

# INTERMOUNTAIN WEST CLIMATE SUMMARY



by The Western Water Assessment

Issued May 11, 2005

## May 2005 Climate Summary

**Hydrological Drought** – Hydrological drought continues in much of the West even though many areas have Standardized Precipitation Indices in the normal or above normal range. This is because several years of below normal precipitation have depleted soil and groundwater as well as reservoirs, and these conditions will take more than one average-to-wet year to replenish in most areas of the Intermountain West.

**Temperature** – April temperatures were close to average for the Intermountain West region, but they seemed cold compared to the past few years when April temperatures were above average throughout the region.

**Precipitation and Snowpack** – Wyoming and Colorado's precipitation was average or below average in April, while Utah continued to receive average or above average precipitation last month. The cool temperatures in April helped maintain the snowpacks in the mountains, rather than causing an early melt as we have seen in previous years.

**El Niño** – The sea surface temperatures in the equatorial Pacific are around average, ENSO-neutral, so El Niño is not a factor in the forecasts for the upcoming summer or fall.

**Climate Forecasts** – Based on long-term trends, an increased risk of above normal temperatures is predicted across much of the western U.S. for this summer. There is a slight increase in the risk for above normal precipitation for most of Wyoming for the June-August 2005 forecast period.

## HYDROLOGIC CONDITIONS VARY ACROSS THE INTERMOUNTAIN WEST

The conditions around the Intermountain West this spring highlight that different spatial and temporal scales of climate variables can give different views of water resources conditions. In Wyoming, for example, much of the state is still in severe to exceptional drought, although April precipitation was near average in many areas and the 12-month Standardized Precipitation Index (SPI) is near normal. In Utah, local experts have declared that the drought over after a wet winter and spring. The story is mixed in Colorado: above normal precipitation for the water year in the southwestern part of the state has significantly improved



conditions, and spring storms on the Front Range have improved the Surface Water Supply Index and drought status. But the central mountains and northwestern part of the state still have precipitation deficits and reservoirs there may not fill. On the scale of the Colorado basin, the water supply outlook is improving, with inflows into Lake Powell projected to be slightly above average for the first time in seven years. However, Lake Powell will only reach 50% full under the most probable conditions, ironic given that the drought is over on its shores. This month, the products in this Climate Summary show many scales of hydrologic conditions.

## IN THIS ISSUE

- 1 May 2005 Climate Summary
- 2 Feature: Seasonal Forecasting: Skill in the Intermountain West?

## RECENT CONDITIONS

- 4 Temperature
- 5 Precipitation
- 6 U.S. Drought Monitor
- 7 Intermountain West Snowpack
- 8 Reservoir Levels
- 9 Regional Standardized Precipitation Index
- 10 Colorado Water Availability
- 11 Wyoming Water Availability
- 12 Utah Water Availability

## FORECASTS

- 13 Temperature Outlook
- 14 Precipitation Outlook
- 15 Seasonal Drought Outlook
- 16 El Niño Status and Forecast
- 17 Water Supply Forecast

## FOCUS PAGE

- 18 Overview of NOAA's Colorado Basin River Forecast Center

**On the Web:** <http://wwa.colorado.edu>

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## Seasonal Forecasting: Skill in the Intermountain West?

By Brad Udall, director of the Western Water Assessment; and Martin Hoerling, meteorologist at the NOAA Climate Diagnostics Center.

People have long been interested in outlooks of climate, as shown by the popularity of the Farmer's Almanac for over two centuries. More recently, climate scientists have been producing official climate forecasts on a regular basis. This article describes what seasonal forecasts are, the scientific basis for making forecasts, and the skill of these forecasts over the U.S. West.

A seasonal climate forecast is about the average conditions over a future period of time, rather than a prediction for a particular day. (The latter is commonly called a weather forecast.) In addition, a seasonal climate forecast is a prediction of the departure from the normal march of the seasons. So, saying that summer comes after winter is hardly a seasonal forecast! What we really wish to know is whether this summer will be abnormally hot and whether a drought will leave our crops stunted where typical summer rains normally nourish the soil.

Therein lies a most curious situation. While the daily weather much beyond two weeks is nearly impossible to predict accurately, the seasonal climate is, at times, quite predictable. The reason is that the climate system has a modest degree of memory, which is mostly imperceptible on a daily basis, but detectable in the average of seasons. Long-term temperature trends

also provide valuable clues to the future.

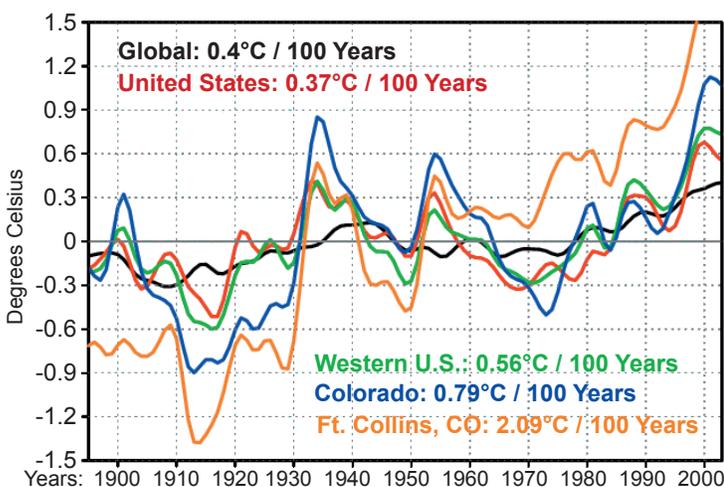
The memory of climate conditions can influence the future seasonal state of the atmosphere, and leave a definable and predictable signal. Climate memory is most prevalent in the world oceans, where cool or warm anomalies in the sea surface can take months, and sometimes years, to revert to normal. Unusual land surface conditions, such as excess spring soil moisture accumulated from heavy rains or deep early winter snow cover, may also provide memory. Climatologists have only recently fully understood the "granddaddy" of these signals, an irregular prolonged warming (or cooling) of the tropical Pacific Ocean, known as El Niño (or La Niña) or collectively as the El Niño/Southern Oscillation (ENSO). In the late 20th century, climate scientists were able to unravel the global mystery linking tropical Pacific Ocean conditions to the subsequent seasonal climate of many far-away places, including the United States. ENSO is the phenomenon that has formed the backbone of seasonal forecasting since its official inception.

**Who produces these "official" seasonal climate forecasts?** In 1995, the Climate Prediction Center (CPC), a part of NOAA's National Weather Service, began issuing seasonal climate forecasts for precipitation and temperature

each month based on dynamical and statistical forecasting techniques. CPC issues forecasts for three-month periods with lead times ranging from 0.5 to 12.5 months. For example, in mid-May, CPC will issue temperature and precipitation forecasts for June-July-August (0.5 month lead), July-August-September (1.5 month lead) and all subsequent forecasts up to June-July-August of 2006 (12.5 month lead). These forecasts rely primarily upon two critical climate processes: (1) the status of ENSO and (2) long-term upward temperature trends, which climatologists have been observing for the past several decades. In the Western U.S. especially, this trend is pronounced (see Figure 1a).

**How do we assess these forecasts?** There are two standard measures to assess the performance of forecasts, accuracy and skill. Accuracy is a measure of how close the prediction is to the observed climate variable, such as temperature or precipitation. Skill, on the other hand, measures how well one forecast performs compared to a reference or baseline forecast. Climatology is used as a typical baseline forecast, referring to the expected values of temperature, precipitation or other climate variables for a given location and time of year. Climatology is the simplest way to predict future climate, and suggests that the average temperature or precipitation is the most likely outcome, but a range of conditions that have occurred in the historical record are also possible. Skill measures the ability of a forecast method to predict conditions.

**What is the skill of CPC forecasts?** In late 2004, NOAA's Climate Services Division (CSD) evaluated the forecast skill of the ten years of CPC forecasts. NOAA CSD chief Bob Livezey and University Corporation for Atmospheric Research scientist Marina Timofeyeva performed the study, evaluating forecasts



**Figure 1a:** Temperature trends for different regions of the globe since 1900. The Western U.S. has warmed about 1°F, Colorado 1.5°F and Fort Collins about 4°F during the last 100 years. (1°C is approximately 2°F.)



on a regional basis using climatology as the baseline forecast. During 1995-2004, CPC official forecasts show skill in three distinct ways, depending on climate variable, time of year and ENSO status. First, in ENSO years, CPC forecasts are skillful at predicting *temperature* for the winter and early spring throughout the U.S. (except California). Second, in ENSO years, CPC forecasts are skillful at predicting *precipitation* for the winter and early spring in the southwestern, southeastern and northwestern U.S. (Figure 1b). Third, in non-ENSO years, CPC forecasts are skillful at predicting *temperature* for the spring, summer, and early fall in the western U.S. (Figure 1c).

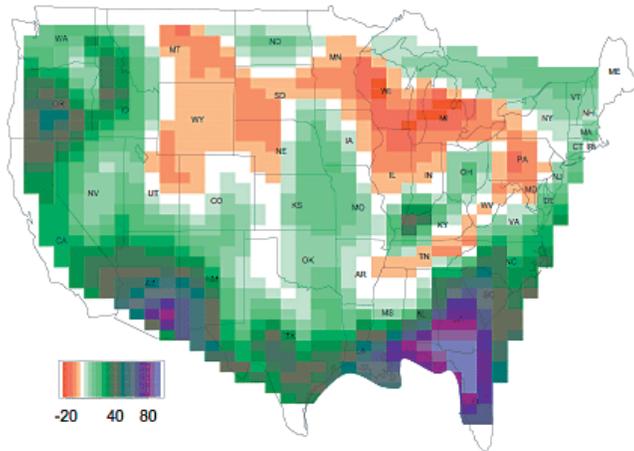
Along with demonstrating where and when CPC seasonal climate forecasts have skill, the CSD assessment also examined the times and places for which the CPC forecasts lack skill. In general, they have no skill for summer precipita-

tion and very low skill for temperature during non-ENSO years in areas outside of the western U.S. More specifically, skill in the Intermountain West region includes temperature skill in spring and summer attributed principally to trends, and some modest precipitation skill in the southernmost part of the region (central and southwestern Colorado and southern Utah), likely connected to the ENSO signal in the Southwest. This area has quite complex physical geography, which is difficult to represent in climate models.

