Intermountain West Climate Summary

by The Western Water Assessment

Issued July 22, 2005

July 2005 Climate Summary

Hydrological Conditions – Over the past few months, drought status has eased or reversed in Colorado and Utah, but Wyoming is still dry. Streamflows are in the near-normal range in much of the Intermountain West.

Temperature – Near-average temperatures in June were followed by higher than average temperatures in July. In areas influenced by the summer monsoon, the high temperatures are partly due to the late arrival of the summer monsoon that usually mitigates July temperatures.

Precipitation – The monsoon has just begun and was unseasonably late, so July precipitation is low in monsoon-affected areas. However, the 12-month SPI is average to wet for most of the region.

ENSO – Near- normal sea-surface temperatures, or ENSO-neutral conditions, are expected through early 2006.

Climate Forecasts – CPC outlooks suggest a weak southwest monsoon, favoring dry conditions in the western part of the region. Long-term temperature trends continue to indicate above normal temperatures for parts of the Intermountain West region. In the absence of an ENSO anomaly, models are unable to predict seasonal precipitation anomalies in the upcoming months. However, a strong interdecadal trend is the basis for above average temperatures in most of the Intermountain West.

Summer Climate: The Dog Days, the Monsoon, and Flash Flooding

Denver was one of many cities setting high temperature records in mid-July, setting a record for hottest July day with 105°F on July 20th, and tying the all time record from August 8, 1878. The NWS Grand Junction office calls the period from early July to mid-August the "Dog Days," the most sultry period of summer in western Colorado. Most of Colorado experiences a dry and often hot period that extends from June into early to mid-July, when the North American monsoon begins in the southwestern U.S. Colorado is not in the core monsoon region, but atmospheric circulation associated with the monsoon may bring moisture and cooler temperatures. The NWS definition for the onset of the monsoon in southern Arizona is three consecutive days when the dew point averages 55 degrees or higher. This occurred in Tucson on July 18th, almost two weeks later than the average start date of July 3rd. The monsoon is related to a shift northward of a high-pressure system ("ridge") from northern Mexico to the west Texas and New Mexico area, which occurred late this year. For eastern Colorado, the monsoon brings the possibility of widespread precipitation, and slow moving thunderstorms, which pose a threat for flash flooding.

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CIRES

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The State of Western Water: Summer 2005

By Keah Schuenemann, Andrea Ray and Jessica Lowrey of the Western Water Assessment.

During the 2005 water year, indicators of hydrologic conditions improved in many parts of the Intermountain West. Drought status has eased or reversed in Colorado and Utah, streamflows are in the near-normal range in much of the region, and the standardized precipitation indices are normal to wet everywhere but parts of Wyoming. An active southern storm track during some of the 2005 water year brought above average precipitation in the fall and winter, especially in the southern and western parts of the Intermountain West. The above average snowpack, in addition to a late warming at the end of May, resulted in flooding and high peak flows at levels not seen in the recent past. This article is a short synopsis of Water Year 2005 to date, and it explores the cause of the precipitation pattern and effects of the above average runoff in Colorado, Wyoming, and Utah.

Is El Niño responsible for the 2005 precipitation pattern?

According to the NOAA Climate Prediction Center, there was a weak El Niño through this past winter and early spring. El Niño is associated with the precipitation pattern that occurred this winter: a gradient from below normal in the northern part of the West to above normal in the southern part (Figure 1a). The association is based on the tendency of El Niño to shift the upper tropospheric jet stream further south, steering the incoming storm track from over the Pacific Ocean to a more southern path and causing above average precipitation across the southwest.

Climate Diagnostics Center scientists Martin Hoerling and colleagues conducted studies to see if the weak El Niño was a factor in causing the storm track to move further south this year. The scientists used multiple runs on five different widely used climate models (NCEP, NSIPP, CCM3, ECHAM, and GFDL models) that were initialized with sea surface temperatures associated with the recent, weak El Niño. They found that a blocking high-pressure system located in the Gulf of Alaska was responsible for shifting the jet stream, and there was no significant correlation with the blocking high and El Niño. The scientists concluded that El Niño was not the cause of the 2005 water year's precipitation abnormalities in the West.

Water year 2005.

Three related climatological factors contributed to an above average water year in the Intermountain West: above average fall precipitation, above average winter snowfall, and below average spring temperatures changing to extreme high temperatures at the end of May. The heavy rains in the fall of 2004 helped to

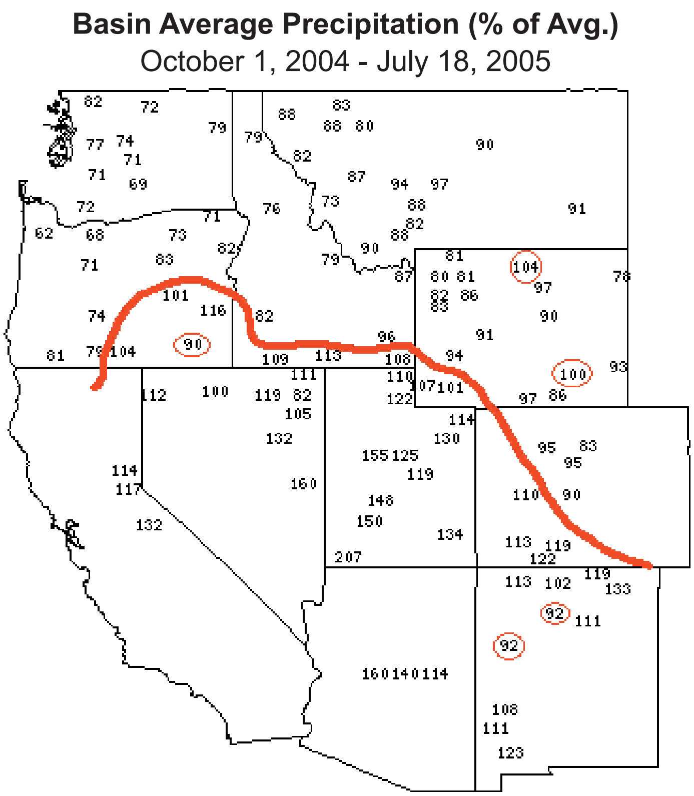


Figure 1a. The basin average precipitation numbers are the total precipitation as a percent of average for the 2005 water year thus far (October 1, 2004 through July 18, 2005). The average value is based on 1971 to 2000 conditions. The red contour indicates the approximate position of the 100% of average contour with the small red circles indicating the outliers. This map is a product of the Western Regional Climate Center with data from NRCS SNOTEL sites.

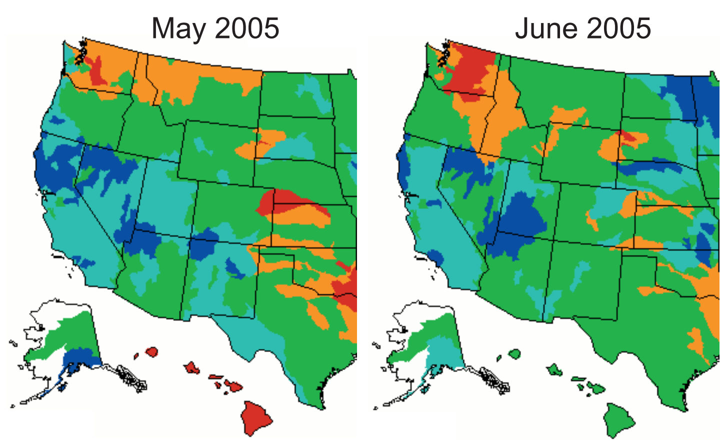


Figure 1b. USGS monthly-average streamflow for the West in May and June 2005 indicating normal to above normal streamflows in the Intermountain West. The colors represent monthly average streamflow compared to percentiles of historical streamflow for the calendar month. The green areas had normal streamflow. The orange, brown, and red areas had below normal streamflows and can be considered dry. Blue areas had above normal streamflows and can be considered wet.

improve the soil moisture deficits that had accumulated over the past few years of drought. Then, in winter 2005 the Intermountain and southwestern U.S., including the Sierra Nevada Mountains, experienced above average snowpack. According to the NOAA 2005 Spring Outlook, "Preliminary data show the Southwest had its wettest September-February in 110 years of record keeping." For example, the snowpack throughout Utah was above normal, and in the southern half of the state it was more than double the average in some areas.

Higher streamflows this spring were a result of the increase in soil moisture and above average snowpack. In May and June 2005, Utah had above average streamflows while most of Wyoming and Colorado had nearly average flows for that time of year (Figure 1b). Governor Jon Huntsman, Jr. of Utah began a Spring 2005 flood and spring runoff preparedness campaign in April to promote awareness of the high flooding potential throughout the state. Despite many preparations for high streamflows due to high soil moisture and snowpack, flooding during high peak flows throughout Utah still caused some unavoidable damage, although not nearly the amount it would have without the early awareness of the flood risk (Figure 1c).

Figure 1c. Spring flooding in Pleasant Grove, Utah near Utah Lake. Pleasant Grove citizens are sandbagging at the start of a potential flood risk for their town. Photo from 5-KSLTV in Utah.

Figure 1d. Peak Flows -- Chart right & Data Table below. The peak flow values above are in cubic feet per second from 2000 through 2005 for seven different sites in the Colorado River Basin. At the bottom of the table are comparisons of the 2005 peak flows with 2004 peak flows, the 2000-2004 average (drought years), and the historical average. Data is from the Colorado Basin River Forecasting Center.

Peak Flows **Mean daily flows in cubic feet per second (cfs)** Rivers in order from North to South as read from left to right.

