

INTERMOUNTAIN WEST CLIMATE SUMMARY



by The Western Water Assessment

Issued March 17, 2006

March 2006 Climate Summary

Hydrological Conditions – Most of the Intermountain West region is not categorized in drought, or is in low stages of drought, but due to low snowpack and projected warm temperatures drought development is likely in parts of eastern Colorado and drought is likely to persist in current drought areas in Colorado and Wyoming.

Temperature – Temperatures in February were below average for much of the region, with the exception of northeastern Utah and northwestern Colorado, which had above average temperatures for the month. However, the average for the December-February winter season was above average across the region.

Precipitation/Snowpack – Precipitation was at or above average for most of Wyoming in February, but significantly below average in parts of Colorado and Utah, especially the southern parts.

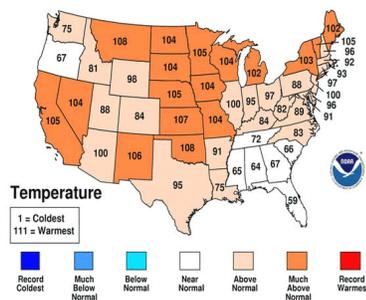
ENSO – La Niña conditions are likely to continue during the next 6-9 months, but its effect on the climate of North America for the next season or two may be weak.

Climate Forecasts – Forecasts project above average temperatures for the Intermountain West region through August, and eastern Colorado is forecasted to have below average precipitation in the spring and early summer. These forecasts are based on trends and soil moisture; the impact of La Niña may be weak.

A WARM WINTER ACROSS THE U.S.

The winter of 2005-2006 has been the fifth warmest December-February (DJF) period on record for the contiguous United States, based on preliminary data, according to scientists at the NOAA National Climatic Data Center (NCDC). NCDC ranked the DJF temperature in each state compared to historic records with 111 indicating the warmest year and 1 the coldest. The Intermountain West states all ranked in the above average category. DJF in Wyoming ranked 98 of 111, Utah's temperatures ranked 88, and Colorado 84. Midwestern states were even warmer, with Nebraska 105 of 111 and Kansas 107. These warm conditions are consistent with long-term trends in the West, which have

been the basis for the Climate Prediction Center's seasonal forecasts this winter (pages 13-14). Nationwide, the mean 2005-2006 winter temperature in 41 states was above- or much above average, with only seven states near average and none cooler than the long-term mean. The relatively warm winter led to below normal residential energy demand for the U.S., as measured by the nation's Residential Energy Demand Temperature Index. Using this index, NOAA scientists determined that the national residential energy demand was approximately 11 percent less than what would have occurred under average climate conditions for the season. See story at <http://www.noaanews.noaa.gov/stories2006/s2591.htm>.



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

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New & Improved NRCS Snow and Water Supply Forecast Products

By Thomas Pagano, National Water and Climate Center, NRCS-USDA, Portland, OR

This year, the Natural Resources Conservation Service (NRCS) is celebrating 100 years of providing snow information to natural resource managers and the general public. This month's feature article honors this occasion and introduces some new products from the NRCS National Water and Climate Center.

History of NRCS snow monitoring

Nearly 100 Years ago Dr. James E. Church of the University of Nevada, Reno began the first routine snow surveys in the mountains around Lake Tahoe. Church was a renaissance man and one of the great American naturalists, a cultured classics professor, rugged outdoorsman, exacting scientist, and early member of the Sierra Club. Spurred on by the same turn-of-the-century sense of exploration and adventure that drove Cook, Scott and Amundsen to the North and South Poles, Church ventured into hostile terrain, decades before the popularity of winter sports. He designed and developed the manual measurement technology still in use today, collected the early snow samples and helped produce the first water supply forecasts.