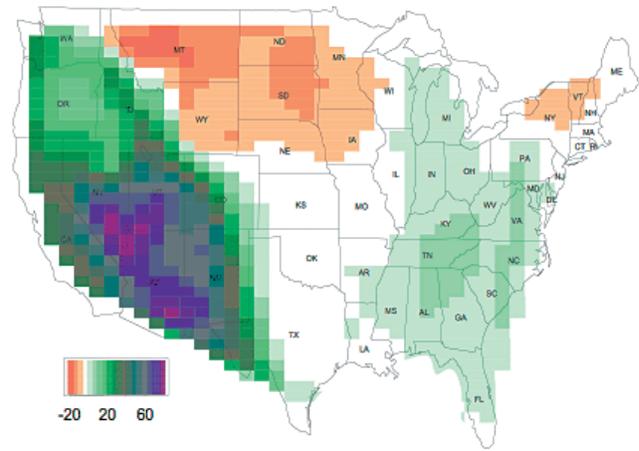
**What's the future of climate predictions?** As they say in the mutual fund industry, past performance is no guarantee for future success. The CPC forecasts evaluated have only been issued for 10 years, not enough to compile meaningful statistics, and the forecast methodologies used at CPC have evolved and will continue to evolve. In an effort to improve seasonal predictions, climatolo-

gists have been searching the globe for new climate drivers since the significance of ENSO was discovered. Researchers are combing through sea surface temperature records of the North Pacific, the South Pacific, the Atlantic, and all other oceans and seeking to understand their predictive value. Scientists are also engaged in "great archeological digs", in which climate records are being reconstructed for the entire past 1000 years using "proxies" for temperature and precipitation, such as the growth patterns of trees. However, given the current state of forecasting, not all CPC forecasts have the same skill, and users should consider these skill scores when valuing these forecasts. WWA is involved with NOAA in improving the basis for, and usability of, seasonal forecasting in the West and will continue to report on the skill of seasonal forecasting.

The diagrams below show the modified *Heidke skill score* of CPC forecasts relative to a seasonal average baseline forecast. Heidke skill scores range from negative infinity to 100 with 100 indicating perfect forecasts, zero being no improvement over the baseline forecast, and negative infinity indicating the worst possible score. A simplistic way to consider skill scores is to consider the score as a percent improvement (or decline in the case of negative skill) over the baseline forecast. Thus, a score of 20 would indicate a 20% improvement over the baseline forecast.



**Figure 1b:** Skill scores for December to April precipitation during El Niño and La Niña events, predicted at 0.5 to 6.5 months in advance. Note the strong skill in the southwest, southeast, and northwest; areas where ENSO most directly affects precipitation.



**Figure 1c:** Skill scores for February to June temperature during non-ENSO events, predicted at 0.5 to 12.5 months in advance. Note the strong skill in the western United States.

**On the Web**

- Climate Prediction Center Forecasts: <http://www.cpc.ncep.noaa.gov/products/predictions/90day/>
- Skill Study on CPC Forecast by Scientists Robert Livezey and Marina Tamofeyeva: [http://www.cpc.ncep.noaa.gov/products/outreach/proceedings/cdw29\\_proceedings/livezey.ppt](http://www.cpc.ncep.noaa.gov/products/outreach/proceedings/cdw29_proceedings/livezey.ppt)
- Australian Bureau of Meteorology website discussion about 'forecast verification' measures such as skill and accuracy: [http://www.bom.gov.au/bmrc/wefor/staff/eee/verif/verif\\_web\\_page.html](http://www.bom.gov.au/bmrc/wefor/staff/eee/verif/verif_web_page.html)



# Temperature through 4/30/05 Source: High Plains Regional Climate Center

The Intermountain West region saw April temperatures that were close to average (Figures 2b); similar to March 2005. The region was 0-2°F above average in most of Wyoming, western Colorado and southeastern Utah. It was 2-4°F below average in western Utah, central Wyoming and parts of eastern Colorado. These cooler temperatures will help to preserve the snowpack in western Utah, although melting has started. All of the average temperatures in the region were above freezing, with the exception of a few select areas in each state (Figure 2a).

April temperatures were warmer in 2004 than during this April, as the entire Intermountain West region experienced above average temperatures in April of 2004 (Figure 2c). Therefore, the snow has stayed in the mountains longer this year, rather than starting to melt out like it did in April 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-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.

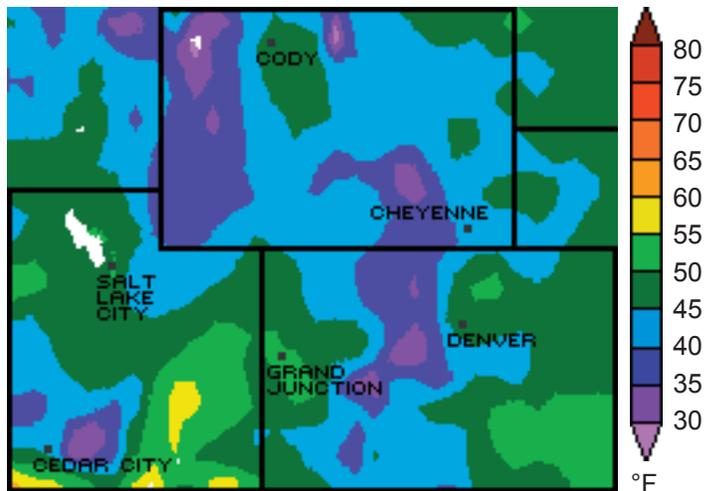


Figure 2a. Average temperature for the previous month in °F (April 2005).

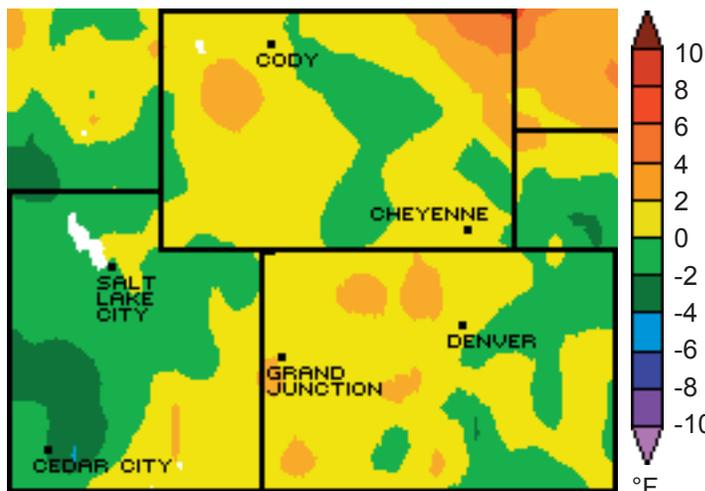


Figure 2b. Departure from average temperature for the previous month in °F (April 2005).

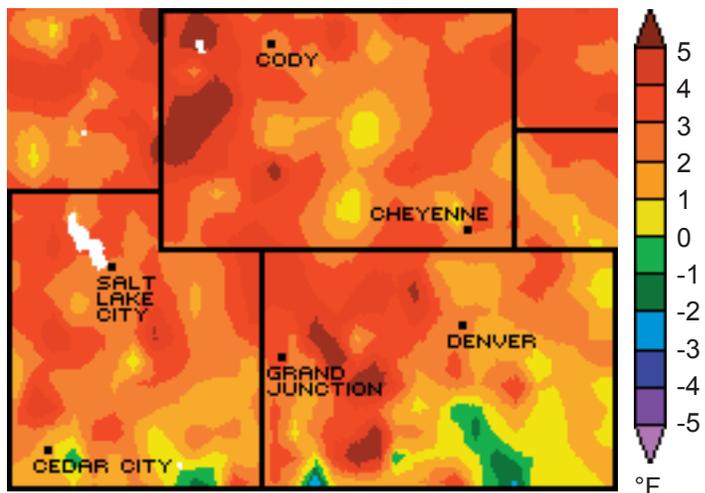


Figure 2c. Last year's departure from average temperature in °F (April 2004).

## 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>.



# Precipitation through 5/01/05

Source: NOAA Climate Diagnostic Center, NOAA Climate Prediction Center

Precipitation in the Intermountain West region falls primarily as snow in the mountains in April. However, it can be either rain or snow in the plains, depending on temperature. While this page displays precipitation totals that include both rain and snow, the snowpack levels on page 7 only reflect the snow water equivalent (SWE). In April, precipitation totals in the Intermountain West region ranged from 0.25-3 inches. (Figure 3a). While the mountainous areas of western Utah, north-central Colorado and north/northeastern Wyoming received the most precipitation in April (up to 3 inches of SWE), the eastern plains of Colorado and Wyoming had over 1 inch of rain in April as well.

Wyoming and Colorado's precipitation was average or below average again in April. The central part of both states only received 40%-80% of average precipitation. On the other hand, Utah continued to receive average or above average precipitation for April with the western and southern mountains getting 150%-200% of average precipitation. See Figure 3b.

The percent of average precipitation since the start of water year 2005 reflects the anomalously high snowfall levels in Utah and southwestern Colorado and anomalously low snowfall levels in Wyoming this winter (Figure 3c).

## 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 1996-2004. This period of record is only nine years long because it includes SNOTEL data, which has a consistent 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 Figures 3a-c come from NOAA's Climate Prediction Center, but the maps were created by NOAA's Climate Diagnostics Center, and they are updated daily (see website below). 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.

## On the Web

- For these precipitation maps, which are updated daily visit: <http://www.cdc.noaa.gov/Drought/>.
- For precipitation maps similar to the temperature maps on the previous page, visit <http://www.hprcc.unl.edu/products/current.html> and [http://www.wrcc.dri.edu/recent\\_climate.html](http://www.wrcc.dri.edu/recent_climate.html).
- 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>.

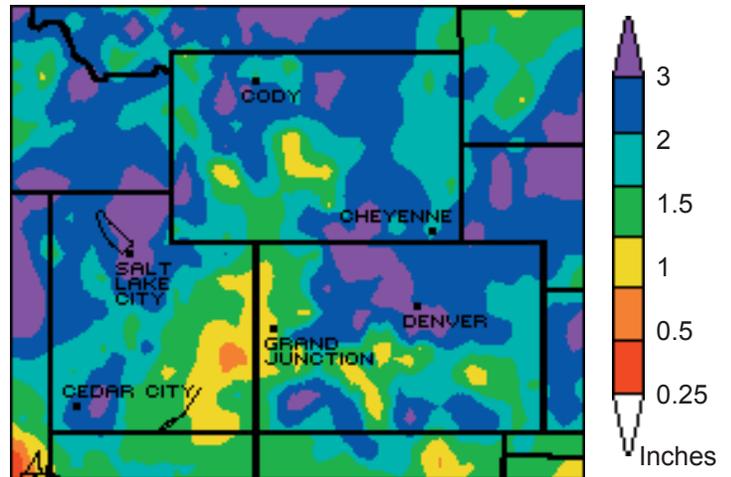


Figure 3a. Average precipitation for the previous month in inches (April 1, 2005- May 1, 2005).

