Precipitation totals through the third week in July 2006 have been well above normal in most of **Colorado**, reaching record levels along the Central and Southern Front Range.

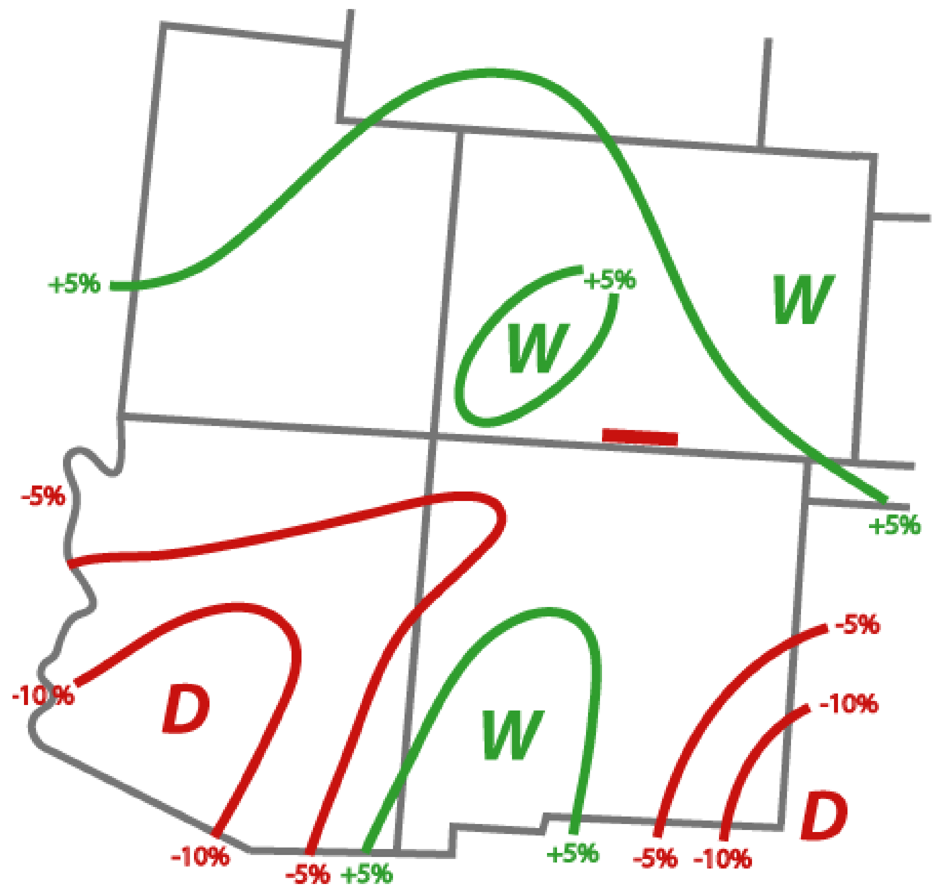


Figure 11c. Experimental guidance for seasonal precipitation in the southwest for July - September (issued July 14, 2006).

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 October 2006 Source: NOAA Climate Prediction Center