River	**Bear**	**Green**	**Yampa**	**Green**	**Colorado**	**Gunnison**	**San Juan**	
City	UT-WY Stateline	Green River	Maybell	Green River	CO-UT Stateline	Somerset	Bluff	
State	UT, WY	WY	CO	UT	CO, UT	CO	UT	
2000 Peak	1,240	1,660	9,830	18,400	17,000	2,130	5,120	
2001 Peak	1,500	1,600	7,900	18,100	13,000	1,820	7,940	
2002 Peak	830	1,400	3,300	7,300	4,470	655	847	
2003 Peak	1,600	1,430	14,500	21,500	24,500	3,250	3,540	
2004 Peak	680	3,220	5,950	11,100	9,230	1,700	4,420	
Avg Drought Peak 2000-2004	1,170	1,862	8,296	15,280	13,640	1,911	4,373	
Average Peak 1971-2000	1,610	7,110	10,475	22,560	26,150	3,310	7,340	
2005 Peak	1,820	7,000	12,500	33,200	26,200	4,480	12,100	
Compare to 2005:								**Total Averages:**
2005 Peak/ 2004 Peak	268%	217%	210%	299%	284%	264%	274%	259%
2005 Peak/ Avg Drought Peak	156%	376%	151%	217%	192%	234%	277%	229%
2005 Peak/Avg Peak 1971-2000	113%	98%	119%	147%	100%	135%	165%	125%

Peak Flows.

Peak flow refers to the highest average flow for an entire day at a location during the runoff season during the April through July runoff period. Temperatures in April and early May were cooler than usual, causing a delay in the snowmelt and a buildup of more snow in higher elevations. A quick warming in late May caused rapid snowmelt and above average peak flows, which were associated with flooding around the region.

We compared the 2005 peak flows from seven stations in Wyoming, Utah, and Colorado to their averages and to the peak flows of the last five years using data from the Colorado Basin River Forecasting Center (Figure 1d). 2005 peaks were generally over 200% of average peak flows for the previous five years of drought. In Wyoming the Green River peak flows were near the historical average, but were almost four times the average peak flows for the recent drought years. Peak flows in central and southern Utah were the highest compared to average in the Intermountain West, corresponding to very high snowpack observed across Utah this winter. Colorado also experienced some above average peak flows in basins with higher than average snowpack such as the San Juan River in southwestern Colorado (Figure 1e).

Figure 1e. Flooding along the San Juan River in Pagosa Springs, Colorado from May 24-25, 2005, just before the peak flow. Notice that the picnic tables on the lower level of the hot springs are underwater. Photo courtesy of the CWCB.

Reservoir levels.

During the late May peak flows, some reservoirs were filling at almost a foot a day. As high volumes of water from the rivers rushed in, some reservoirs in the Intermountain West filled or nearly filled in 2005 (see page 8 for more information on current reservoir levels). Lake Powell, however, did not. According to the Bureau of Reclamation, Lake Powell has been on a steady decline since 1999 due to the low inflows during the recent drought. It was 95% full at the end of the 1999 water year, but by April 8, 2005 it had reached a low elevation of 3,555 feet, which was 33% of live capacity. The last time the storage level was that low was when it was still filling in 1969 (Figure 1f). Since the spring runoff began in April this year, Lake Powell has had above average inflows, reaching an elevation of 3608.38 feet on July 12, with storage of 52% of live capacity. Many other reservoirs have filled or nearly filled, including Flaming Gorge, Utah Lake, and Dillon Reservoirs.

In Conclusion.

In the critical precipitation accumulation period of the 2005 Water Year, a Pacific storm track was pushed southward by a blocking high in the Gulf of Alaska, bringing high levels of precipitation to parts of the Intermountain and Southwestern U.S. Flooding, above average peak flows, and recovery of reservoirs were all associated with not only the increased precipitation, but also the somewhat unusual timing of a cool spring and rapid warm up.

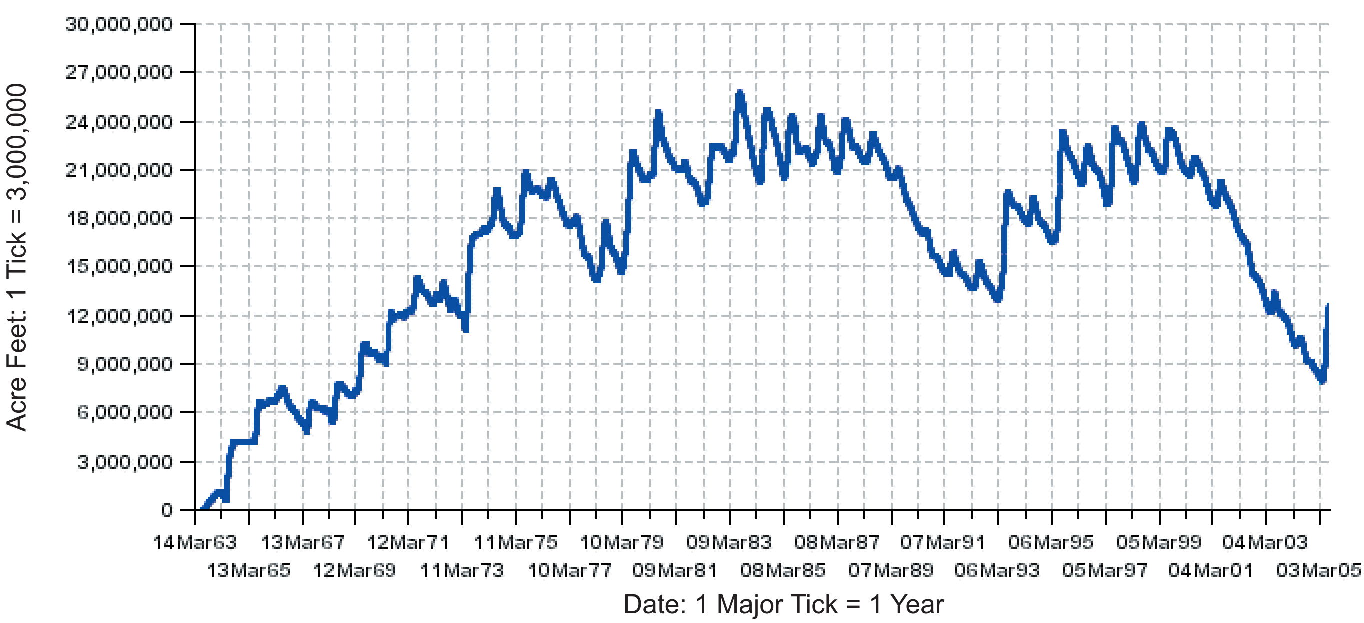


Figure 1f. Lake Powell storage in acre-feet from 1963 through 2005 indicating that 2005 pre-runoff storage reached levels not seen since the filling of the reservoir in the late 60's. Source: Bureau of Reclamation Upper Colorado Region.

Temperature through 7/18/05 Source: High Plains Regional Climate Center

Because this month's climate summary is being released later than usual in the month, we present average temperatures (Figure 2a) and departure from average temperatures (Figure 2b) for the period of June 19 to July 18. Two additional maps show the departure from average temperatures last year because the High Plains Regional Climate Center provides this information in whole-month segments (Figures 2c and 2d).

Between June 19 and July 18, 2005, average temperatures in the Intermountain West region ranged from the upper 50s in the mountains of **Colorado** and western **Wyoming** the upper 80s in parts of southeastern **Utah** (Figure 2a). Overall, the temperatures ranged from 0 °F – 4 °F above normal throughout the region (Figure 2b). These above normal temperatures occurred in July for the most part. According to a NOAA bulletin, June temperatures for the entire Intermountain West Region were near normal or cooler than normal (See http://www.noaanews.noaa.gov/stories2005/s2474.htm). Therefore, weather in July was responsible for the departure from normal temperatures in this region. In fact, seven stations in central Wyoming had record breaking high temperatures on July 16th, according to the Casper Star Tribune (See http://www.casperstartribune.net/articles/2005/07/19/news/wyoming/bf5e7311a30796d0872570420058243d.txt).

June 2004 was 2°F – 4°F below normal in most of Wyoming and eastern Colorado, while Utah stayed at or slightly above normal for the month (Figure 2c). July 2004 had below normal temperatures in eastern Colorado and most of Wyoming and above normal temperatures in most of Utah as well, but the difference from normal was lower. Overall, the region was closer to normal in July 2004 than June 2004.

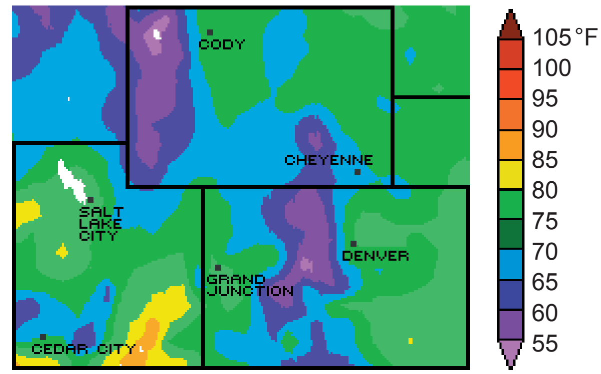


Figure 2a. Average temperature for the previous 30 days in ° F (June 19, 2005 – July 18, 2005)

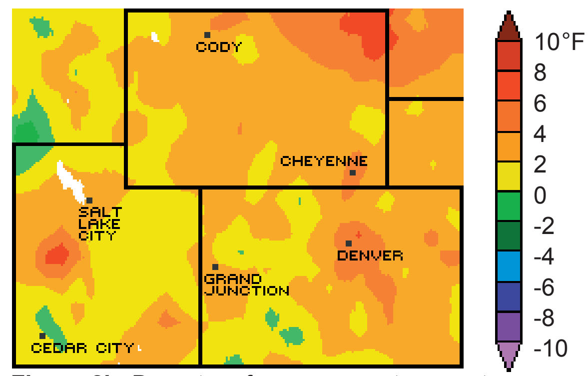


Figure 2b. Departure from average temperature for the previous 30 days in °F (June 19, 2005 – July 18, 2005).

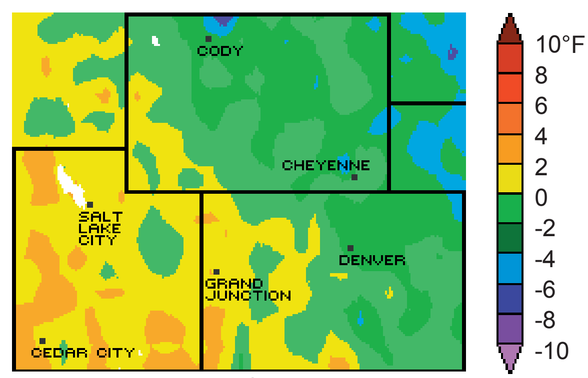


Figure 2c. Departure from average temperature in °F for last year, June 2004.