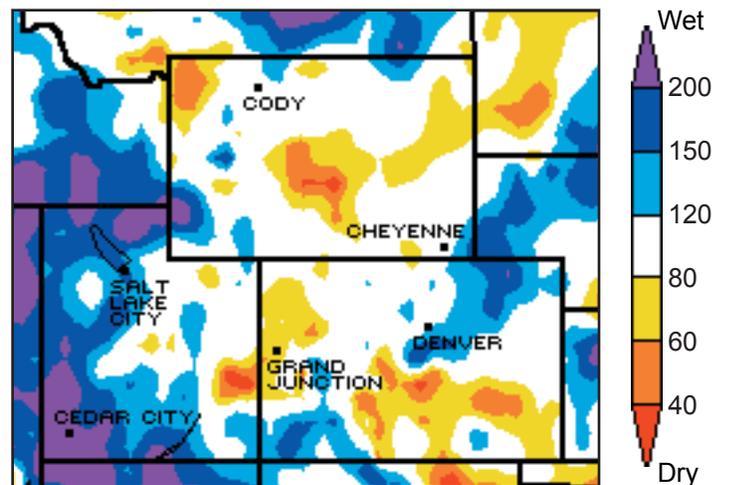


Figure 3b. Percent of average precipitation for the previous month (April 1, 2005- May 1, 2005).

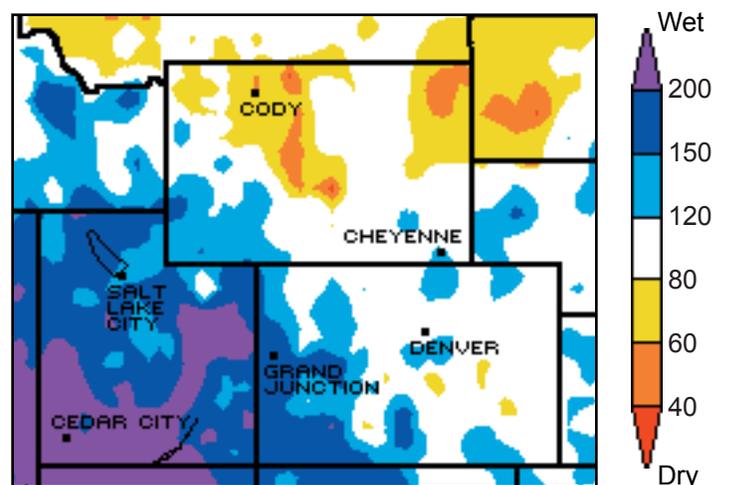


Figure 3c. Percent of average precipitation accumulated since the start of the water year (October 1, 2004- May 1 2005).



# U.S. Drought Monitor conditions as of 5/03/05

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

The Drought Monitor did not change very much in the last month, but there was limited improvement in the Intermountain West region. Continued coolness in the Rockies has helped keep remaining snow in place. Due to continued above average precipitation in April, **Utah** is no longer in a drought. In addition, southern and central **Colorado** also moved out of drought condition, and parts are in the lowest category, “abnormally dry” (D0). However, northwest Colorado remains in drought conditions, and the drought intensity remained constant in most of **Wyoming**, but the northern part of the state moved from a D4 to a D3 drought.

The Drought Monitor states, “the entire West is marked as ‘H’ indicating hydrological drought is still a concern for water supply both above and below ground.” Although many areas of the West have had precipitation this year, the several years of

low precipitation “are tough to overcome, especially for places in Wyoming, Montana and Idaho,” which have been the epicenter of this multi-year drought and have been in it the longest of any region in the West.

## 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 Mark Svoboda of the National Drought Mitigation Center.

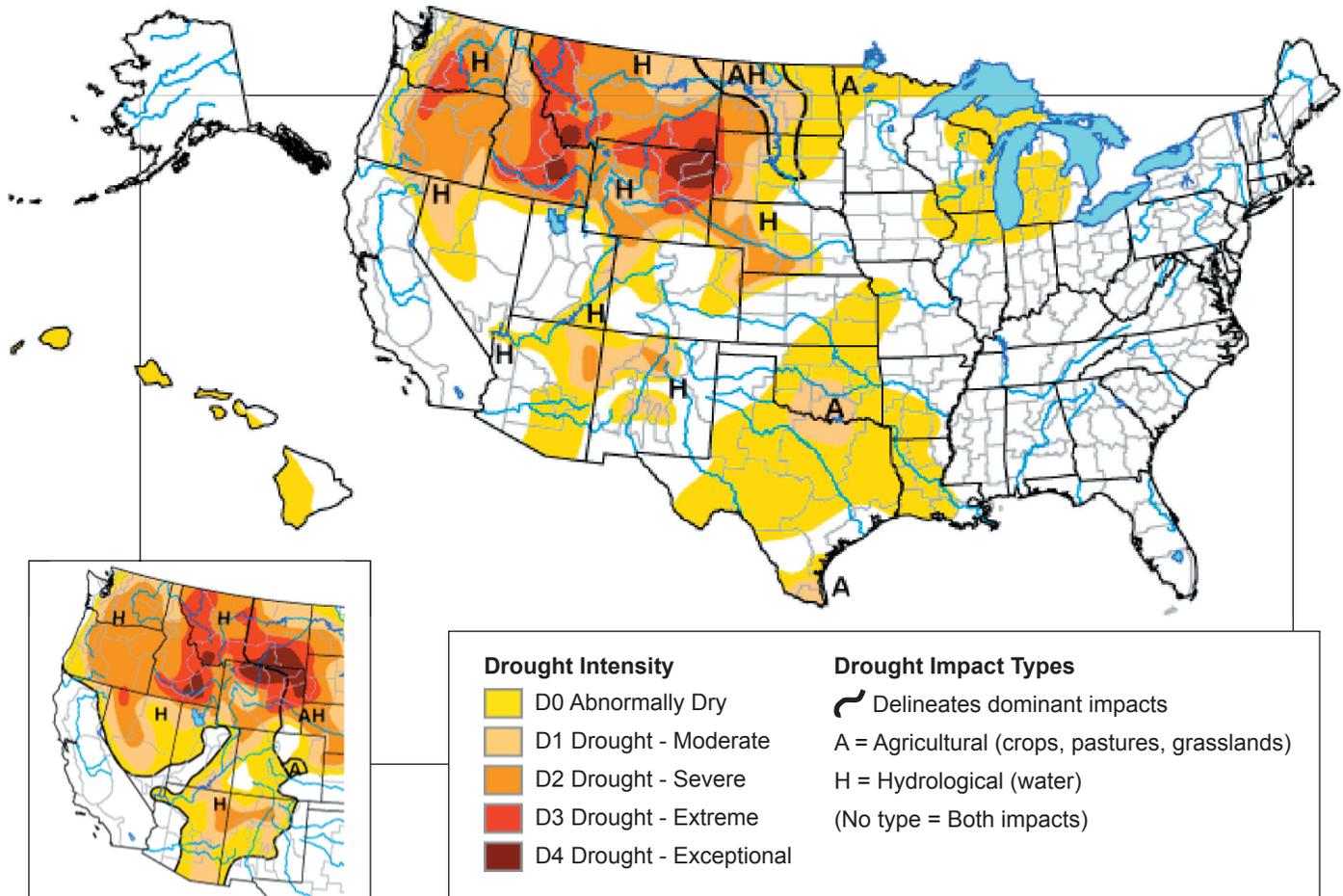


Figure 4. Drought Monitor released May 5, 2005 (full size) and last month April 7, 2005 (inset, lower left) for comparison.

## On the Web

For the most recent drought monitor, visit: <http://www.drought.unl.edu/dm/monitor.html>. This site also includes archives of past drought monitors.



## Intermountain West Snowpack released 5/05/05

Source: USDA Natural Resources Conservation Service (NRCS) Water and Climate Center

**Colorado** snowpack percentages did not change very much from last month. Basins in the south and southwest remain from 110%-180% above normal. The Upper Colorado, South Platte and Arkansas basins remain below average at 70%-90% of average snowpack, even though precipitation was above average for the month in some areas (see page 5 for recent precipitation).

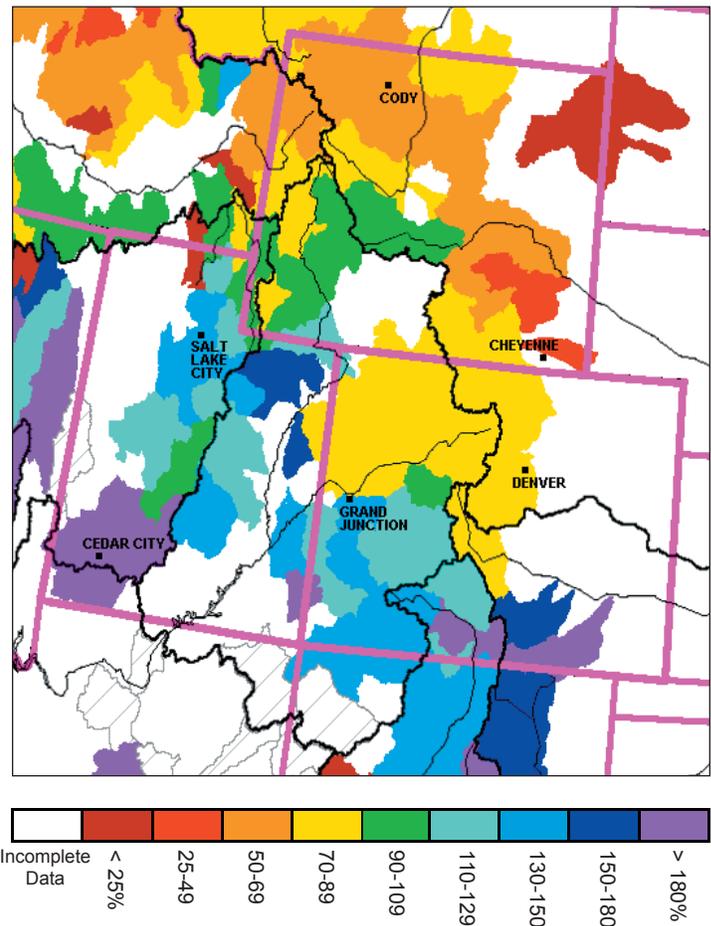
**Utah's** snowpack is similar to last month due to average snowfall in April. Snowpack levels range from 102% in the Bear River basin to 294% in southwest Utah. According to the NRCS, lower elevation snowpacks are already starting to melt, and they continue to warn of likely spring flooding in southern Utah and the Uintah basin. See page 17 for water supply forecasts.

Most of **Wyoming's** snowpack is below average and they received average or below average precipitation in April, but snowpack levels have slightly increased as a percent of average, according to the NRCS. The biggest improvement was in the southwestern part of the state where snowpack levels went from 40%-50% of average to 90%-110% of average.