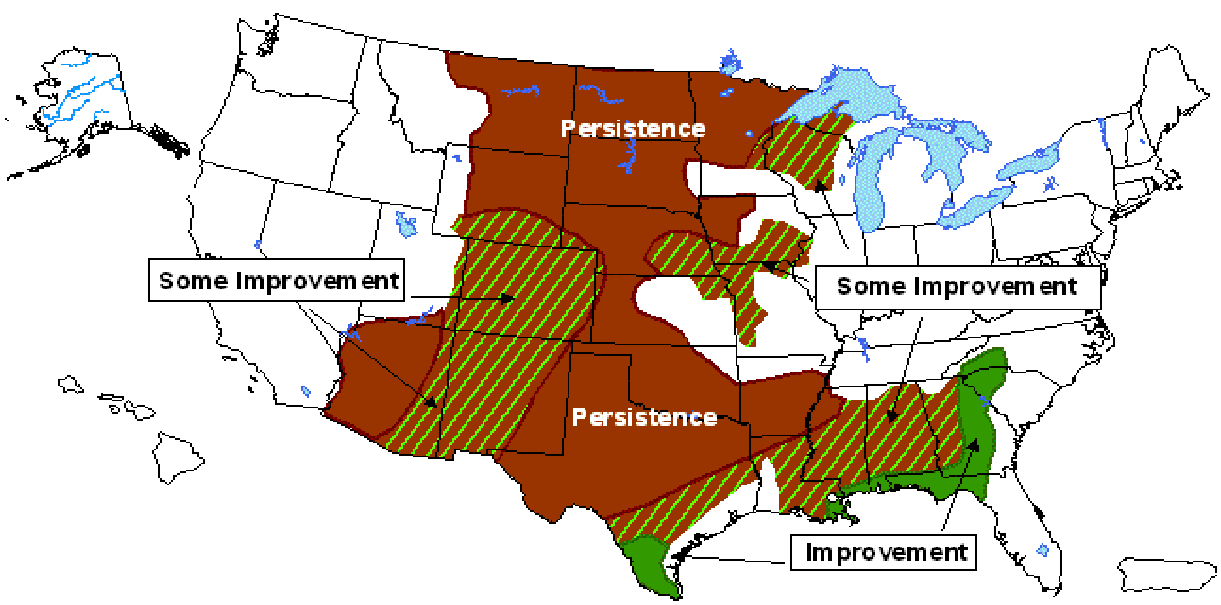
According to the Drought Outlook issued July 20th by the NOAA Climate Prediction Center, drought status in the Intermountain West is likely to persist in central and eastern **Wyoming** and western Nebraska and Kansas. Improvements are anticipated in southern **Wyoming**, eastern and southern **Colorado**, and eastern Nebraska. Improvements in **Colorado** are partly based on forecasted above average precipitation for western **Colorado** in the CPC 6-10 day outlook (http://www.cpc.ncep.noaa.gov/products/predictions/610day/).

According to CPC, July heat and dryness in the northern Plains (including parts of **Wyoming**) and upper Midwest rapidly worsened conditions and contributed to expansion of drought across those areas. In contrast, the summer monsoon rains are likely to offer seasonal relief to the Southwest, **Colorado**, and southern **Wyoming**. However, because snow melt is the major source for water in the West, longer-term improvement in water supplies will likely need to wait until next winter's snow season. Another impact of the monsoon rains is the reduction of fire danger in July and August.

The Seasonal Drought Outlook is based on the CPC long-lead precipitation outlook for the upcoming season in this case August-October (pp. 14 and 15** check these pages!!), drought termination and amelioration probabilities from the NOAA/National Climatic Data Center (see URL below), and various medium and short-range forecasts and models such as the 6-10 day and 8-14 day forecasts, and the soil moisture tools.

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.



Drought Outlook

- Drought to persist or intensify
- Drought ongoing, some improvements
- Drought likely to improve, impacts ease
- Drought development likely

Figure 12. Seasonal Drought Outlook through October 2006 (release date July 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

Sea surface temperatures (SSTs) in much of the central and eastern equatorial Pacific are currently close to normal, indicating neutral ENSO conditions (Figure 13a). According to both the NOAA/CPC and the International Research Institute for Climate and Society (IRI), ENSO-neutral conditions are expected to prevail through the rest of 2006. Most prediction tools indicate that SST anomalies will be slightly positive but no more than 0.5° C in the equatorial Pacific regions that are influenced by ENSO.

There has been a build up in upper-ocean heat content along the equator recently, but because the low-level easterly winds along the equator have been near average, it seems likely that ENSO-neutral conditions will continue at least for the next three months. However, the spread of the forecasts (ENSO-neutral to El Niño) indicates considerable uncertainty in the outlook for late 2006 and early 2007 (Figure 13b). Based on the latest observations and models, IRI estimates that the likelihood of ENSO-neutral conditions persisting through the July-September 2006 period is about 65%, and the probability of an El Niño developing is about 30% .

In the absence of ENSO anomalies in SST, climate impacts related to El Niño or La Niña will be negligible for the next few months.