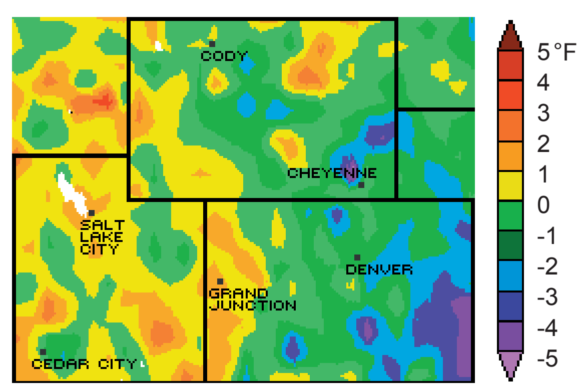


Figure 2d. Departure from average temperature in °F for last year, July 2004.

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 continuous color maps are derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points. Interpolation procedures can cause aberrant values in data-sparse regions. For maps with individual station data, please see web sites listed below.

Figures 2a-d are experimental products from the High Plains Regional Climate Center. This data is considered experimental because it utilizes the newest data available, which is not always quality controlled.

On the Web

- For most recent versions of these and other climate maps, visit: http://www.hprcc.unl.edu/products/current.html.
- For information on temperature and precipitation trends, visit: http://www.cpc.ncep.noaa.gov/trndtext.htm.
- For a list of weather stations in Colorado, Utah, and Wyoming, visit: http://www.wrcc.dri.edu/summary.

Precipitation through 7/18/05 Source: High Plains Regional Climate Center

As for the recent temperature maps, the precipitation maps this month feature averages for the period between June 19 and July 18 in order to provide the most current information. This month the maps come from the High Plains Regional Climate Center (HPRCC). Although their data does not include SNOTEL sites, because it did not snow during this period in the Intermountain West, these maps accurately reflect precipitation.

From June 19 to July 18, most of the Intermountain West received 1 inch or less of precipitation (Figure 3a), well below average for most of the region The low precipitation occurred in July, not June (Figure 3b). According to data from the HPRCC (not shown), parts of southern **Utah**, northwestern **Colorado**, and a small part of southeastern **Wyoming** received over 200% of average precipitation in June. However, the Intermountain West region as a whole received under 50% of normal precipitation so far in July, and the entire state of **Utah**, northwestern **Colorado**, and a large part of southwestern and central **Wyoming** received less that 5% of normal precipitation in July so far. The precipitation deficit is most likely due to the unseasonably late onset of the summer monsoon season, according to a meteorologist at the NOAA Climate Diagnostics Center.

Despite the below average precipitation in the Intermountain West for the last 30 days, most of Utah still has 150% above average precipitation totals since the beginning of the water year 2005 (Figure 3c). Wyoming and Colorado precipitation totals are closer to normal, with areas ranging from 70% to 130% of normal.

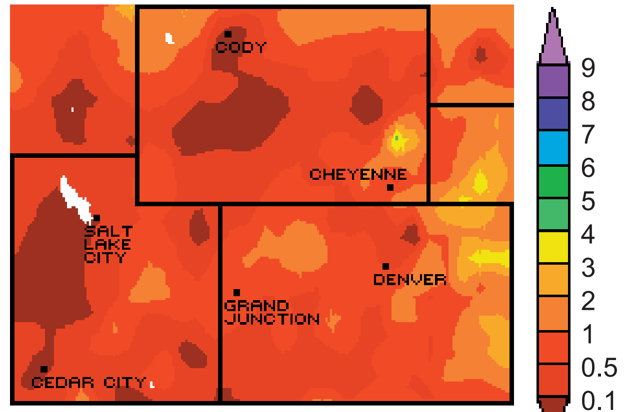


Figure 3a. Average precipitation for the previous 28 days in inches (June 19, 2005 – July 18, 2005).

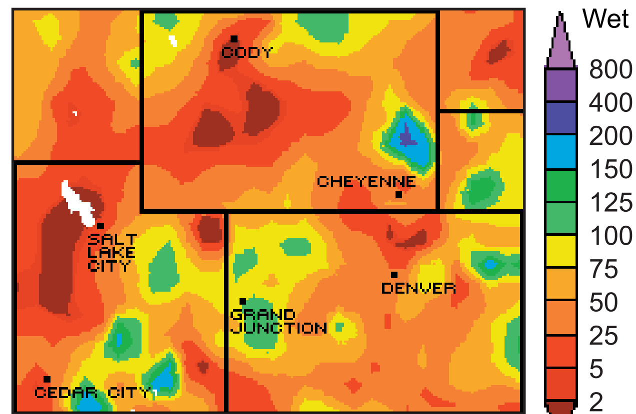


Figure 3b. Percent of average precipitation for the previous 30 days (June 19, 2005 – July 18, 2005).

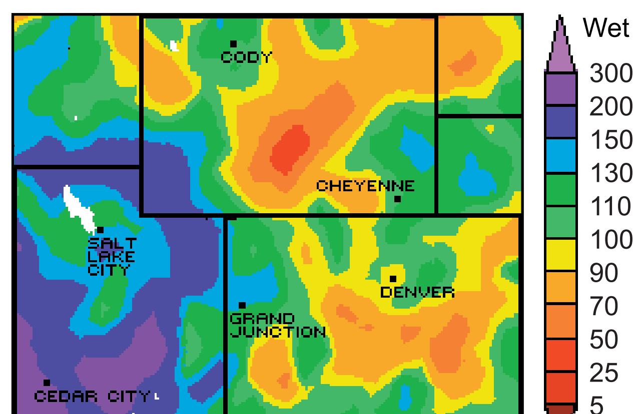


Figure 3c. Percent of average precipitation accumulated since the start of the water year (October 1, 2004- July 18, 2005).

Notes

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2004 we are in the 2005 water year. The water year is a more hydrologically sound measure of climate and hydrological activity than is the standard calendar year. It reflects the natural cycle 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 1971-2000. Departure from average temperature is calculated by subtracting current data from the average. The result can be positive or negative.

These continuous color maps are derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points. Interpolation procedures can cause aberrant values in data-sparse regions. For maps with individual station data, please see web sites listed below.

Figures 3a-c are experimental products from the High Plains Regional Climate Center. This data is considered experimental because it utilizes the newest data available, which is not always quality controlled.

On the Web

- For the most recent versions these and maps of other climate variables: http://www.hprcc.unl.edu/products/current.html.
- For precipitation maps like those in the previous summaries, which are updated daily: http://www.cdc.noaa.gov/Drought/.
- For National Climatic Data Center precipitation reports: 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 7/19/05

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

According to the Drought Monitor, the upper air circulation pattern conspired to delay the onset of the western monsoon again this week. A few stations in Colorado received rain, but little or no precipitation occurred across the region. Instead, the weather was dominated by extremely hot temperatures, with several records set at stations in **Colorado** and **Wyoming**. Much of the Southwest has experienced exceedingly hot temperatures during the last month or so, resulting in very high evaporation rates. See the Drought Monitor page for discussion of topsoil moisture in the region. A gap in D2 conditions in central **Wyoming** was bridged, forming one area of D2 in the state. This gap had roughly coincided with the area of greatest precipitation departures at 90 days to 6 months. The Great Plains were characterized by a contrast of precipitation extremes during the past week. One to 2 inch rains in Nebraska and Kansas were spotty and easily mitigated by the hot windy conditions, with generally dry conditions predominating in the north.

The Drought Monitor authors adjusted some impact boundaries and indicators this week, including over **Nebraska**, **Wyoming**, and northwest **Colorado** to separate hydrologic, and agricultural impacts from areas with both.

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.

These 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 authors of this monitor are Richard Heim and Jesse Enloe of the NOAA National Climate Data Center.