In the 1930s, snow survey and water supply forecast responsibilities were gathered together under the Natural Resources Conservation Service (NRCS, then called the Soil Conservation Service). Today, the NRCS National Water and Climate Center (NWCC) in Portland, Oregon continues this legacy, analyzing and archiving snow data, as well as producing water supply forecasts. The NWCC benefits from the dense network of NRCS field personnel, including the Data Collection Officers and Water Supply Specialists who collect and quality control data and work closely with local irrigators and water managers in interpretation, planning and decision-making.

To this day, routine manual measurements of snowpack at high elevations continue every month through the snow accumulation and melt season. Originally designed to support water supply forecasting, this data has found many research applications, becoming the most comprehensive record in existence of winter mountain climate, at many remote and climatologically harsh locations far from any traditional valley weather stations. About 25 years ago, the NRCS invested heavily in automating this manually intensive monthly observation system, creating the SNOTEL (SNOW TELemetry) network. By increasing the numbers of and spatial distribution of snow measurement sites through the years, the NRCS is able to provide more precise estimates of basin-wide snowpack and better streamflow forecasts.

New GIS-based map products

Today, the NRCS combines manual measurements, an ever-expanding network of SNOTEL sites, and the powerful advances

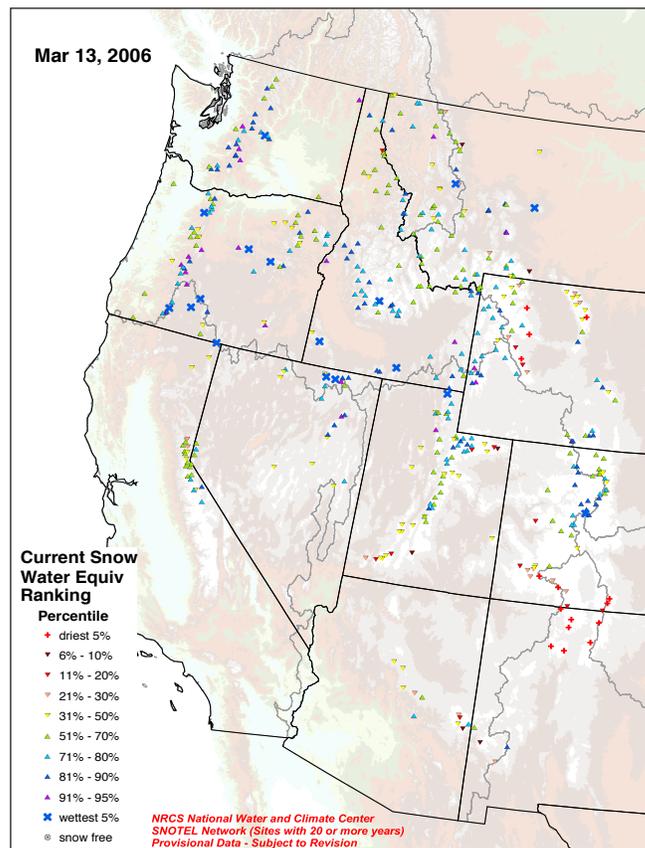


Figure 1a: March 13, 2006 SNOTEL Snow water equivalent (SWE) percentile map for the western U.S. The SWE for this date highlights the short spatial distance between record highs and record lows in the Intermountain West region. The water availability pages for each state in this Summary (pages 10-12) contain maps similar to this one, but show the percent of normal SWE rather than the percentile ranking.

in information technology and data communication, to monitor the pulse of western snowpacks and water supplies and communicates that information to users through innovative new products. In just the past few years, the NRCS has made great advances in visualization of hydrologic data. In 2006, the NWCC added an extensive section of real-time map-based GIS products (<http://www.wcc.nrcs.usda.gov/gis/>). Every day an array of maps containing snowpack, snow density, precipitation, and temperature are generated in a variety of contexts.