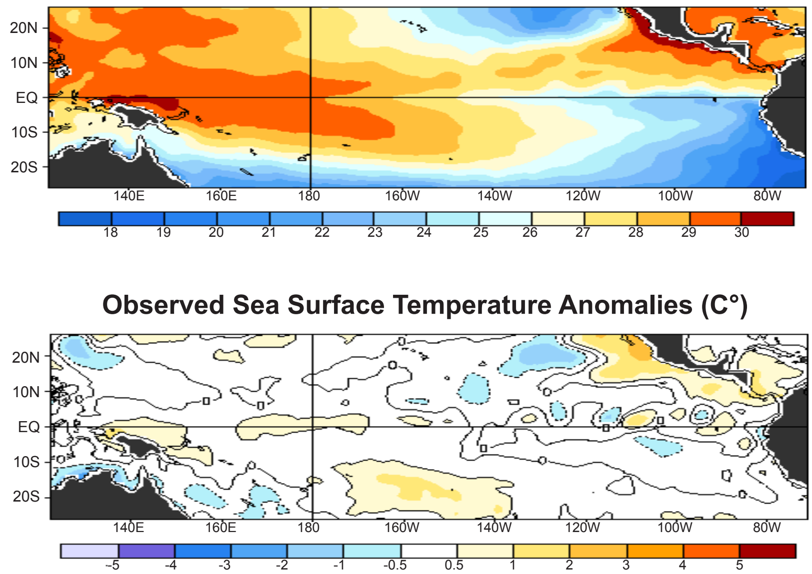


Figure 13a. Two graphics showing the observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. The Niño 3.4 region encompasses the area between 120ºW-170ºW and 5ºN-5ºS. The graphics represent the 7-day average centered on July 12, 2006.

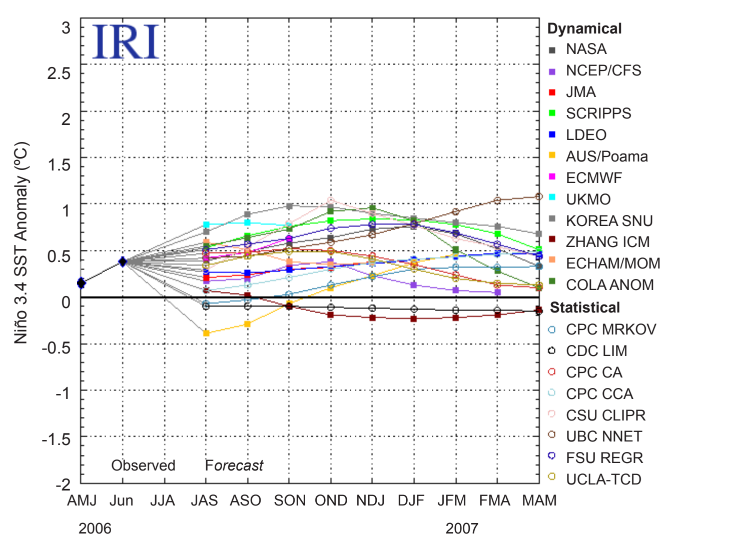


Figure 13b. Forecasts made by dynamical and statistical models for sea surface temperatures (SST) in the Niño 3.4 region for nine overlapping 3-month periods from June 2006 through May 2007 (released July, 19 2006). Forecasts are courtesy of the International Research Institute (IRI) for Climate and 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/.

Update on the 2006 North American Monsoon

By Eileen McKim, WWA and University of Colorado Dept of Geography

The North American Monsoon is a prominent feature of the climate of the Southwest U. S. including a significant part of the Intermountain West region. The monsoon is an important feature of the atmospheric circulation over the North American continent, and its effects are noticeable over a large portion of western United States, particularly Arizona, New Mexico, and to a lesser degree, Utah and Colorado. Monsoon circulation plays a significant role in the hydrological cycle of the arid southwest U. S., with parts of Arizona and New Mexico receiving 40-50% of their annual precipitation from the summer monsoon (Douglas et al. 1993). Also known as the Southwest U.S. monsoon, Mexican monsoon, or the Arizona monsoon, the North American Monsoon is a pronounced increase in rainfall in the region from an extremely dry June to a rainy July over large areas of southwestern U. S. and northwestern Mexico. This increase in precipitation typically begins in northwest Mexico and Arizona in early July, then the precipitation gradually works its way northward, eventually reaching Utah, Colorado and into the Front Range by early to mid-July. These summer rains typically last until mid-September when a drier regime is reestablished over the region.