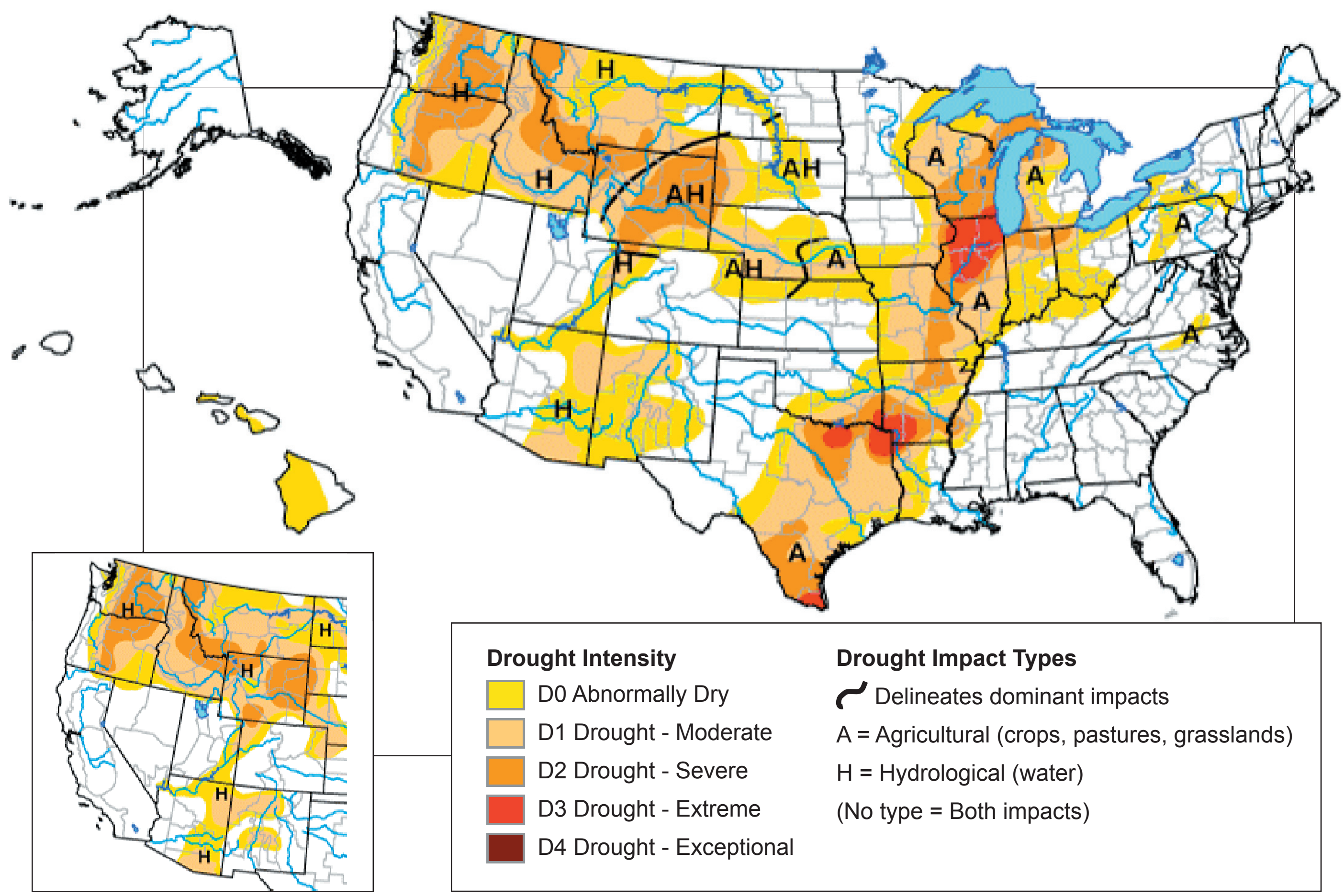


Figure 4. Drought Monitor released July 21, 2005 (full size) and last month June 23, 2005 (inset, lower left) for comparison.

On the Web

For the most recent drought monitor, as well as archives, visit: http://www.drought.unl.edu/dm/monitor.html

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

The majority of inflow to most western reservoirs is from snowmelt in April-July. All of the reservoir levels in Figure 5 have increased since the beginning of May. According to a bulletin from the Colorado River Water Conservation District (http://www.crwcd.gov/droughtpage7-02.html), while Blue Mesa Reservoir on the Gunnison River in south-central Colorado saw a less-than-expected inflow and will not fill, other reservoirs on the Colorado River in western Colorado that were not expected to fill defied forecasts by actually filling. Dillon Reservoir on the Blue River spilled water for the first time in years.

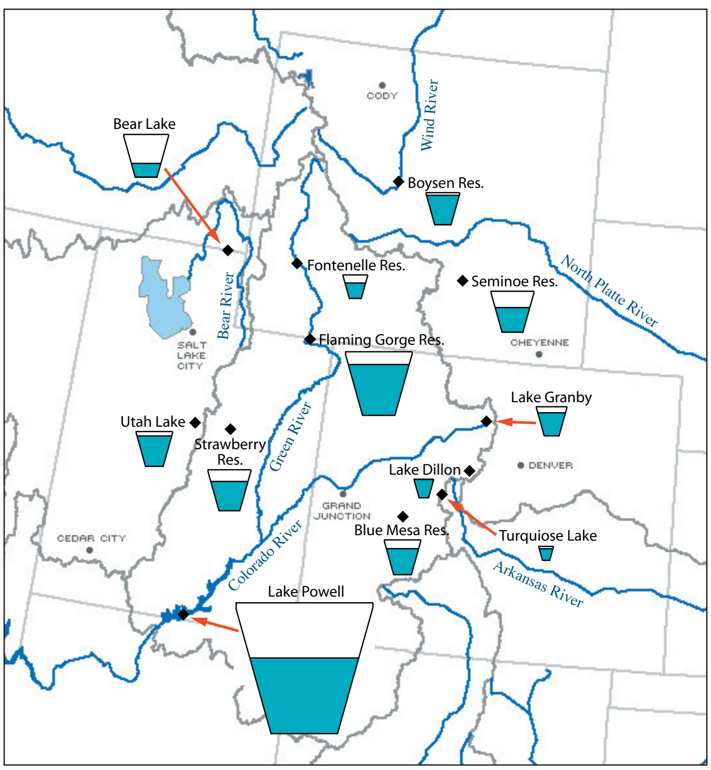
The same bulletin estimated that total storage in the big main-stem Colorado River reservoirs that supply water to the states of the Lower Basin has increased to 61% of capacity and is now 8% ahead of last year. Lake Powell annual inflow is forecast at 13.34 million acre-feet, or 111% of average, for water year 2005. This is a marked departure from the previous five years when Powell's inflow has been: 2000 - 61%; 2001 - 59%; 2002 - 25%; 2003 - 51% and 2004 - 51%.

Reservoir "% Full" in July reflects a combination of the April-July inflows, which are the majority of the supply for the water year, and the fact that the reservoirs are making releases to supply down stream demands

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 statuses are updated at different times, so for the most recent information, see the websites listed in the "On the Web" box. Averages with (*) were hand calculated by using raw data from the USBR for all July 18s, whereas the other averages were calculated by the organization that keeps the data for those reservoirs. All averages date back to when the specific reservoir was filling.

The percent of average is the storage from July 18, 2005 divided by the average storage for that day.



Reservoir	Current Water (KAF)	Total Capacity (KAF)	% Full	% of Average
Colorado				
Blue Mesa Res.	649.9	829.5	78%	94%*
Lake Dillon	253.8	254.0	100%	103%
Lake Granby	431.2	539.8	79%	101%
Turquiose Lake	122.5	129.4	95%	88%
Utah				
Bear Lake	338.0	1,302.0	26%	N/A
Lake Powell	12,548.0	24,322.0	52%	72%*
Strawberry Res.	854.5	1,106.5	77%	120%
Utah Lake	785.9	870.9	90%	90%
Wyoming				
Boysen Res.	725.1	741.6	98%	118%
Flaming Gorge Res.	3,222.3	3,749.0	86%	108%*
Fontenelle Res.	283.8	344.8	82%	108%*
Seminoe Res.	612.5	1,017.3	60%	85%

KAF = Thousands of Acre Feet

Figure 5. Tea-cup diagram of several large reservoirs in the Intermountain West Region. All data from 7/18 or 19/05, except Utah Lake and Bear Lake data from 6/30/05.

On the Web

- Lake Dillon ["check res. levels" pdf]: http://www.water.denver.co.gov/indexmain.html
- Turquoise Lake, Lake Granby, Boysen Reservoir, and Seminoe Reservoir: http://www.usbr.gov/gp/hydromet/teacup_form.cfm
- Blue Mesa Res., Lake Powell, Flaming Gorge Res., and Fontenelle Res. : http://www.usbr.gov/uc/wcao/water/basin/tc_cr.html
- Strawberry Res.: http://www.cuwcd.com/operations/currentdata.htm
- Utah Lake and Bear Lake: http://www.wcc.nrcs.usda.gov/cgibin/resv_rpt.pl?state=utah

Regional Standardized Precipitation Index data through 6/30/2005

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

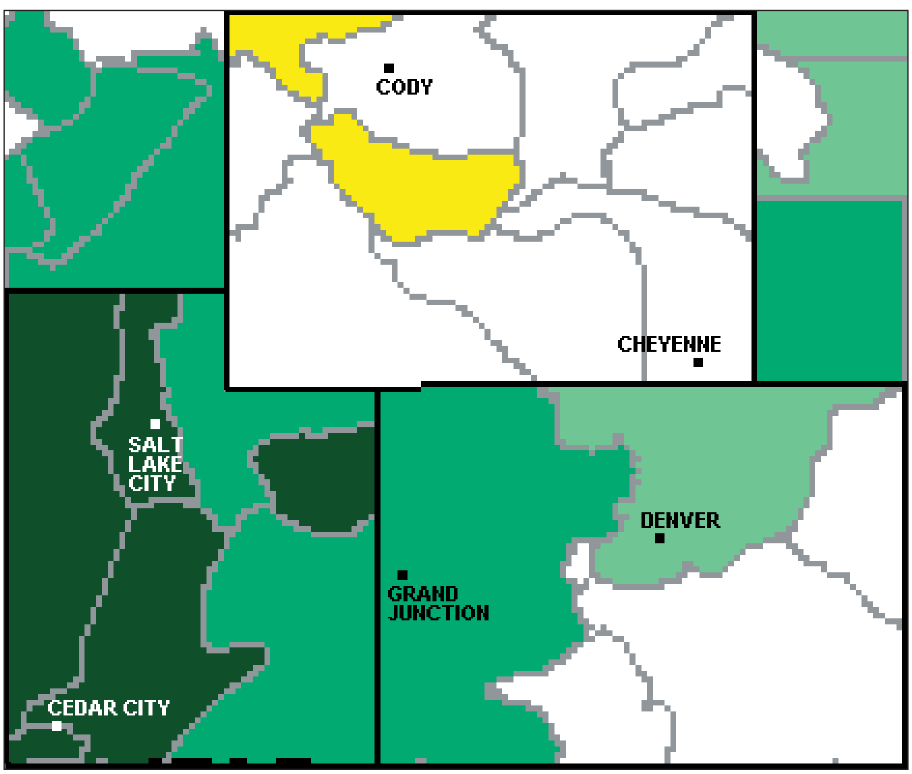
The Standardized Precipitation Index (SPI) can be used to monitor conditions on a variety of time scales. 3- and 6-month SPIs are useful in short-term agricultural applications and longer-term SPIs (12 months and longer) are useful in hydrological applications. The 12- month SPI for the Intermountain West region (Figure 6) reflects precipitation patterns over the past 12 months (through the end of June 2005) compared to the average precipitation of the same 12 consecutive months during all the previous years of available data.

This month brought both wet and dry changes to the 12-month SPI for the Intermountain West region. Western **Utah** and the Uinta basin in the east both moved into the extremely wet category due to continued abnormally high precipitation in June. On the other hand, a large part of **Wyoming** did not receive average precipitation and the Wind River and Yellowstone River basins are now considered moderately dry. In **Colorado**, the state is split, becoming wetter in the west and drier in the east in the Arkansas River basin.