While many users are familiar with snow data displayed as percent of normal, new maps of percentile rankings and of record highs or lows help users determine the historical significance of current conditions (Figure 1a). In order to monitor the current water year, some maps show the change in conditions over the last week, others show current status with respect to the entire season. The NWCC webpage also provides fine resolution snow





Figure 1b: NRCS Google Earth product with links to site photos (showing Utah, near Salt Lake on March 13, 2006).

depth maps of every state, useful for winter recreation and other purposes such as wildlife management.

Precipitation and temperature maps using data collected at SNOTEL sites are also available on the NWCC GIS website. Precipitation and temperature data are also extracted from the Applied Climate Information System (ACIS) to create merged National Weather Service (NWS) and NRCS maps. High density maps show monthly and seasonal precipitation and the multi-agency temperature maps are sufficiently detailed to see when inversions occur between NWS valley stations and NRCS stations in the mountains. All of the data behind the GIS-based maps are available for any user interested in doing finer scale analysis.

New Google Earth-based map products

The NWCC recently released a 3-D visualization layer to view SNOTEL data using Google Earth. (<http://www.wcc.nrcs.usda.gov/snotel/earth/index.html>) SNOTEL sites are color-coded by snowpack as percent of normal, and if one highlights an individual station, a new window to additional information opens including site photos and tables and charts of real-time and historical data (Figure 1b). Later this spring, a Google Earth Layer of water supply forecasts will be released. These layers make an excellent companion to the spatial data compiled by the National Operational Hydrologic Remote Sensing Center (NOHRSC), available at <http://www.nohrsc.noaa.gov/earth/>

Other snowpack and water supply products available by request from NWCC

Often forecasters and users ask about snow conditions: “Where we are now? How does this compare to history? What is the range of possibilities for the future?” The NWCC developed a product that answers all of these questions for daily SNOTEL data. The chart in Figure 1c shows the historical range

of snowpack variability for a station in southern Colorado over the period of record in gray. The 1971-2000 normal is shown as a heavy black line. The current year to date is displayed in red and, in this example, the snowpack has reached new record highs for this date. Derived using a statistical technique, the colored lines on the right side of the graph depict the range of possibilities, showing that not even the best case scenario could bring the snowpack back to 100% of average by April 1st. The various colored lines indicate the probability that future snow will be less than a certain amount on any given day. While the NWCC moves towards an interactive web interface to this product, NWCC personnel will gladly provide this information on request.

While having up-to-date snowpack information is useful, ultimately, users would like to know the implications for water supplies. The most common request from users to the NWCC is for more frequent updates to the official forecasts issued once per month, i.e. “A large storm just hit our basin. What does this mean for this summer’s flow? Do these storms mean that we will have enough water to irrigate?” To address these concerns, the NWCC is further taking advantage of daily SNOTEL data by developing an automated daily statistical forecast system. The current prototype system is running twice daily for 45 locations in the Intermountain West region (15 in the state of Colorado, 6 in Utah, and 1 in Wyoming).

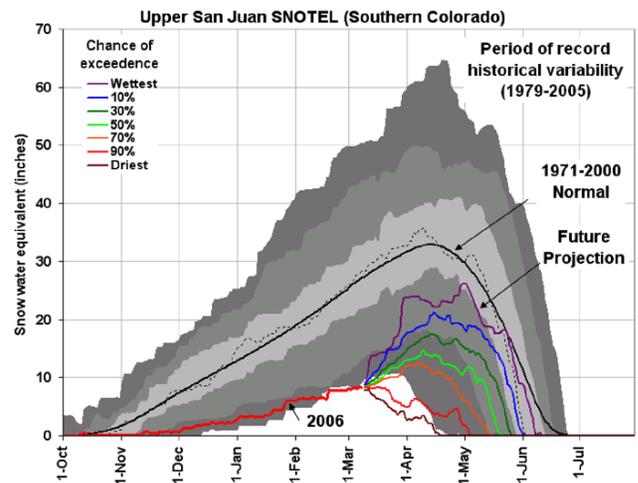


Figure 1c: Progress of snowpack to date (red) in the context of historical variability (gray) with the range of future possibilities (colored lines). The future lines indicate the percent chance that snowpack will be more than a particular amount on a given day. For example, the top purple line is the most possible snow, the blue line shows the amount for which there is a 10% chance exceeding and the dark green line shows the amount for which there is a 30% chance exceeding. The gray areas show the period of record frequency of occurrence so that the top of the gray area is the maximum of record, and below that is the 10%, 30%, 50% (dotted line), 70%, 90% exceedance and minimum of record. Since mid-February this site has set new record lows for this date. The 1971-2000 normal (heavy black line) is provided for reference.