The monsoon extends into the southwest U.S. as it matures in mid July when an area of high pressure, called the monsoon ridge, develops in the upper atmosphere over the four corners region, creating an easterly to southeasterly wind flow. This wind flow pattern directs moisture originating in the Gulf of Mexico, Gulf of California and the tropical Pacific into the region, setting off brief, but sometimes torrential thunderstorms. The NWS, Grand Junction, notes that "once the monsoon season is underway, the southwesterly circulation does not produce thunderstorms everyday, but rather consists of a pattern that undergoes a series of "bursts" and "breaks" (definitions by climatologist Andrew Carleton). While the monsoon thunderstorms can bring beneficial rains to eastern Utah and western Colorado, they can also result in flash flooding, one of our deadliest weather events."

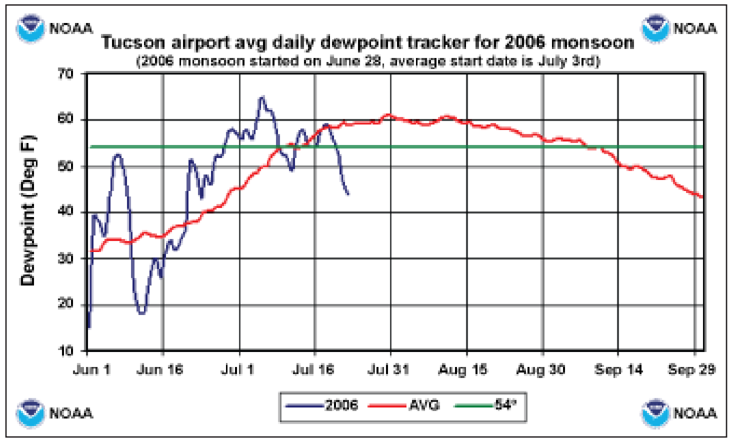


Figure 14a. 2006 monsoon daily average surface dewpoint at Tucson International Airport. The red line shows historic average daily dewpoint and the blue line shows the average daily dewpoint values for 2006.

Southwest Monsoon and Flash Floods

Several historical flash floods of note along the Front Range of southern Wyoming and northern Colorado (Big Thompson 1976, Cheyenne 1985, and Fort Collins 1997) have occurred during late July and early August, with each strongly tied to the southwest monsoon. A study by Weaver and Doesken (1990) showed that the recurrence probability for a catastrophic severe weather event along the Front Range was greatest during this period. This is especially likely during very active monsoon seasons. Monsoonal "bursts", the convectively unstable periods of the event, can be particularly wet and enduring during La Niña years. During cold phases in the Eastern Pacific (JMA SST index is 0.5C below average for six consecutive months), enhanced tropical activity and intensity associated with La Niña often increases the available moisture for transport into the southwest United States (Bove et al. 1998).

Tracking the 2006 Monsoon

One guideline for determining the onset of the monsoon season is when the average daily dew point there reaches, or exceeds, 54° F for 3 or more consecutive days. Because the monsoon is a phenomenon that moves northward, there is no single start date. According to the NWS, this year the monsoon began in Tucson, Arizona, on June 28th, which was 5 days earlier than the average start date of July 3rd in Tucson (Figure 14a). The earliest start date recorded in Tucson is June 17, 2000 and the latest start date is July 25, 1987. Start dates are a little later further north, with the average start date in Phoenix is July 7, while the average ending date is September 13, To continue tracking the monsoon, see the "Monsoon Tracker 2006" at http://www.wrh.noaa.gov/twc/monsoon/monsoon_info.php

References:

Bove et al., 1997; Effects of El Nino on U. S. landfalling hurricanes revisited, Bulletin of American Meteological Society, 79, no. 11. 2477-2482.

Douglas, DM, Maddox RA, Howard K,(1993) The Mexican Monsoon. J. Clim 6; 1665-1677.

Weaver J. F., and N.J. Doesken, 1990: Recurrence probability- a different approach. Weather, 45, 333-339.

On the Web

- The North American Monsoon Experiment: http://www.joss.ucar.edu/name/
- NWS Phoenix Monsoon webpage: http://www.wrh.noaa.gov/psr/general/monsoon/
- NWS Flagstaff Monsoon webpage: http://www.wrh.noaa.gov/fgz/science/monsoon.php?wfo=fgz
- NWS Tucson Monsoon webpage: http://www.wrh.noaa.gov/twc/monsoon/monsoon.php