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, and wet periods can also be monitored using the SPI.



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

Figure 6. 12-month Intermountain West regional Standardized Precipitation Index. (data through 6/30/05)

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 2005

Source: Colorado Division of Water Resources, State Engineer, USDA Natural Resources Conservation Service, U.S. Geological Survey

The Surface Water Supply Index (SWSI) is a useful measure of water availability related to streamflows, reservoir levels, and even groundwater levels, in contrast to the SPI, which uses precipitation to calculate an index of precipitation compared to average,

Water availability status continues to vary across basins in Colorado (Figure 7a). Increased water supplies in the Yampa raised it above 0, while low water supplies in the Dolores and Rio Grande basins brought them from abundant supply to near normal. Overall the state is near normal.

This month we introduce a new product; a map of streamflow from USGS gauges (Figure 7b). Most of Colorado's rivers are running near normal (25th – 75th percentile) for this time of year. However, there are low reaches in both the Arkansas and some South Platte tributaries, and several reaches in western Colorado (tributaries of the Colorado and White Rivers) are running high.

Surface Water Supply Index July 1, 2005

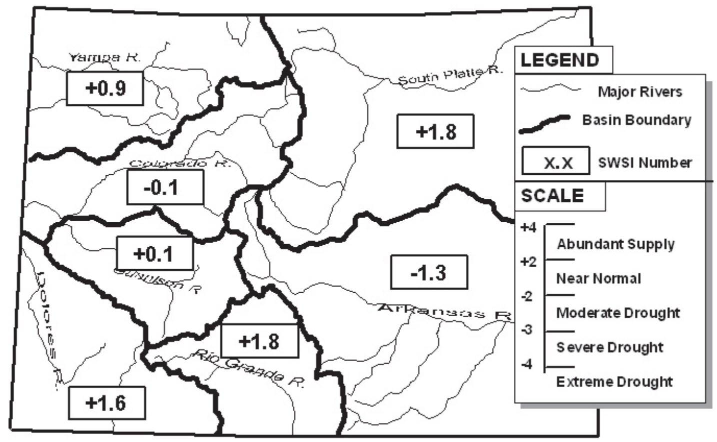


Figure 7a. Colorado Surface Water Supply Index. The map is an indicator of mountain-based water supply conditions in the major river basins of the state as of July 1, 2005.

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 8a were computed for each of the seven major basins in Colorado for July 1, 2005, and reflect conditions through the month of June 2005.

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.

7-Day Average Streamflows

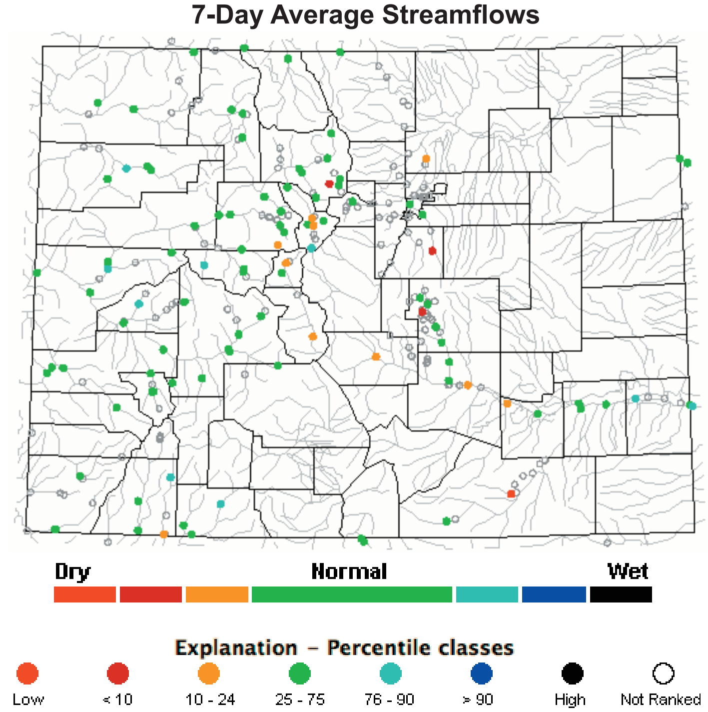


Figure 7b. Seven-day average streamflow conditions for points in Colorado, as of July 18, 2005 computed at USGS gauging stations. The colors represent 7-day average streamflow compared to percentiles of 7-day average streamflow for July 18th.

On the Web

- For the current SWSI map, and for the latest "Colorado Water Supply Conditions" Report from the State Engineer, go to: http://water.state.co.us/pubs/swsi.asp.
- For current streamflow information from USGS, visit: http://water.usgs.gov/waterwatch/.

Wyoming Water Availability July 2005

Source: Wyoming Resources Data System and the U.S. Geological Survey

According to the Wyoming State Climatologist, while last month Wyoming's projected drought status improved throughout most of the state, this month it reversed (Figure 8a), in the central and south-central part of the state moved from normal to watch, and the eastern part of that area moved from a watch to a warning. The northwest corner of the state decreased drought status and moved from a warning down to a watch.

This month we introduce a new product; a map of streamflow from USGS gauges (Figure 8b). Streamflows in Wyoming are mostly in the normal range (25th – 75th percentile), according to USGS gauges, with some low flows in the north on the Snake and Powder Rivers and high flows in the southwest, especially on the Fontenelle and New Fork Rivers. The WY state climatologist, in his Drought Status Report- http://www.wrds.uwyo.edu/wrds/wsc/dtf/droughtupdate.pdf - pointed out that the USGS categorizes most of Wyoming's streamflows as in the normal range. He notes that normal flows in the mid-summer are considerably lower than normal flows in the late spring and early summer. He attributes the dry conditions in the northeastern part of the state to recent record high temperatures and evaporation.

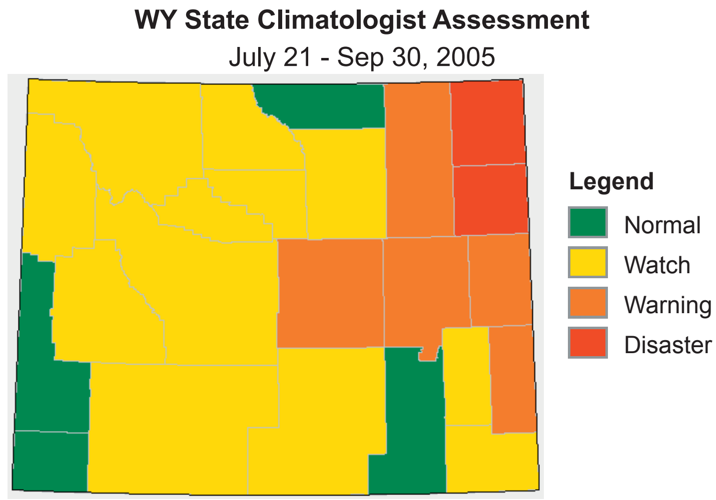


Figure 8a. Wyoming drought status. This map shows the Wyoming State Climatologist's assessment of the status of the drought throughout the state.

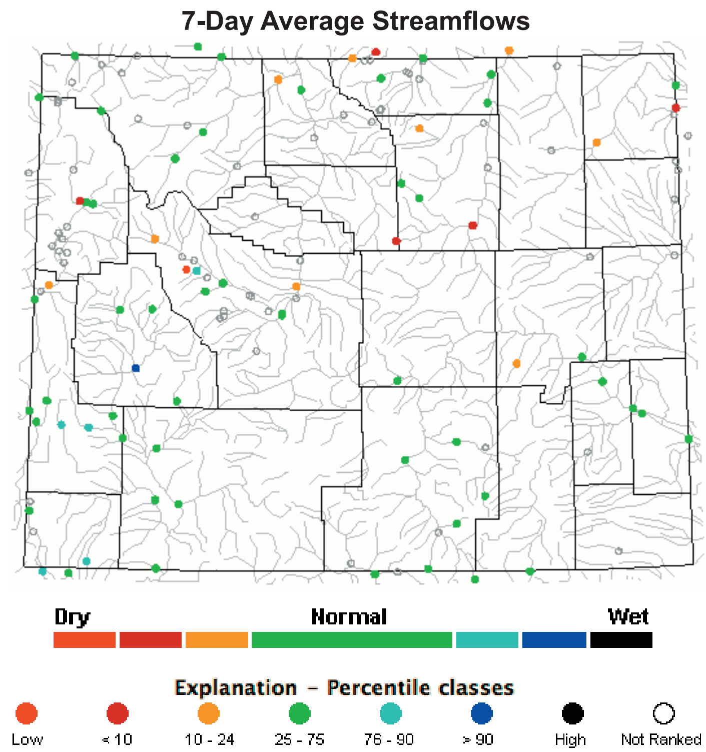


Figure 8b. Seven-day average streamflow conditions for points in Wyoming, as of July 18, 2005 computed at USGS gauging stations. The colors represent 7-day average streamflow compared to percentiles of 7-day average streamflow for July 18th.

Notes

Each state calculates their SWSI a little differently.

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

- The Wyoming 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 Wyoming Drought Status is found at: http://www.wrds.uwyo.edu/wrds/wsc/dtf/drought.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/

Utah Water Availability July 2005

Source: U.S. Geological Survey

June continued to bring precipitation to most of Utah, so despite the dry days of July, the rivers are still running strong. Almost all streamflow sites on the USGS map are normal or wet, with a few in the central/southwestern basins achieving new record high flows.

Notes

Each state calculates their SWSI a little differently.

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.