Figure 1d tracks the progress of the forecasts for inflows to the Vallecito Reservoir in the San Juan basin in southern Colorado. Again, the gray background indicates the range of historical variability and the colored lines show how a forecast of April-July water volume changes throughout the season. As early as December, a month before the first official forecast for the season, dry conditions already indicated a diminished water supply.

The graphs provide a quick look whereas a data sheet provides a wealth of additional information and diagnostics. Several users are helping the NWCC refine and improve this product. If you are interested in more information, contact Tom Pagano at the address provided below.

New directions for NRCS forecasting products

The NRCS is forging ahead with other new forecasting technologies, such as simulation modeling. This technique involves the running of sophisticated models that track the growth and melt of snow across a basin, and can simulate the conversion of melt into runoff, quantifying the effects of long-term soil moisture deficits.

Picking the right model and running it properly is not a trivial task and the NRCS has found Regional Integrated Science Experiments (RISAs) such as the Western Water Assessment invaluable in helping the agency take advantage of the latest modeling technology. The southwest RISA, CLIMAS, has also aided the NRCS’s forecast evaluation activities, working with water managers to develop a better understanding of how they interpret the quality and utility of NRCS water supply outlooks.

While the NRCS has been forecasting water supplies for close to 70 years, it is evident that the physical and demographic landscapes of the Intermountain West are changing.

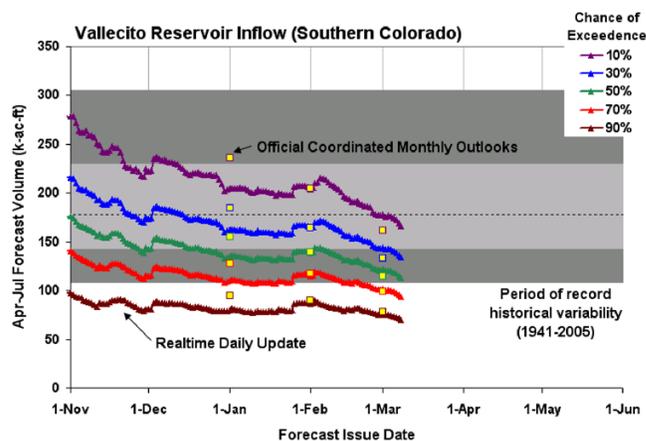


Figure 1d: Official outlooks (yellow squares) are available once a month while an experimental system (colored lines) fills in the gaps daily, tracking with snow events or dry conditions as they happen. The color scheme is similar to Figure 1c, where the gray background shows the historical range of variability, including the period of record 10%, 30%, 50% (dotted line), 70% and 90% chance of exceedance.

Over allocated supplies and increasing demands require precision management of water. The NRCS plays a significant role in that process, from the deserts of southern Arizona to the rivers of the Arctic Circle. It is now more important than ever that natural resource managers understand risks and operate using the best guidance. NRCS strives to provide this guidance in the most understandable form and in a rich context of hydrological and societal information. To this end, the importance of the climate and social science research and user outreach and education by the RISA groups cannot be understated.