### Notes

Snow water equivalent (SWE) or snow water content (SWC) is determined by measuring the weight of snow on a "pillow" (like a very large bathroom scale) at the SNOTEL site. Knowing the size of the pillow and the density of water, SWE is then calculated from the weight measurement. SWE depends mainly on the density of the snow, and it refers to the depth of water that would result by melting the snowpack at the measurement site. Given two snow samples of the same depth, heavy, wet snow will yield a greater SWE than light, powdery snow. SWE is important in estimating runoff and streamflow. Snowpack telemetry (SNOTEL) sites are automated stations operated by NRCS that measure snowpack. In addition, SWE is measured manually at other locations called snow courses. (See page 17 for streamflow outlooks.)

Figure 5 shows the SWE based on SNOTEL and snow course sites in the Intermountain West states, compared to the 1971-2000 average values. The number of SNOTEL or snow course sites varies by basin. Individual sites do not always report data due to lack of snow or instrument error, these basins with incomplete data are designated in white on the map.



**Figure 5.** Snow water equivalent (SWE) as a percent of average for available monitoring sites in the Intermountain West as of May 1, 2005.

### On the Web

For graphs like this and snowpack graphs of other parts of the western U.S., visit:  
[http://www.wcc.nrcs.usda.gov/snowcourse/snow\\_map.html](http://www.wcc.nrcs.usda.gov/snowcourse/snow_map.html).

For snow course and SNOTEL data updated daily, please visit one of the following sites:

- River basin data of SWE and precipitation: <http://www.wrcc.dri.edu/snotelanom/snotelbasin>.
- Individual station data of SWE and precipitation for SNOTEL and snow course sites:  
[http://www.wcc.nrcs.usda.gov/snowcourse/snow\\_rpt.html](http://www.wcc.nrcs.usda.gov/snowcourse/snow_rpt.html) or <http://www.wcc.nrcs.usda.gov/snotel/>.
- Graphic representations of SWE and precipitation at individual SNOTEL sites:  
<http://www.wcc.nrcs.usda.gov/snow/snotel-data.html>.



# Reservoir Status

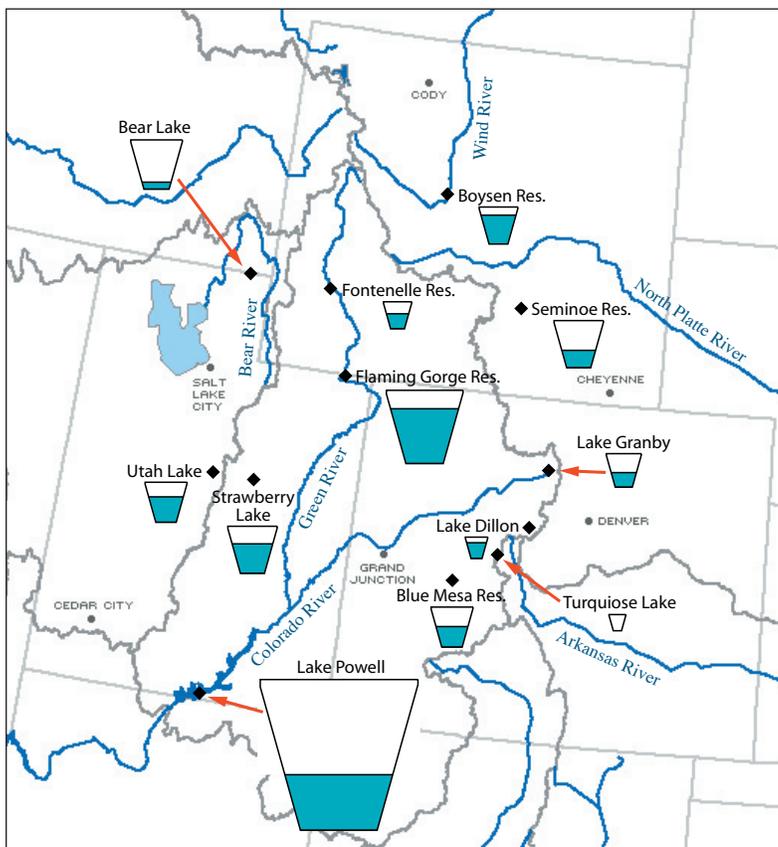
Source: Denver Water, U. S. Bureau of Reclamation, Natural Resources Conservation Service and Central Utah Water Conservancy District

In April and early May, many reservoirs are near their low point for the year due to the seasonal nature of reservoir storage. The majority of inflows to most western reservoirs is from snowmelt in April-July. Releases are made through the year, and in the spring, reservoirs are low to catch the spring runoff and mitigate possible spring flooding. Thus, the current % capacity of many reservoirs is still low. In contrast to recent years, many reservoirs in the region are projected to fill, such as Blue Mesa on the Gunnison River. However, the regions largest reservoir, Lake Powell, stands at about 37% of capacity, and will only reach about 50% capacity this summer under the most probable runoff conditions. Although Lake Powell does not directly serve

the Upper Colorado basin, it provides the storage to meet Upper Basin obligations to the Lower Colorado basin. Because of continued low storage, many Upper basin water managers are uneasy about the potential for a future call on the Colorado River.

## Notes

The size of each “tea-cup” is proportional to the size of the reservoir, as is the amount the tea-cup is colored in. The data is in acre-feet; the first is the current contents, or amount of water in the reservoir and the second number is the total capacity of the reservoir. The percentage shown is the current contents divided by the total capacity, it is NOT the percent of average water in the reservoir for this time of year.



Reservoir	Current Water (KAF)	% Full	Total Capacity (KAF)
<b>Colorado</b>			
Blue Mesa Res.	373.1	45%	829.5
Lake Dillon	198.9	78%	254.0
Lake Granby	205.6	38%	539.8
Turquoise Lake	no data	no data	129.4
<b>Utah</b>			
Bear Lake	121.7	9%	1,302.0
Lake Powell	8,602.8	35%	24,322.0
Strawberry Lake	727.4	66%	1,106.5
Utah Lake	582.4	67%	870.9
<b>Wyoming</b>			
Boysen Res.	629.2	85%	741.6
Flaming Gorge Res.	2,916.9	78%	3,749.0
Fontenelle Res.	175.3	51%	344.8
Seminole Res.	355.3	35%	1,017.3

KAF = Thousands of Acre Feet

Figure 6. Tea-cup diagram of several large reservoirs in the Intermountain West Region.

## On the Web

- Lake Dillon, operated by Denver Water [“check res. levels” pdf]: <http://www.water.denver.co.gov/indexmain.html>
- Turquoise Lake, Lake Granby, Boysen Reservoir, and Seminole Reservoir, operated by the U.S. Bureau of Reclamation (USBR) – Great Plains Region: [http://www.usbr.gov/gp/hydromet/teacup\\_form.cfm](http://www.usbr.gov/gp/hydromet/teacup_form.cfm)
- 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](http://www.usbr.gov/uc/wcao/water/basin/tc_cr.html)
- Strawberry Lake, 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](http://www.wcc.nrcs.usda.gov/cgibin/resv_rpt.pl?state=utah)



# Regional Standardized Precipitation Index released 5/04/2005

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

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 7) reflects precipitation patterns over the past 12 months (through the end of April 2005) compared to the average precipitation of the same 12 consecutive months during all the previous years of available data.

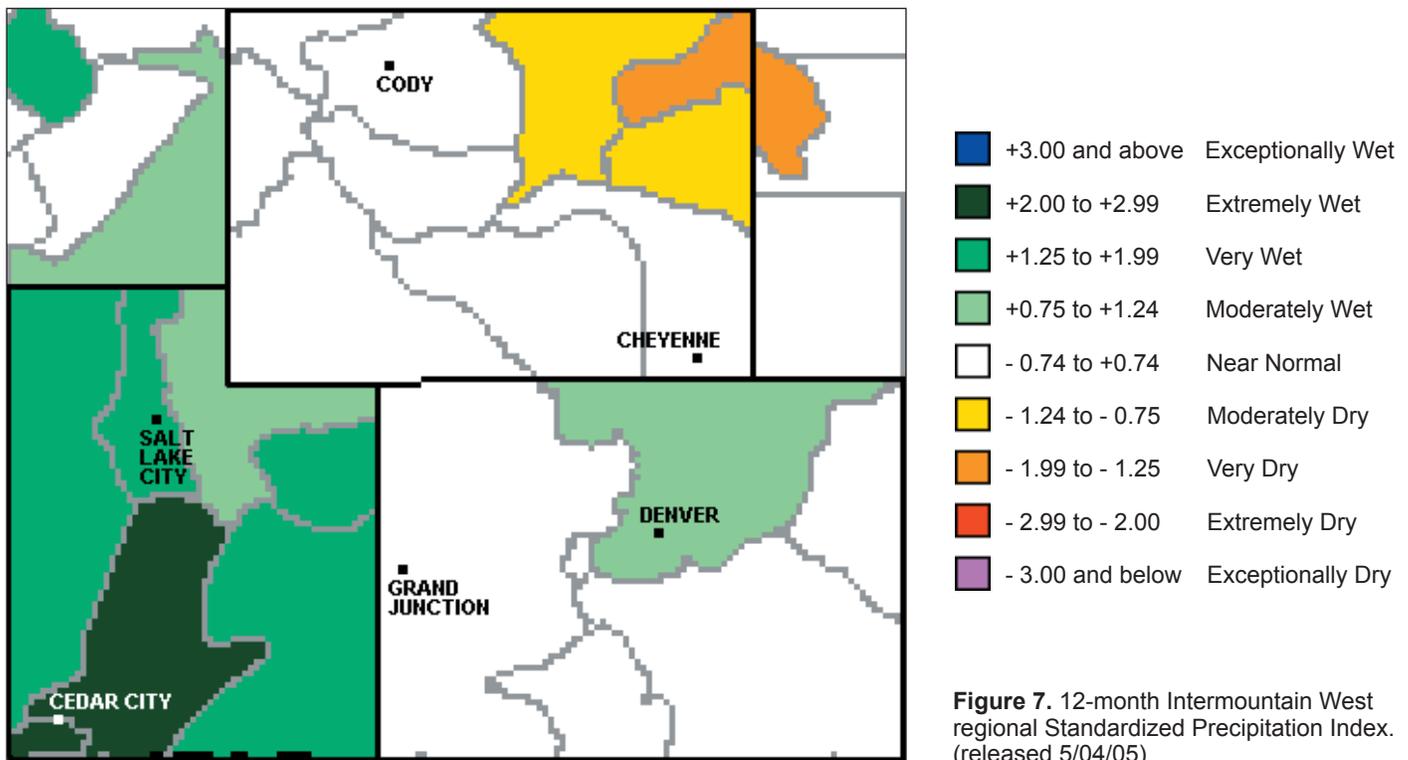
The 12-month SPI for the Intermountain West region ranges from very dry in northeast Wyoming, to extremely wet in southern Utah. Most of Colorado is in the near normal range. However, this reflects a shift from the moderately wet conditions that the western and southeastern parts of the state were in last month. Wyoming SPI is mostly in the normal range, with the exception of the northeast, which is very dry. However, the Cheyenne basin in the northeast went from moderately dry last month to near normal this month. The dry conditions in Wyoming are due to the lower than normal snowfall this winter in addition to the low lev-

els of precipitation for that area for the entire past year. Finally, Utah has seen record high levels of snow this winter, boosting its SPI despite a dry summer in 2004. In April, however, the SPI decreased in southeastern, western and north-central Utah, but the state remains on the wet side.