7-Day Average Streamflows

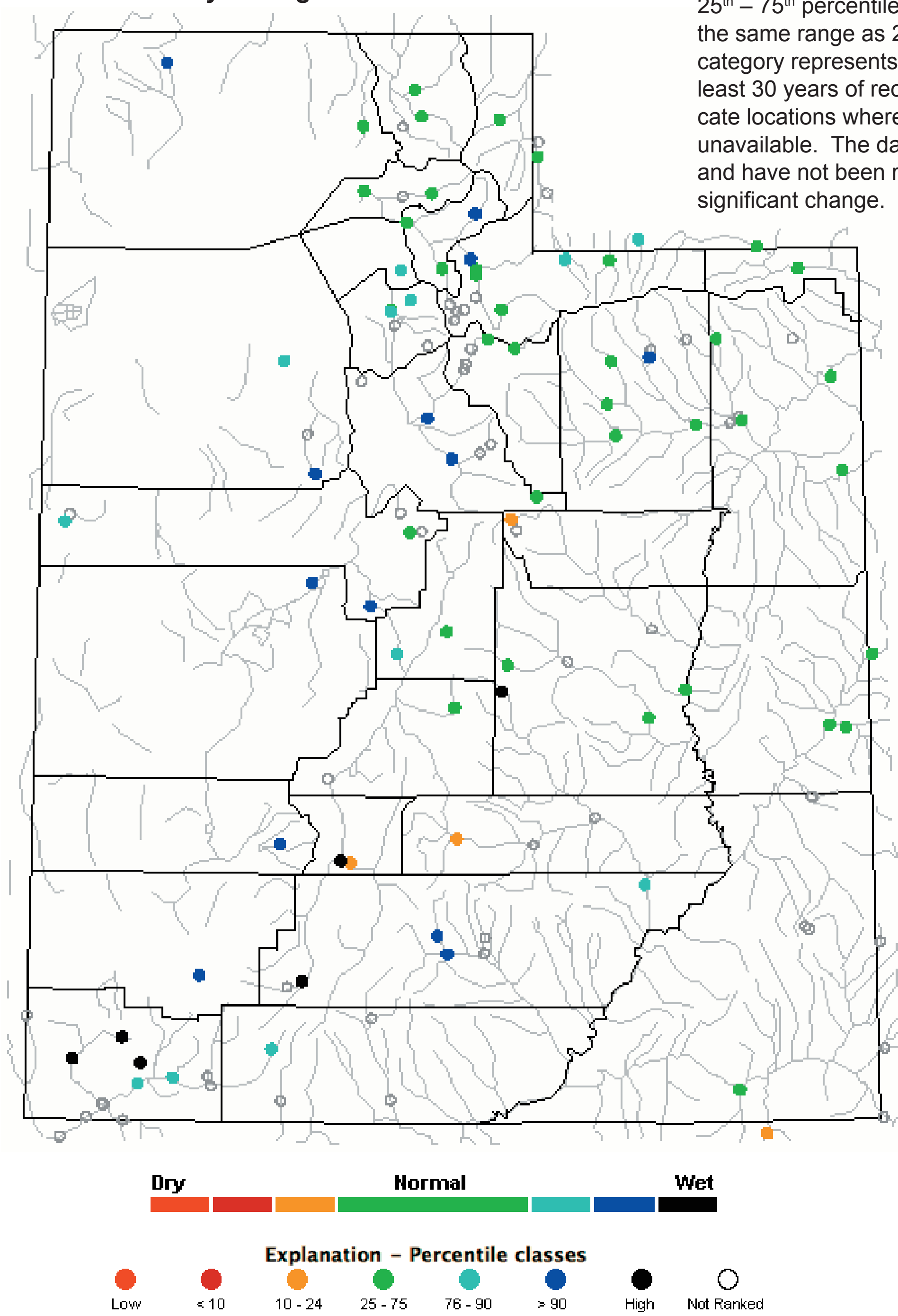


Figure 9. Seven-day average streamflow conditions for points in Utah, as of July 18, 2005 computed at USGS gauging stations. The colors represent 7-day average streamflow compared to percentiles of 7-day average streamflow for July 18th.

On the Web

- For current streamflow information from USGS, visit: http://water.usgs.gov/waterwatch/

Temperature Outlook August - December 2005

Source: NOAA Climate Prediction Center

According to the NOAA/CPC, because ENSO is weak the temperature and precipitation forecasts reflect interdecadal trend more than any other factors. The outlook for the August 2005 forecast period is based on statistical tools reflecting these trends. Most of **Utah**, **Wyoming**, and northwestern **Colorado** are projected to be above average. This means that the average temperature for the month is most likely to be in the upper third of August temperatures in the 1971-2000 climatology period (Figure 10a).

For the August-October forecast periods and beyond, there is a strong consensus among forecast tools for above normal temperatures in the Intermountain West and Southwestern U.S. in all seasons (Figure 10b). For the September-November 2005 forecast period, the risk of the seasonal average being in the upper tercile is 40-50% for **Utah** and western **Colorado**, which means that the risk of being in the lower (cooler) tercile is reduced to 13-23% from 33% (Figure 10c).

Notes

The seasonal temperature outlooks 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 degrees of temperature.

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 percent 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.

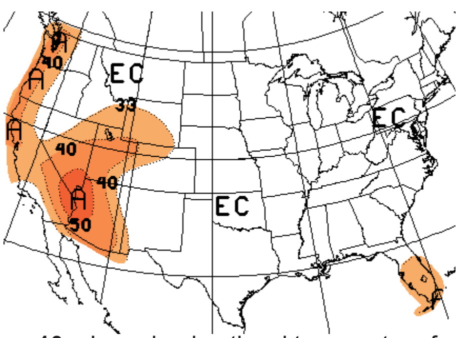


Figure 10a. Long-lead national temperature forecast for August 2005. (released July 21, 2005)

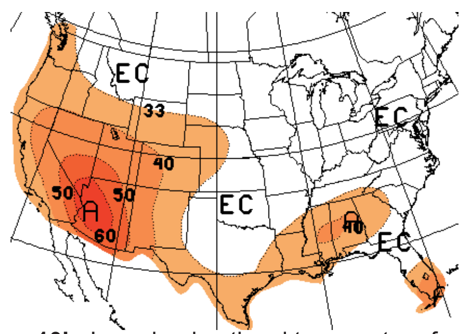


Figure 10b. Long-lead national temperature forecast for August – October 2005. (released July 21, 2005)

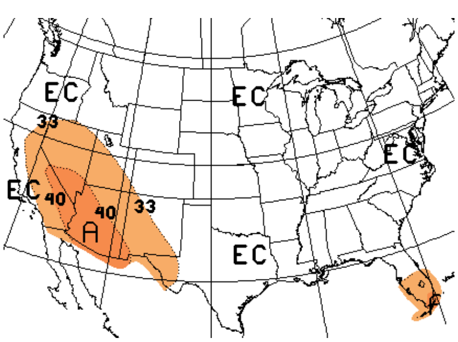


Figure 10c. Long-lead national temperature forecast for September – November 2005. (released July 21, 2005)

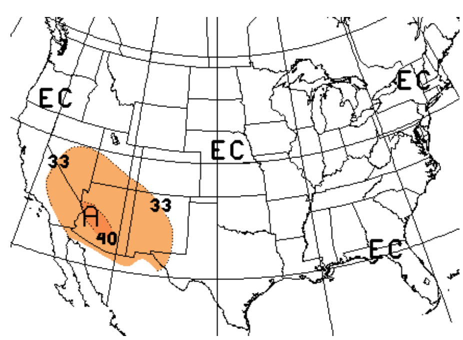


Figure 10d. Long-lead national temperature forecast for October – December. (released July 21, 2005)

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

B = Below
- 40.0–49.9%
- 33.3–39.9%

EC = Equal Chances

On the Web

- For more: http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html.
- 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 – December 2005

Source: NOAA Climate Prediction Center

The NOAA/CPC forecast tools are not able to skillfully predict any anomalies for the August 2005 forecast period (Figure 11a). While the monsoon onset in the U.S. Southwest was quite late this year, according to the NOAA/CPC, there is no known relationship between dry Julys and the rainfall in August, so the forecast map shows "EC" everywhere. Consistent with the weak monsoon so far this year, there is consensus among dynamic models for a slightly increased chance for below median precipitation amounts in the southwestern U.S. for the August-October 2005 forecast period (Figure 11b). This region includes **Utah** and western **Colorado**.

Forecast tools also are unable to make any predictions yet for the September- November 2005 forecast period (Figure 11c-d) and beyond, so the precipitation maps for those seasons are left with "EC" nearly everywhere.

Notes

The seasonal precipitation outlook in Figures 11a-d 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.

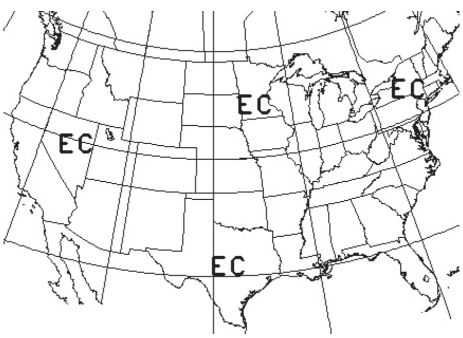


Figure 11a. Long-lead national precipitation forecast for August 2005. (released July 21, 2005)

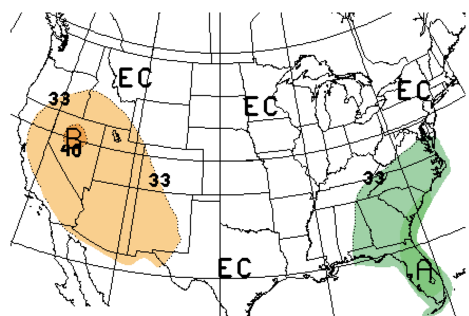


Figure 11b. Long-lead national precipitation forecast for August – October 2005. (released July 21, 2005)

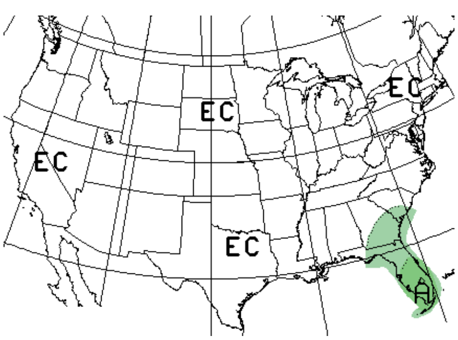


Figure 11c. Long-lead national precipitation forecast for September – November 2005. (released July 21, 2005)

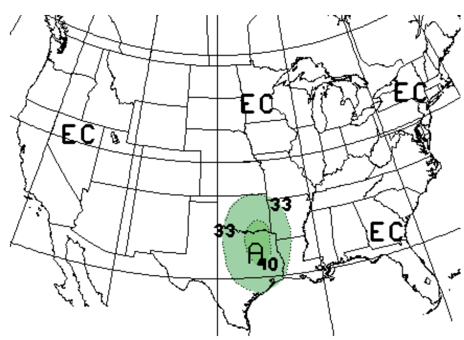


Figure 11d. Long-lead national precipitation forecast for October – December 2005. (released July 21, 2005)

A = Above
40.0–49.9%
33.3–39.9%

B = Below
40.0–49.9%
33.3–39.9%

EC = Equal Chances

On the Web

- For more: http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html.
- 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.