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On the Web

- To find out more about the snow science centennial celebration, visit <http://www.wcc.nrcs.usda.gov/centennial.html>
- To find new GIS-based products, visit <http://www.wcc.nrcs.usda.gov/gis/>
- To find Google Earth-based products, visit <http://www.wcc.nrcs.usda.gov/snotel/earth/index.html>



Temperature through 2/28/06

Source: High Plains Regional Climate Center

The monthly average temperatures for February 2006 in the Intermountain West region ranged from lows of 0°F to 15°F in the western **Wyoming** mountains, the Gunnison Valley in western **Colorado**, and north central **Colorado** mountains, to highs of 30°F to 40°F in southeast **Colorado** and west central and southeast **Utah**. **Wyoming**, on average, was cooler with maximum temperatures from 25°F to 30°F (Figure 2a).

In February 2006, much of **Wyoming** was below average by 2° F to 8°F. The northern tier of **Colorado** was also 2°F to 6°F below average. Most of **Utah** was at or near average with the exception of the northwest corner 2°F to 4°F below average and the northeast section 2° to 4°F above average (Figure 2b).

Temperatures in the Intermountain West region in February 2006 were near average to 2°F to 6°F below average, in contrast to temperatures being 2°F to 8°F above average in 2005 (Figure 2c). **Wyoming** has the largest difference between years, with below average temperature for all the state in 2006, with minor exceptions, whereas in 2005 the state recorded 4°F to 8°F above average, except for the western mountains.

Although much of the region had negative departures from average for the month of February, the average for the December-February winter season was above average across the region (see p. 1).

Notes

Average refers to the arithmetic mean of annual data from 1971-2000. Departure from average temperature is calculated by subtracting current data from the average. The result can be positive or negative.

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

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

On the Web

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

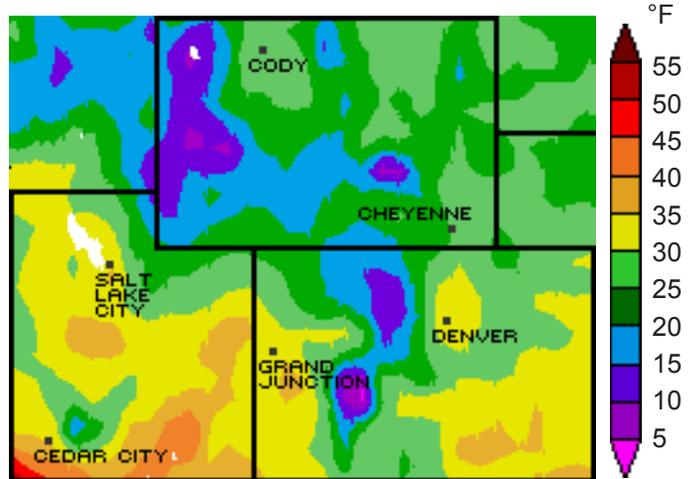


Figure 2a. Average temperature for the month of February 2006 in °F.

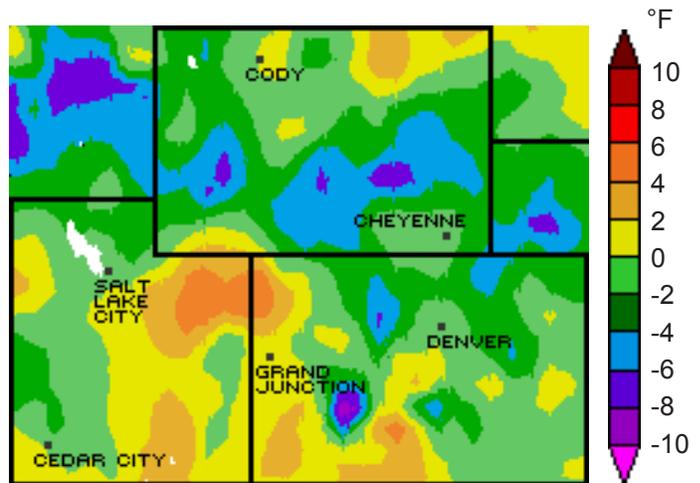


Figure 2b. Departure from average temperature for the month of February 2006 in °F.