## 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. 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.



**Figure 7.** 12-month Intermountain West regional Standardized Precipitation Index. (released 5/04/05)

## 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 released 5/11/2005

Source: Colorado Division of Water Resources, State Engineer and USDA Natural Resources Conservation Service.

While the SPI uses precipitation to calculate a drought severity index, the Surface Water Supply Index (SWSI) is another useful measure of water availability related to streamflows, reservoir levels, and even groundwater levels.

Water availability status varies widely across Colorado in May 2005, as shown by the gradient in SWSI (Figure 8). The Southwestern and Rio Grande basins are in the near normal to abundant supply range, while the South Platte and Arkansas basins are below 0, but still in the near normal range. The Yampa/White basin has the lowest water availability, with values in the moderate drought range.

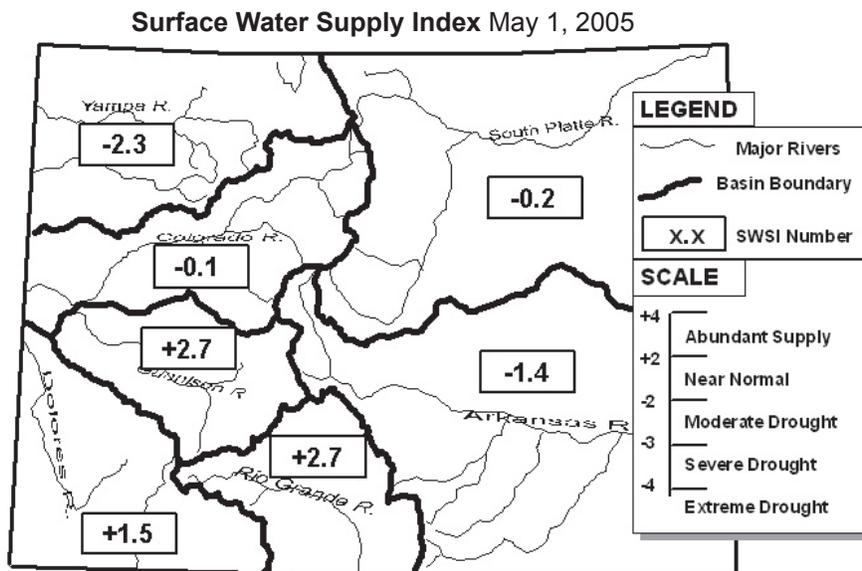
In the Colorado River basin and northwestern basins, snowpack and predicted runoffs are below average. According to a press release on May 5<sup>th</sup> from the Upper Colorado River Endangered Fish Recovery Program (Recovery Program), a voluntary program to provide enhanced spring peak river flows for endangered fish is not feasible this spring due to the below average reservoir levels caused by the current drought. Owners and operators of Upper Colorado River Basin reservoirs above

Palisade, Colorado must capture all available incoming river flows to rebuild storage that has decreased significantly during the last several years of prolonged drought. Snowpack and runoff forecast projections are below average to the point that most reservoirs will either just fill or be short of full. The recent sustained drought has resulted in the augmentation of spring peak flows during only three of the last 10 years since the program was implemented.

### 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 is based on snowpack, reservoir storage, and precipitation for the winter period (November through April). During the winter period, snowpack 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 8 were computed for each of the seven major basins in Colorado for May 1, 2005, and reflect conditions during the month of April 2005.



**Figure 8.** Colorado Surface Water Supply Index. The map shows the projected streamflows by basin for spring and summer 2005, based on current conditions as of May 1. (released 5/11/05)

### On the Web

- For the current SWSI map, visit: <http://www.co.nrcs.usda.gov/snow/watersupply/>.
- For the latest "Colorado Water Supply Conditions" Report from the State Engineer, go to: <http://water.state.co.us/pubs/swsi.asp>.
- The Colorado Water Availability Task Force's next meeting is tentatively scheduled for May 12th at the Colorado Department of Wildlife headquarters in Denver. Agendas and minutes of this and previous meetings are available at: [http://www.cwcb.state.co.us/owc/Drought\\_Planning/Agendas/Agendas.htm](http://www.cwcb.state.co.us/owc/Drought_Planning/Agendas/Agendas.htm)



# Wyoming Water Availability released 5/10/2005

Source: USDA Natural Resources Conservation Service

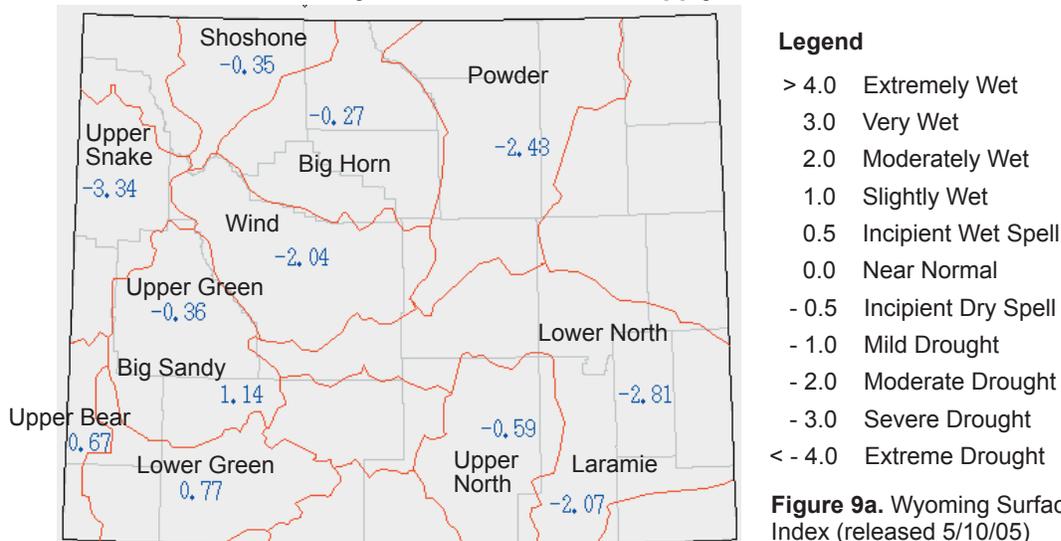
Most of Wyoming’s river basins have below normal surface water supplies (Figure 9a). Nevertheless, almost all basins had an improvement in their surface water supply values during the month of April due to some additional precipitation. The greatest increases were in the north-central mountains where the Big Horn improved from -1.64 (mild drought category) to -0.27 (near normal) and the southeastern plains, where the Laramie basins improved from -4.17 (extreme drought) to -2.07 (moderate drought).

According to the Wyoming State Climatologist, two counties in northeast Wyoming are in drought disaster status, counties along a northwest to south east swath are in drought warning, and the rest of the state is under drought watch or normal (Figure 9b).

## Notes

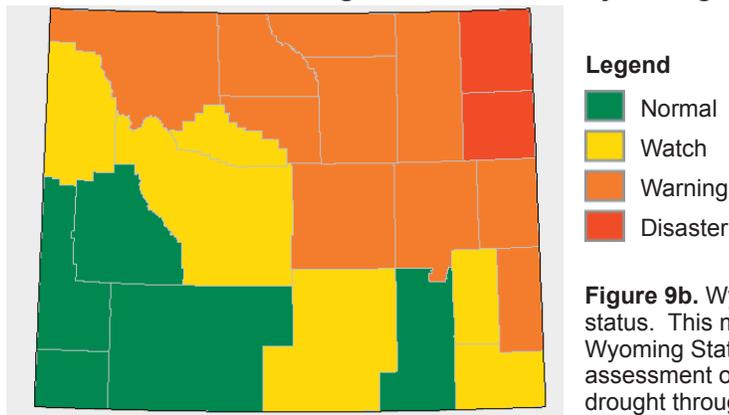
**Each state calculates their SWSI a little differently.**  
 From the WY NRCS site: “The Surface Water Supply Index (SWSI-Figure 9a) is computed using only surface water supplies for the drainage. The computation includes reservoir storage, if applicable, plus the forecast runoff. The index is purposely created to resemble the Palmer Drought Index, with normal conditions centered near zero. Adequate and excessive supply has a positive number and deficit water supply has a negative value. Soil moisture and forecast precipitation are not considered as such, but the forecast runoff may consider these values.” The Drought Status (Figure 9b) is calculated by the Wyoming state climatologist, based on snow water equivalent and other data.

**May 2005 Surface Water Supply Index Values**



**Figure 9a.** Wyoming Surface Water Supply Index (released 5/10/05)

**WY State Climatologist Assessment: May 4 - Aug 31, 2005**



**Figure 9b.** Wyoming drought status. This map shows the Wyoming State Climatologist’s assessment of the status of the drought throughout the state.