Seasonal Drought Outlook through October 2005

Source: NOAA Climate Prediction Center

According to the NOAA CDC, lingering moderate to severe (D1-D2) hydrologic drought is expected to persist across much of the northwest and northern Rockies, including **Wyoming** (Figure 12). Late summer and early fall are generally not the best times of the year for the significant, widespread precipitation needed to ease long term drought, except in places that may receive moisture from tropical storms. In the desert Southwest, a late start to the monsoon will result in a shortened wet season, so summer monsoon rains are not expected to substantially affect lingering drought areas. In areas dependant on the monsoon for the majority of the annual rainfall total, such as Arizona and New Mexico, this may trigger moderate drought.

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.

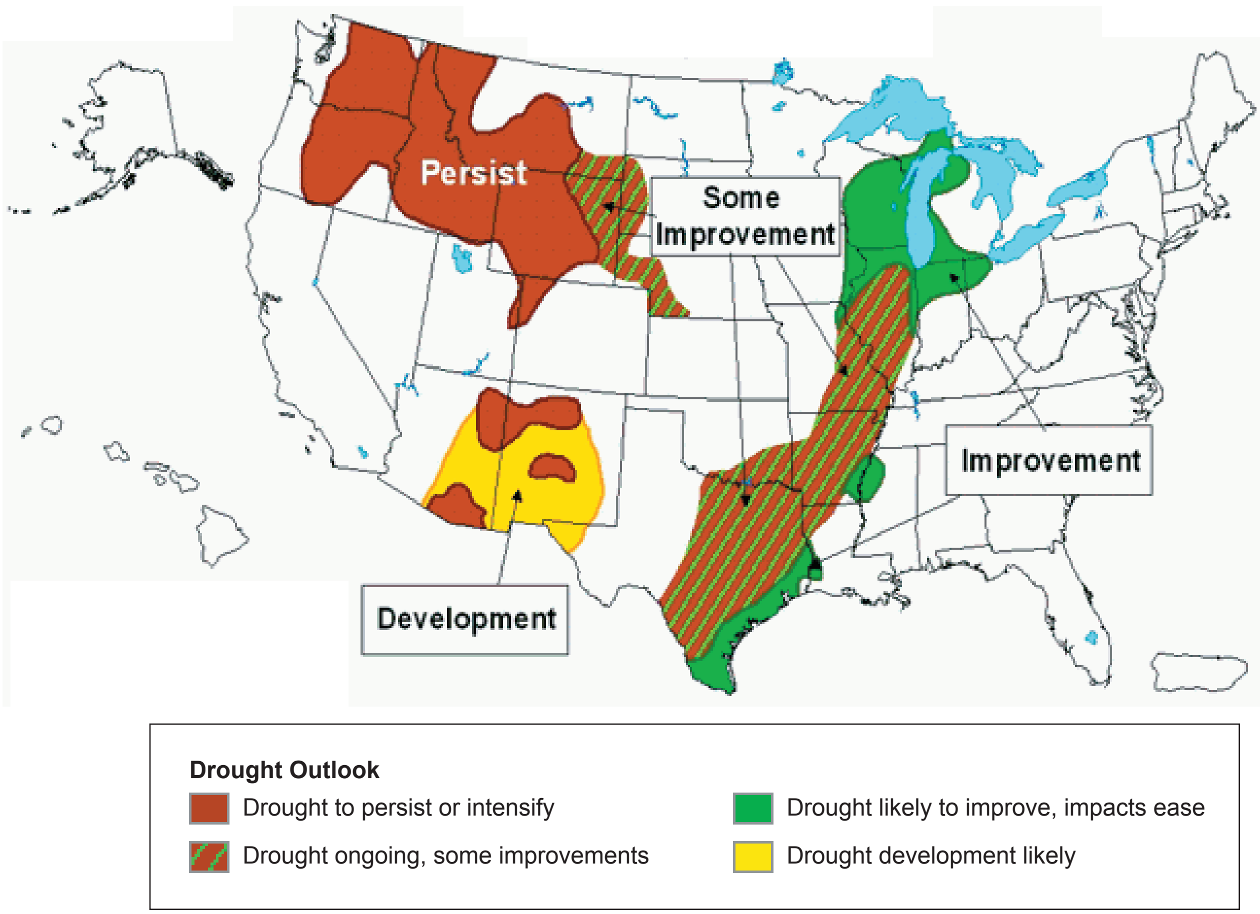


Figure 12. Seasonal Drought Outlook through September 2005 (release date July 21, 2005).

On the Web

For more information, visit: http://www.drought.noaa.gov/.

El Niño Status and Forecast

Source: NOAA Climate Prediction Center

According to the NOAA Climate Prediction Center, sea surface temperatures (SSTs) along the equator are within about ± 0.5°C of average across the Pacific (Figure 13). Other indicators of ENSO conditions are also quite close to normal: ocean temperatures in the upper 200 meters throughout the east-central equatorial Pacific, and the trade winds and convection in the equatorial pacific. Taken together, these indicators suggest that neutral ENSO conditions will likely prevail in the next few months. The consensus of several models used at CPC shows seasonal mean Niño 3.4 SST anomalies remaining close to long term averages for the remainder of the year. The projected SST anomalies are less than the NOAA definition for an El Niño: 0.5°C SST anomaly in the Niño 3.4 region for 3 months running.

While the equatorial Pacific is near normal, there are unusually warm SSTs in the subtropical Atlantic Ocean and the Caribbean Sea, that cover nearly the entire development region for Atlantic basin tropical storms. The warm SSTs are expected to further enhance the decadal signal toward active hurricane seasons. The CPC outlook for Atlantic basin tropical storms suggests a 70 percent chance of above normal tropical storm activity for the 2005 hurricane season.

Notes

Two graphics produced by NOAA show the observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean (Figure 13). 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 transmits data around the world in real-time. NOAA uses these observations to predict short-term (a few months to one year) climate variations.

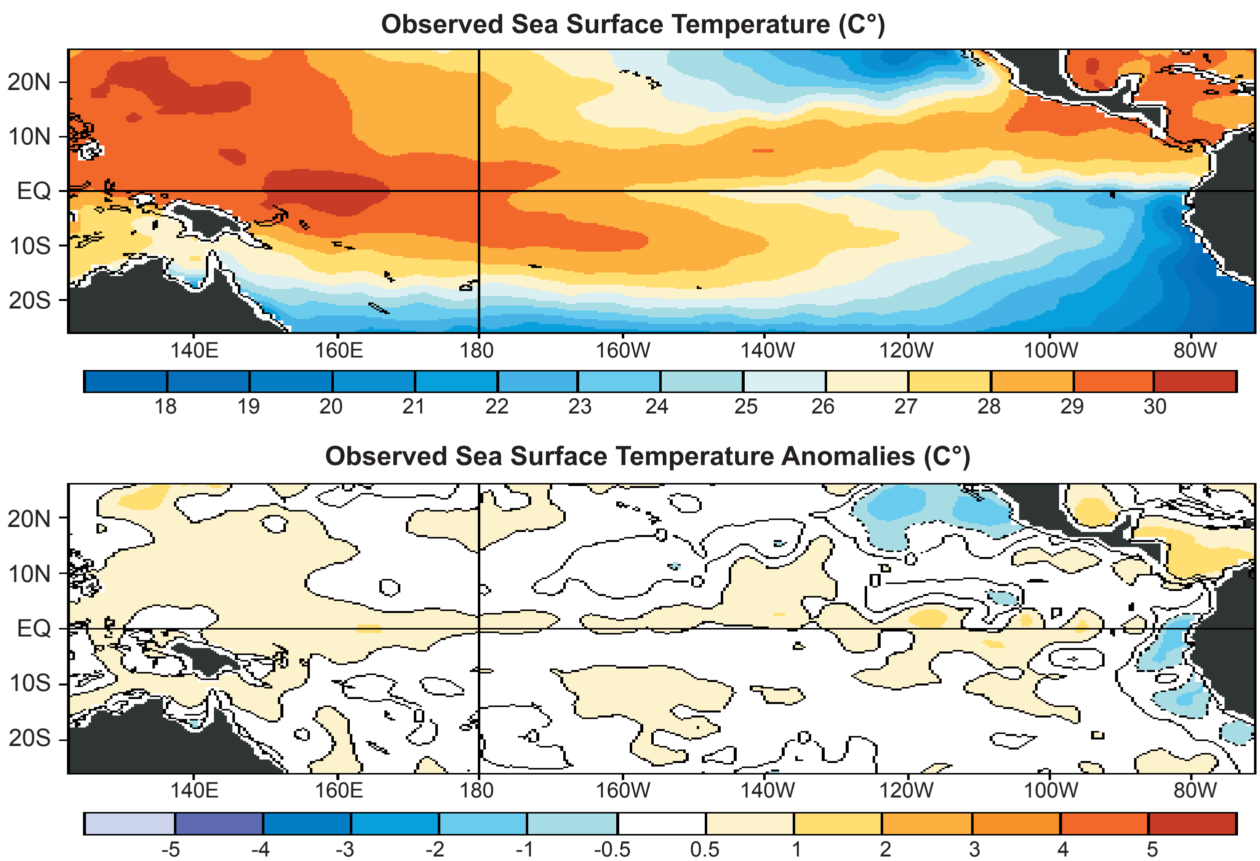


Figure 13. Two graphics showing the observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. The Niño 3.4 region encompasses the area between 120°W-170°W and 5°N-5°S. The graphics represent the 7-day average centered on July 13, 2005.