## On the Web

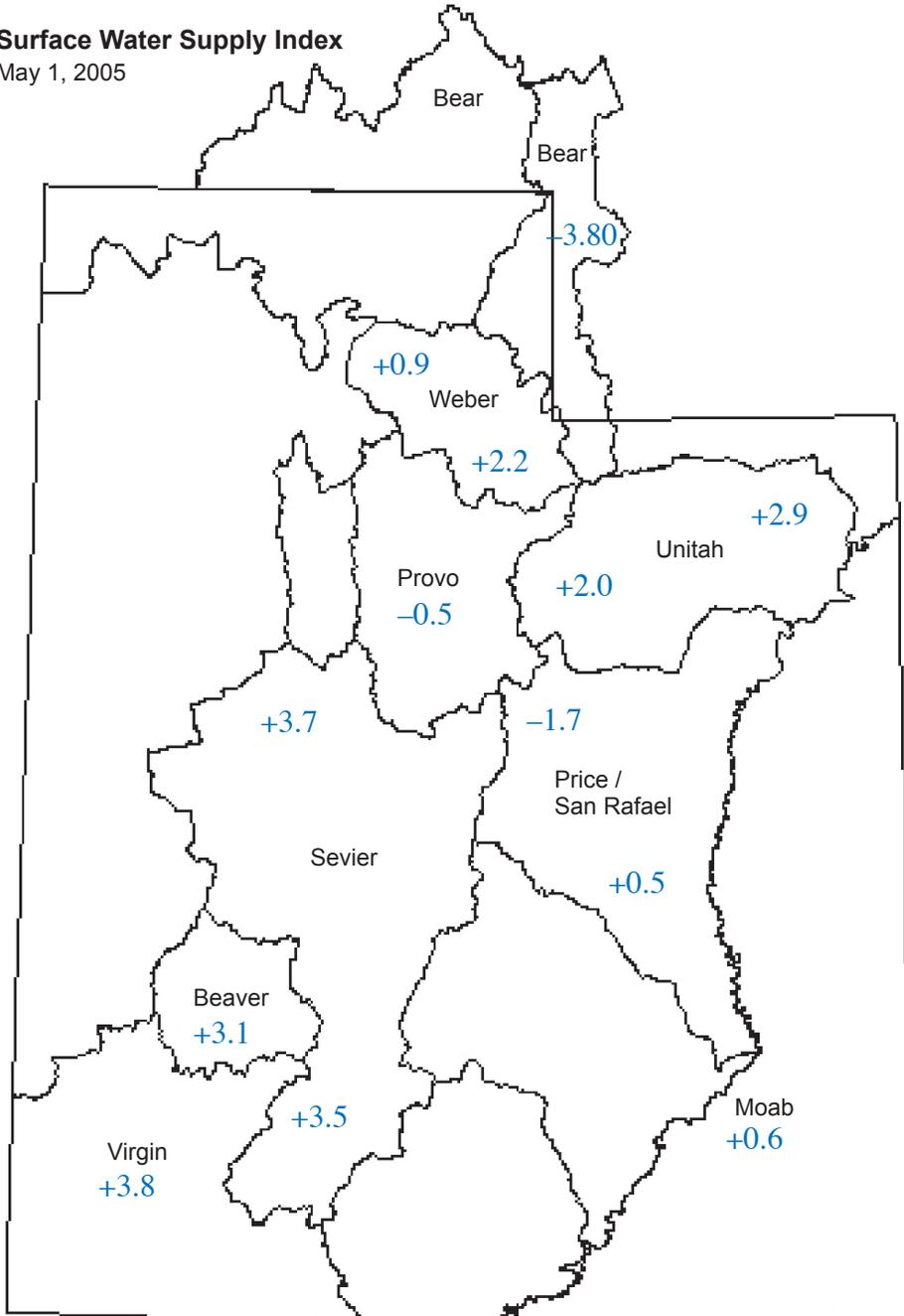
- The Wyoming SWSI, along with more data about current water supply status for the state can be found at: <http://www.wrds.uwyo.edu/wrds/nrcs/nrcs.html>.
- The Wyoming Drought Status is found at: <http://www.wrds.uwyo.edu/wrds/wsc/df/drought.html>
- The Palmer Drought Index is found on NOAA’s drought page: [www.drought.noaa.gov](http://www.drought.noaa.gov).



# Utah Water Availability released 5/04/2005 Source: USDA Natural Resources Conservation Service

The Salt Lake City Tribune declared, “The drought is over, time for a flood?” in Utah, after a wet winter and spring (April 12, 2005, [http://www.sltrib.com/search/ci\\_2645702](http://www.sltrib.com/search/ci_2645702)). A Salt Lake NWS hydrologist says, “We’ve got good snowpack, good soil moisture and we’re going to fill the reservoirs.” The Utah SWSI is similar to last month, with a slight decrease in conditions towards dry in north-central Utah. Four of the river basins in southwest Utah (Upper Sevier, Lower Sevier, Beaver and Virgin) are approaching ‘abundant supply’ due to anomalously high snowpacks this winter (Figure 10). All the other basins have a SWSI above zero with the exception of the Price and Provo Rivers that are below average and the Bear River, which is approaching ‘extremely dry’ conditions.

## Surface Water Supply Index May 1, 2005



## Notes

**Each state calculates their SWSI a little differently.**

From the UT NRCS: “The Surface Water Supply Index (SWSI) is a predictive indicator of total surface water availability within a watershed for the spring and summer water use seasons. The index is calculated by combining pre-runoff reservoir storage (carryover) with forecasts of spring and summer streamflow, which are based on current snowpack and other hydrologic variables. SWSI values are scaled from +4.1 (abundant supply) to -4.1 (extremely dry) with a value of zero (0) indicating media water supply as compared to historical analysis. SWSI’s are calculated in this fashion to be consistent with other hydroclimatic indicators such as the Palmer Drought Index and the [Standardized] Precipitation Index.” See page 9 for the SPI.

## Legend

- +4.1 abundant supply
- 0 water supply is comparable to historical average
- 4.1 extremely dry

**Figure 10.** Utah Surface Water Supply Index (released 5/04/05).

## 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](http://www.drought.noaa.gov).



# Temperature Outlook May – September 2005

Source: NOAA Climate Prediction Center, NOAA Diagnostics Center

The long-lead temperature outlooks from the NOAA Climate Predictions Center (CPC) have not changed significantly since last month. The outlooks indicate an increased probability of above normal temperatures in most of the southwestern U.S., and parts of the Intermountain West for the May and May-July forecast periods, and for forecast periods through September 2005 (Figures 11a-d), although the areas covered vary somewhat. This forecast is consistent with an observed trend towards higher temperatures across much of the Western U.S., which is a large part of the basis for the seasonal forecast. In general due to the strong trend, the temperature forecast skill is very high and may be the most certain of all the projections for the upcoming year.

## 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.

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.

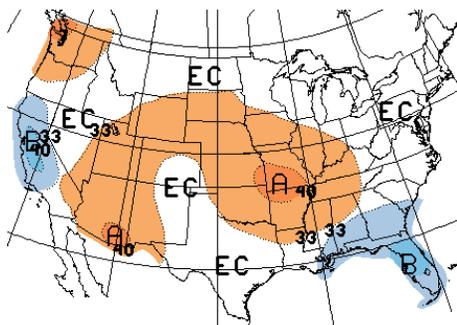


Figure 11a. Long-lead national temperature forecast for May 2005. (released April 30, 2005)

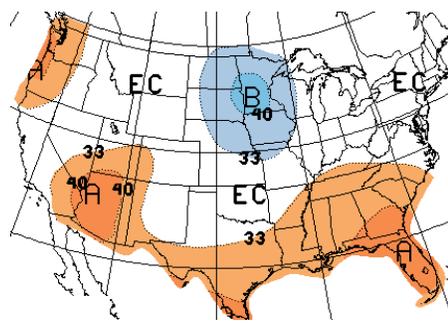


Figure 11b. Long-lead national temperature forecast for May – July 2005. (released April 21, 2005)

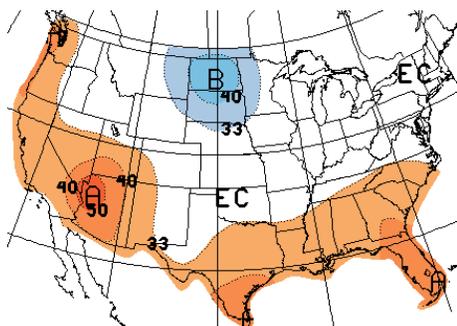


Figure 11c. Long-lead national temperature forecast for June – August 2005. (released April 21, 2005)

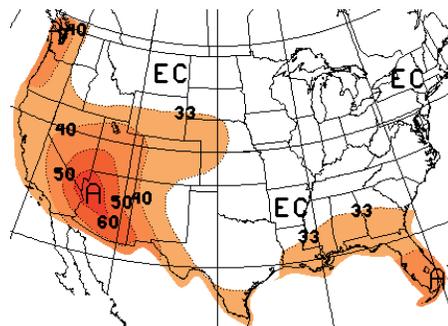
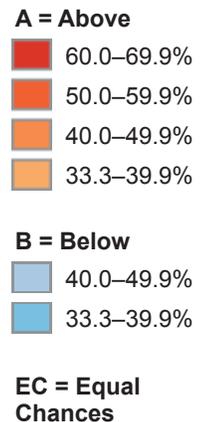


Figure 11d. Long-lead national temperature forecast for July – September 2005. (released April 21, 2005)



## 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](http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html). This website has many graphics and may load slowly on your computer.
- For IRI forecasts, visit: [http://iri.columbia.edu/climate/forecast/net\\_asmt/](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 May – September 2005

Source: NOAA Climate Prediction Center

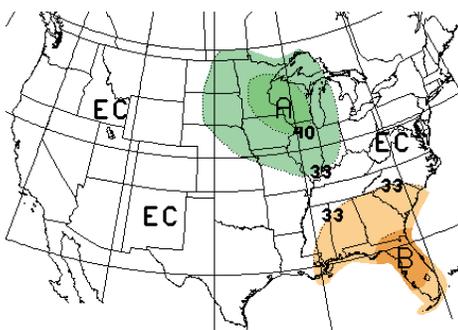
The precipitation outlook issued by the NOAA Climate Prediction Center (CPC) is for “Equal Chances” (EC), or climatology, for the Intermountain West for the May-September 2005 forecast period (Figure 12a). The “Equal Chances” forecast reflects the uncertainty in conditions and the lack of known forcing factors (e.g., an ENSO anomaly) for climate anomalies. El Niño has waned in the equatorial Pacific, so there is little information on which to base a forecast, particularly for the Intermountain West region (see page 16 for the ENSO status and forecast). The only forecast of anomalies in the region for the following few months is a slight shift in the risk of above normal precipitation for most of **Wyoming** for the June-August 2005 forecast period (Figure 12b). According to CPC, there is strong agreement among models for this wet anomaly in the north, which begins near the Great Lakes in the May-July forecast period and drifts west to Wyoming before disappearing in July-September (Figure 12c).

## Notes

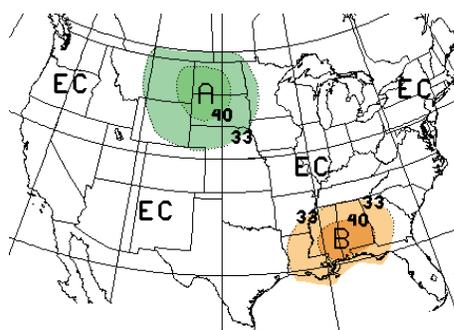
The seasonal precipitation outlook in Figures 12a-c predicts the likelihood (chance) of *above-average*, *near-average*, and *below-average* precipitation, but not the magnitude of such variation. The numbers on the maps refer to the percent chance that precipitation will be in one of these three categories, 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.

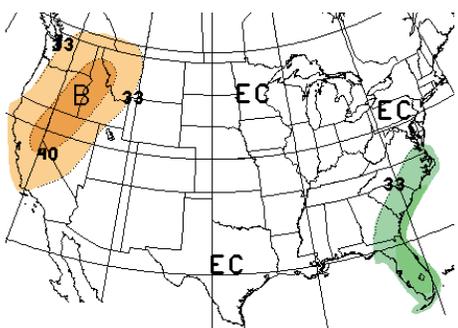
Equal Chances (EC) indicates areas for which the models cannot predict the temperature with any confidence. EC is used as a “default option” representing equal chances or a 33.3% probability for each tercile indicating areas where the reliability (i.e., ‘skill’) of the forecast is poor.



**Figure 12a.** Long-lead national precipitation forecast for May – July 2005. (released April 21, 2005)



**Figure 12b.** Long-lead national precipitation forecast for June – August 2005. (released April 21, 2005)



**Figure 12c.** Long-lead national precipitation forecast for July – September 2005. (released April 21, 2005)

<b>A = Above</b>	<b>B = Below</b>
40.0–49.9%	40.0–49.9%
33.3–39.9%	33.3–39.9%
<b>EC = Equal Chances</b>	

## 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](http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html). This website has many graphics and may load slowly on your computer.
- For IRI forecasts, visit: [http://iri.columbia.edu/climate/forecast/net\\_asmt/](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>.
- To see the average precipitation amounts for May and June, see the April 2005 climate summary found at: [http://www.colorado.edu/forecasts\\_and\\_outlooks/intermountain\\_west\\_climate\\_summary/](http://www.colorado.edu/forecasts_and_outlooks/intermountain_west_climate_summary/).



# Seasonal Drought Outlook through May 2005

Source: NOAA Climate Prediction Center

According to the Seasonal Drought Outlook from the NOAA Climate Prediction Center (CPC), the areas with the best chance for improvement in drought include **Wyoming** and parts of **Colorado**, where storms during the early part of the May-July period could significantly boost soil moisture, “resulting in more favorable prospects for farmers and ranchers while reducing wildfire danger” (Figure 13). Wyoming may benefit from an increased chance of above normal precipitation mid-summer (see precipitation outlook, page 14). Consistent with the Drought Monitor, the Seasonal Drought Outlook cautions that hydrological drought will likely see little improvement across this region, because mountain snow packs remain low and the spring storms will likely come too late to boost water supply in such areas as the North Platte basin in **Wyoming** and Nebraska. Near-record

snowfalls in the Southwest, including **Utah** and southern and southwestern **Colorado**, have significantly reduced drought conditions. Snowmelt will boost water supplies and raise the risk of flooding, while benefiting those reservoirs that remain low.

## Notes

The delineated areas in the Seasonal Drought Outlook (Figure 13) 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.

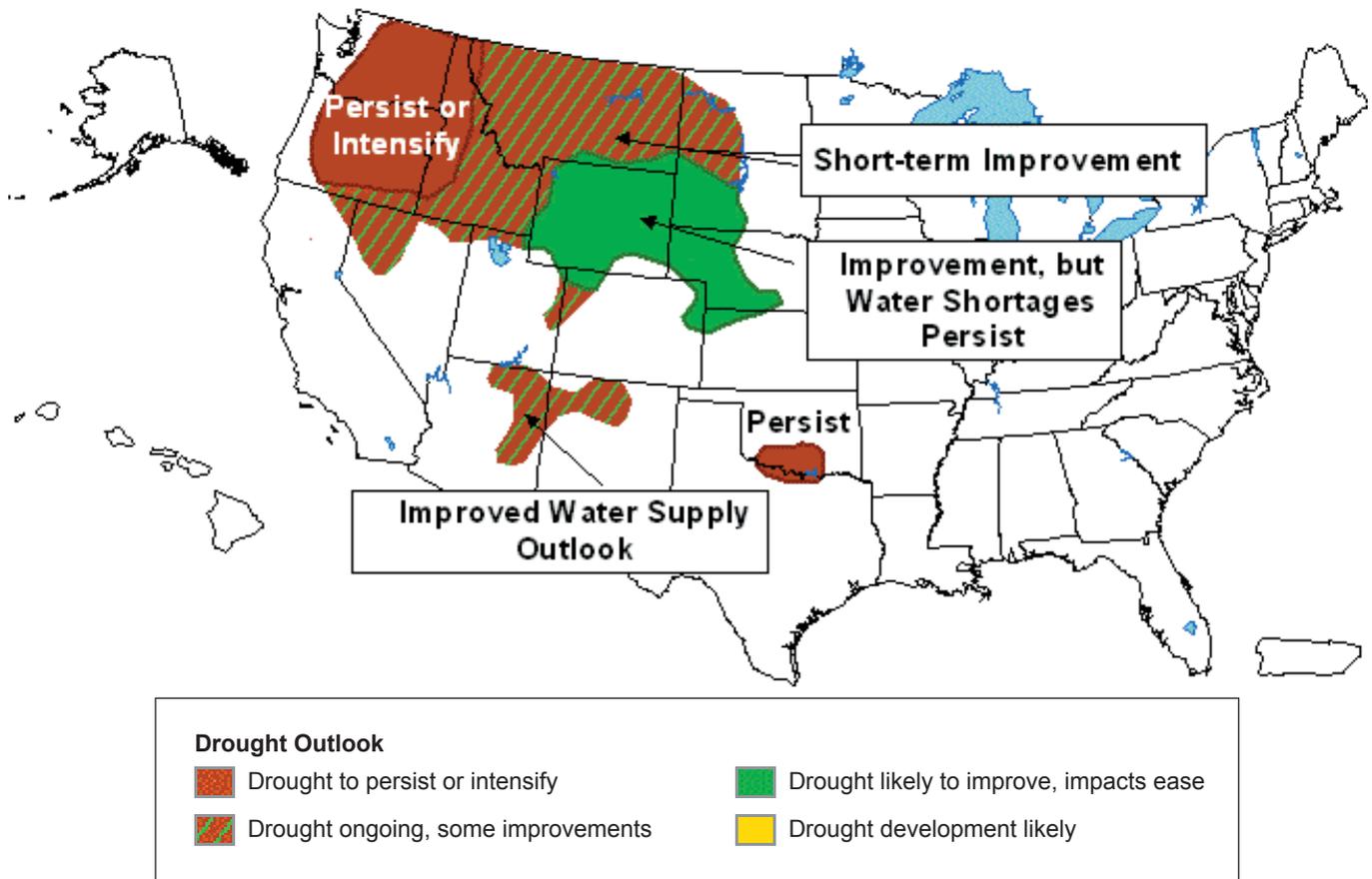


Figure 13. Seasonal Drought Outlook through July 2005 (release date April 21, 2005).

## On the Web

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



## El Niño Status and Forecast

Source: NOAA Climate Prediction Center

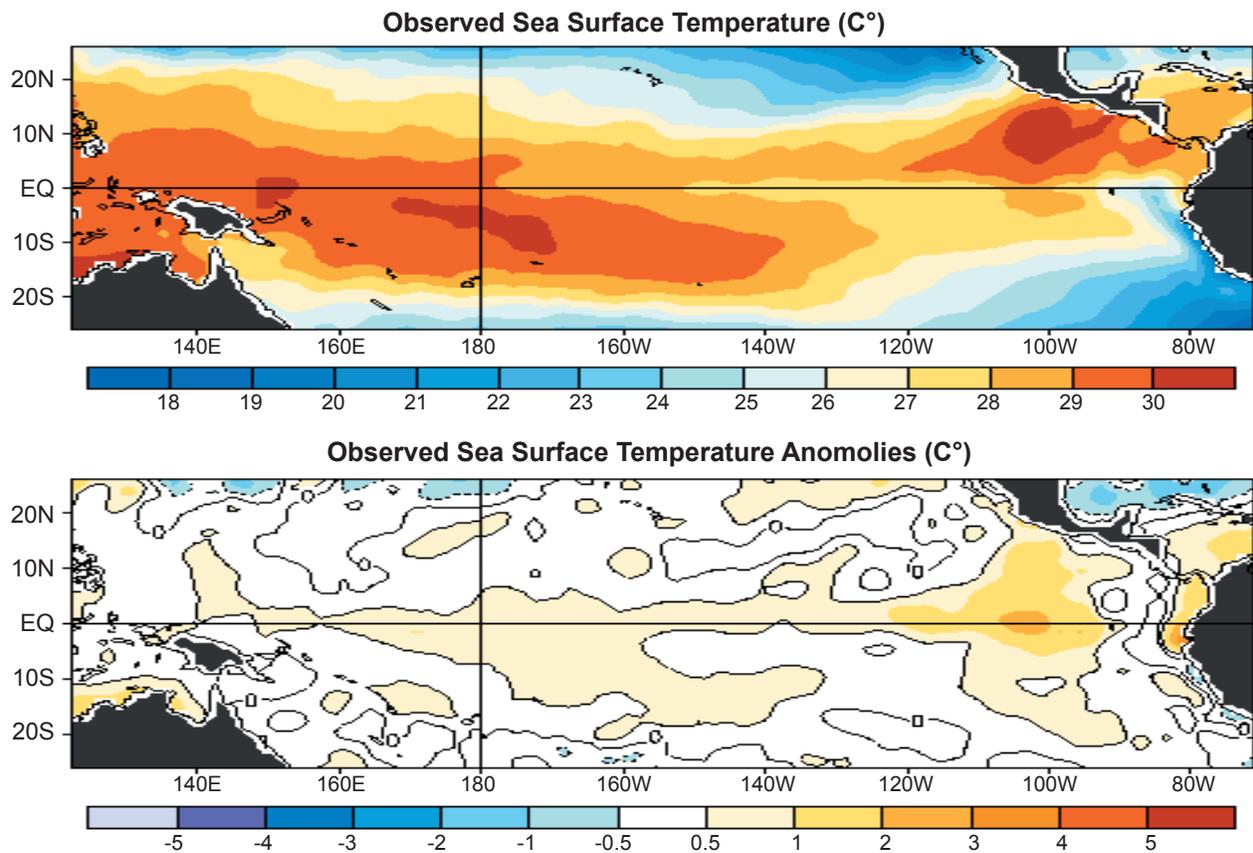
NOAA defines an El Niño as a phenomenon in the equatorial Pacific Ocean characterized by a positive sea surface temperature (SST) departure from normal (for the 1971-2000 base period), averaged over three months, greater than or equal in magnitude to 0.5°C in a region defined by 120°W-170°W and 5°N-5°S (commonly referred to as Niño 3.4).