On the Web

- For a technical discussion of current El Niño conditions, visit: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/.
- For updated graphics of SST and SST anomalies, visit this site and click on “Weekly SST Anomalies”: http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml#current.
- For more information about El Niño, including the most recent forecasts, visit: http://iri.columbia.edu/climate/ENSO/.

An Overview of the Missouri Basin River Forecasting Center

By Keah Schuenemann, a graduate student in the Program in Atmospheric and Oceanic Sciences at the University of Colorado.

The NOAA National Weather Service is responsible for hydrologic forecasting throughout the nation. The Hydrologic Service Program's mission is to "save lives, reduce property damage, and contribute to the optimum use of the nation's water resources." The program accomplishes this through the thirteen River Forecast Centers throughout of the United States. (See the May Intermountain West Climate Summary for a focus on the Colorado Basin River Forecast Center.) The RFCs generate many products including flood forecasts, general river forecasts, navigation forecasts, reservoir inflow forecasts, water supply outlooks, spring flood outlooks, and flash flood guidance. In addition, the RFCs provide many other services, such as developing new forecast procedures, forecast techniques, computer systems, data handling techniques, and hydrologic-related hardware.

The Missouri Basin River Forecast Center (MBRFC) is co-located with the Weather Forecast Office in Pleasant Hill, Missouri near Kansas City. It provides hydrologic services for an area of 530,000 square miles, which includes the entire Missouri River Basin and the Saint Mary Basin in Montana. The Rocky Mountains form the western boundary, and the basin includes parts of ten states (Figure 14a) and two Canadian Provinces. In the Intermountain West region, the northeastern Colorado and central and western Wyoming are in the Missouri River basin. The major rivers that are tributaries of the Missouri in this area include the South Platte (CO), North Platte, Powder, and Big Horn (WY). These watersheds are home to the cities of the Northern Front Range. The elevation of the Missouri basin ranges from 14,000 feet above sea level at the continental divide to 2,000 feet above sea level where the Missouri River flows into the Mississippi River in Missouri. The MBRFC forecasts for 522 river and reservoir locations within an area of a total elevation fall of 3,630 feet, averaging 1.5 feet per mile.

Flooding can be a common Spring problem in the Missouri Basin due to snowmelt, ice jams, high soil moisture, and heavy precipitation. The MBRFC issues several summary products based on their gathered information and models. The Spring Outlooks discuss the potential for flooding during the spring snowmelt. The Water Supply Outlook provides water supply guidance to the region in order to plan ahead for the planting of irrigated crops, municipal water supply, reservoir operations, and to establish the length of the navigation season along the Missouri River. These outlooks, forecasts, and current data can all be found on the MBRFC web page (http://www.crh.noaa.gov/mbrfc/).

The temperature and precipitation differences across the Missouri River basin can make it difficult to forecast river flows in this region. The MBRFC uses both observation data and sophisticated models to produce streamflow guidance products. Water supplies come from both rain and snowmelt, so the MBRFC has a diverse observational network to accurately assess the water supplies at any given time in the basin. Snow cover data is used by hydrologists at the MBRFC to assess the impact of winter snow cover on spring flood potential. The observational data used in hydrological forecasting for the Missouri Basin is gathered in many different ways: ground measurements of snow depths and water equivalents, airborne flights using gamma radiation, geostationary satellite 1km resolution reflectivity data to make snow cover maps, and WSR-88D radar precipitation estimates from more than 25 sites across the basin. The forecasters then review the precipitation data for quality control and process it along with a soil

Figure 14a. This map outlines the area covered by the MBRFC and includes the locations of several major cities within the basin, including Denver, Colorado; Cheyenne, Wyoming; Lincoln and Omaha, Nebraska; Kansas City, Missouri; and many others. The MBRFC office, marked in light purple on the map, is located in Pleasant Hill, Missouri.

moisture accounting model to determine the amount of runoff from rainfall. The MBRFC uses the NWS River Forecast System hydrologic model to create runoff forecasts based on snow. Snowmelt outlooks are produced using two major meteorological scenarios: (1) melt based on future probable temperatures and "normal" future precipitation for the season; and (2) melt based on future probable temperatures and no additional precipitation (rain or snow). The rainfall and snowmelt runoff forecasts are combined to form a flow forecast for a specific point of interest along a river. The accuracy and timing of these forecasts are very important, especially in flooding situations. Water supply forecasts are coordinated with the Natural Resources Conservation Service (NRCS) in Portland Oregon, and issued monthly January through May and/or June. Each February and March, spring snowmelt outlooks are made for those areas with historical and potential snow problems. In addition to daily, monthly, and seasonal forecasts, the MBRFC will make reservoir inflow forecasts upon request. Even in non-flood periods, efficient operation of water control structures, riverside industry, and navigation depends on the accurate and timely forecasts of changes in river stages, and thus has considerable economic impact

The MBRFC provides information in the form of streamflow and flood outlooks to several federal and state agencies and to the general public on its website (Figure 14b). Specifically, the MBRFC provides guidance tailored to the needs of the National Weather Service and other federal government agencies such as the division and district offices of the U.S. Army Corps of Engineers, the Natural Resources Conservation Service, the Bureau of Reclamation, and the U.S. Geological Survey. The MBRFC website also contains other hydrologic resources and educational materials.

This article was adapted from a MBRFC publication, which can be found at http://www.crh.noaa.gov/mbrfc/compend.htm.

6-Hour Flash Flood Guidance -- July 19, 2005

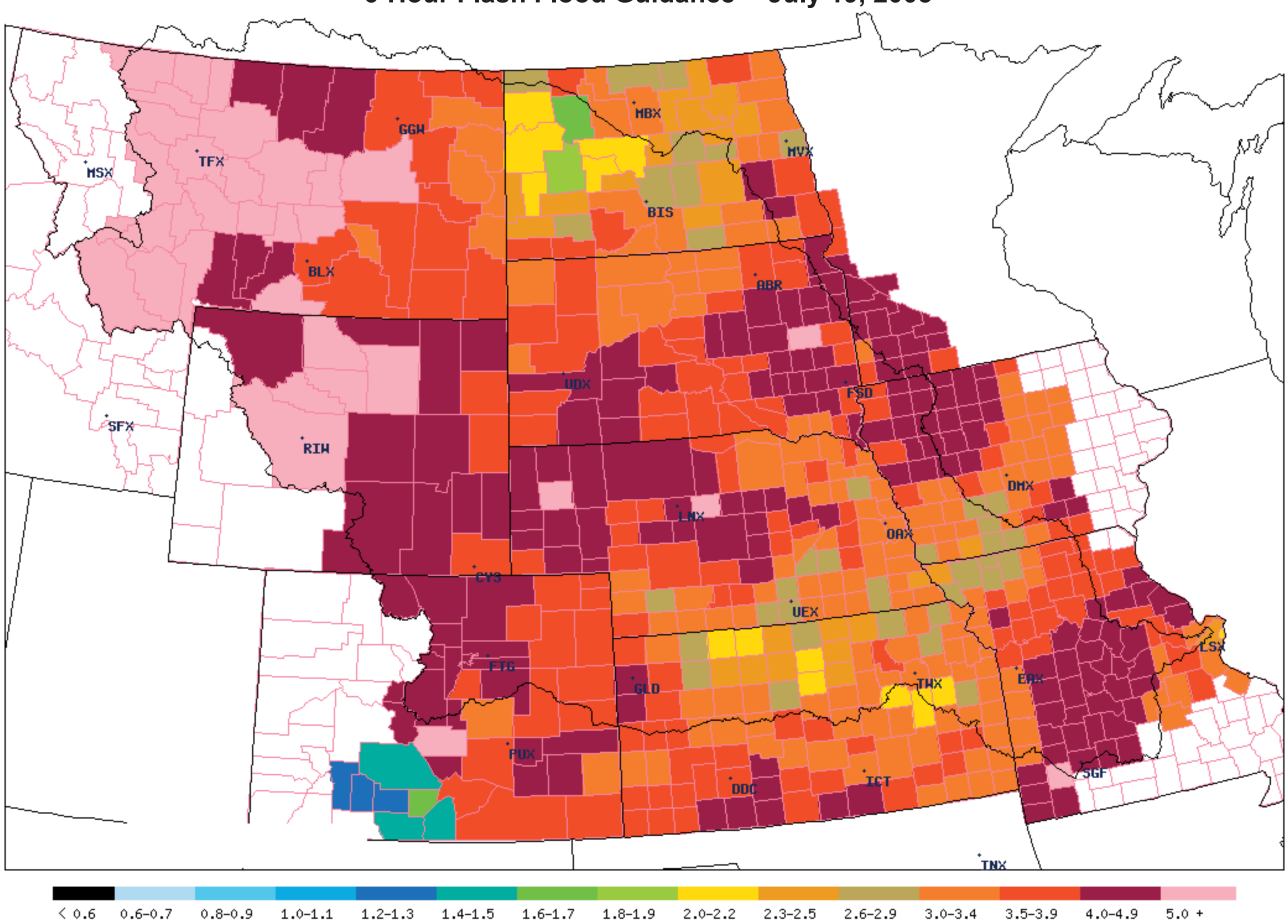


Figure 14b. This MBRFC product is a six-hour flash flood guidance map. The different colors represent 6-hour estimated rainfall totals in inches for all counties within the MBRFC region. Flash Flood Guidance products are issued twice a day by the MBRFC and then used by the Weather Forecast Offices when issuing flash flood watches and warnings to the public. This product can be found on the MBRFC website located at: http://www.crh.noaa.gov/mbrfc/wfo-ffg_files/ffg-6hr.htm

On the Web

http://www.crh.noaa.gov/mbrfc/