According to the NOAA Climate Prediction Center, the weak El Niño of the past few months has waned, and ENSO-neutral conditions (i.e. average sea surface temperatures) are expected to prevail during the northern summer (June-August). Thus, ENSO anomalies should not be a significant factor in creating precipitation and temperature anomalies over the U.S. into the summer and fall. A majority of the statistical and coupled model forecasts indicate that ENSO-neutral conditions will prevail during the

northern summer (June-August), with and increasing uncertainty during the last half of 2005 regarding the state of the equatorial Pacific, and thus whether another ENSO anomaly might occur in the upcoming year

### Notes

Figure 14 consists of two graphics showing the observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. NOAA produces these graphics from data from a system of 70 moored buoys spread out over the Pacific Ocean, centered on the equator. This system, called the TOGA/TAO Array, measures 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 14.** 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 April 27, 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/](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/>.



## Water Supply Forecast for the 2005 runoff season (released 5/06/05)

Source: USDA Natural Resources Conservation Service Water and Climate Center, NOAA National Weather Service

This month's water supply forecast takes advantage of the fact that by May the snow accumulation season is essentially over, limiting one source of uncertainty. Spring and summer water supply forecasts for **Colorado** are higher in the southern part of the state and lower as you go north; a direct result of the distribution of this winter's snowfall. While the lower Arkansas, San Juan and Animas basins can expect over 150% of average water supply, the North Platte, South Platte, Upper Colorado and Yampa basins can only expect from 50%-90% of average water supplies.

Water supply conditions have improved in **Utah** due to above average precipitation levels since the start of the water year (see page 4 for recent precipitation). The NRCS expects record high water supplies in the Virgin basin in the southwest, with streamflows expected to be over 300% of average. While most of the rest of the state can expect average or above water supplies, the Upper Bear basin in the north should only see streamflows around 60% of average.

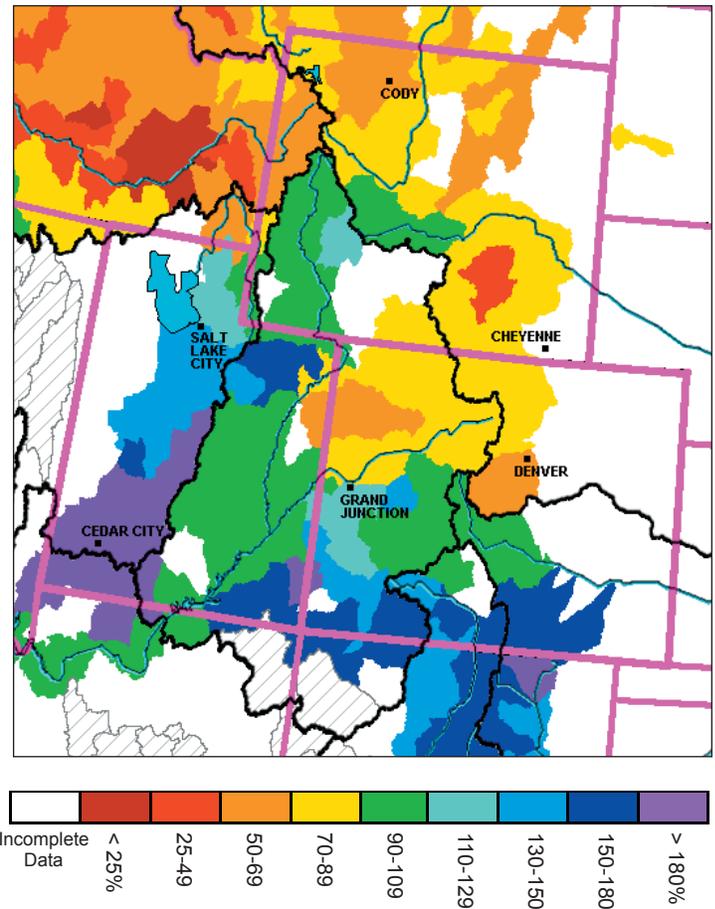
In **Wyoming**, water supply forecasts are low, consistent with generally low snowpack. While the Green and part of the Lower North Platte basins in the southwest should see spring and summer streamflows that are close to average, the rest of the state is expected to only receive 50%-90% of average. The Upper North Platte basin has the lowest water supply forecast at below 25% of average.

### Notes

The map on this page does not display the official NOAA streamflow forecast, official forecasts are developed by individual river basin forecast centers. (See 'On the Web' box below for links to the official forecasts.) We present the NRCS water supply forecasts because they show the entire Intermountain West region together.

Figure 15 shows the forecasts of natural runoff, based principally on measurements of precipitation, snow water equivalent, and antecedent runoff (influenced by precipitation in the fall before

it started snowing). Forecasts become more accurate as more of the data affecting runoff are measured (i.e. accuracy increases from January to May). In addition, these forecasts assume that climatic factors during the remainder of the snow accumulation and melt season will have an average affect on runoff. Early season forecasts are, therefore, subject to a greater change than those made on later dates.



**Figure 15.** Map showing the expected natural streamflows for spring and summer in the Intermountain West region as a percent of average streamflows as of May 1, 2005.

### On the Web

- For more information about NRCS water supply forecasts based on snow accumulation and access to the graph on this page, visit: <http://www.wcc.nrcs.usda.gov/wsf/>.
- The official NOAA streamflow forecasts are available through the following websites of individual River Forecast Centers:
  - Colorado Basin (includes Great Basin): <http://www.cbrfc.noaa.gov/>
  - Missouri Basin (includes South Platte and North Platte): <http://www.crh.noaa.gov/mbrfc/>
  - West Gulf (includes Rio Grande): <http://www.srh.noaa.gov/wgrfc/>
  - Arkansas Basin: <http://www.srh.noaa.gov/abrfc/>
- Also see this month's Focus Page on page X.



# An Overview of NOAA's Colorado Basin River Forecast Center



The NOAA National Weather Service has 13 River Forecast Centers (RFCs) located within major

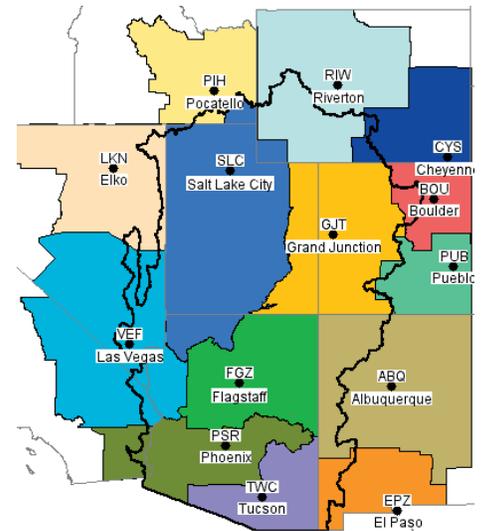
river basins throughout the U. S. The mission of the RFCs is to produce the Nations river, flood and water supply forecasts in support of saving lives and property and to enhance the economy and environment of the country. RFC Hydrologists are the technical experts in operational river and water management forecasting. RFC products and services support many NWS programs including: Flash Flood, River Flooding, River Forecasts, Recreation, Reservoir Management, Drought, and Seasonal Water Supply.

The Colorado Basin River Forecast Center (CBRFC) is responsible for the entire Colorado Basin and the Great Basin, including all or part of seven states with an area of 303,450 square miles (Figure 16a). The basin includes topography ranging from elevations of 200 to over 14,200 feet, from dry desert regions to snowy alpine areas. The basin is distinct in that nearly 80% of the runoff Basin comes from snowmelt, and it has the largest evaporation rates of any RFC. Flooding events range from flashy arroyos due to thunderstorms in the southwest, to longer term rises resulting from snowmelt of large snowpacks.

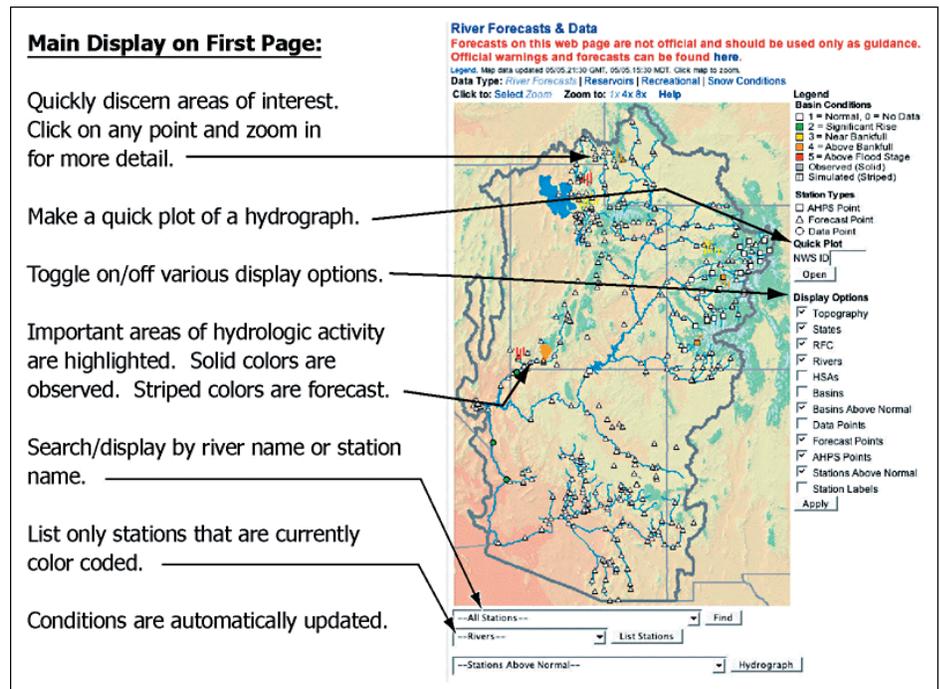
The CBRFC works closely with local Weather Forecast Offices (WFOs) within the RFC's area of responsibility (Figure 16a). The RFCs provide river forecasts and other hydrologic technical support to the WFOs. In turn, the WFOs prepare Flood Watches, Flood and Flash Flood Warnings and disseminate these products and River Flood Warnings to local emergency

managers, media, and the public. The CBRFC also works closely with the Natural Resource Conservation Service, which collects data on snowpack and analyzes streamflows, to issue joint seasonal volume forecast products. The CBRFC distributes much of its products and services through an interactive web page located at: <http://www.cbrfc.noaa.gov>. Many features of the web page allow a user to customize their request for river forecasts and data (Figure 16b). Seasonal water supply and reservoir supply and snowmelt peak flow products are also available on their web page.

The text of the article is adapted from a CBRFC publication.



**Figure 16a.** Map showing NWS weather forecast offices in the western U. S. with an outline of the area that is the responsibility of the Colorado Basin River Forecast Center.



**Figure 16b.** Interactive map of the Colorado River Basin as seen on the CBRFC website. Text explains all the interactive user choices.

## On the Web

The Colorado Basin River Forecast Center's website can be found at: <http://www.cbrfc.noaa.gov/>.