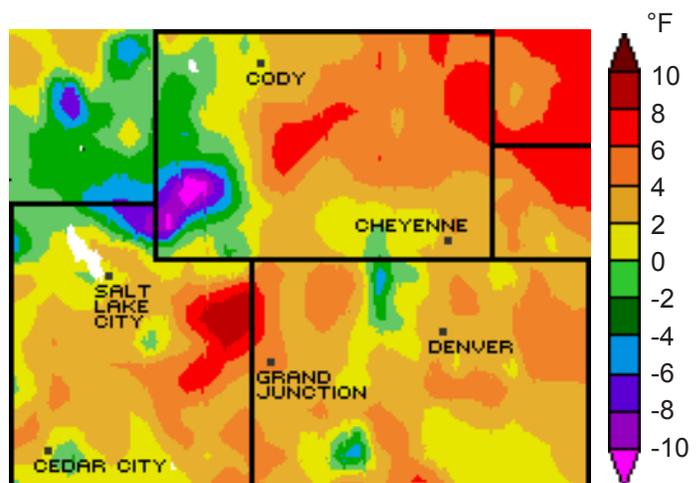


Figure 2c. Departure from average temperature in °F for last year, February 2005.



Precipitation through 2/28/06 Source: NOAA/ESRL/PSD Climate Diagnostics Branch, NOAA Climate Prediction Center

Precipitation in the Intermountain West region falls primarily as snow in February, and snow pack and snow water equivalent (SWE) depend on elevation. On the plains, however, some precipitation does fall as rain at this time of year. Areas receiving above average precipitation in February 2006 are the central and western mountains of **Wyoming**, the north-central and southwestern mountains of **Colorado**, and high elevations of **Utah** (Figure 3a). These areas received from 1 to 3+ inches of precipitation in February, and this amount is about average to 150% of average (Figure 3b). The eastern half of **Colorado** and some areas of southern and eastern **Utah** remain very dry, receiving from 0 to .5 inches of precipitation, about 40% to 60% of average.

Since the start of the 2006 water year, (Figure 3c) **Colorado** has received average to above average precipitation in the northern half of the state, with the north central mountains and north-eastern plains receiving 120% to 200 % of average. Southern **Colorado** precipitation has been average to 60% to 80% of average. **Wyoming** received average precipitation for most of the state, with the exceptions of the southeast plains and northwest mountains, which received 120% to 150% of average precipitation. North-central and northwest **Utah** received 120% of average precipitation, the middle of the state received about average, and the southern portion received 40% to 80% of average precipitation. The gradient of increasing precipitation from south to north is similar to a La Niña pattern (See page 16 for ENSO outlook).

Notes

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

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

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

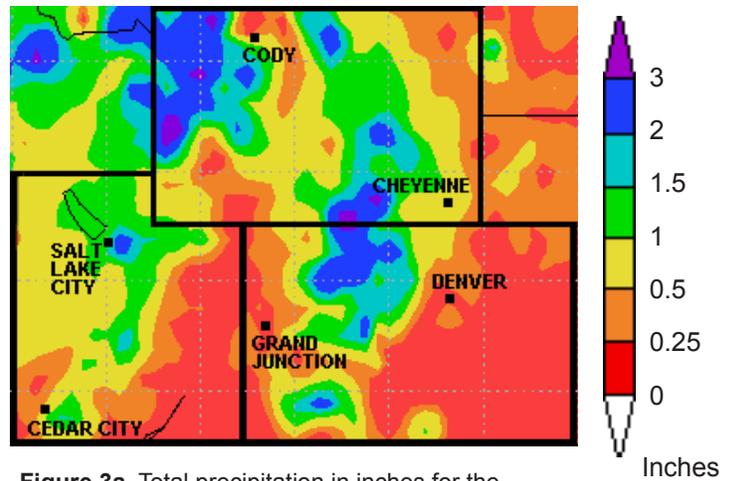


Figure 3a. Total precipitation in inches for the month of February 2006.

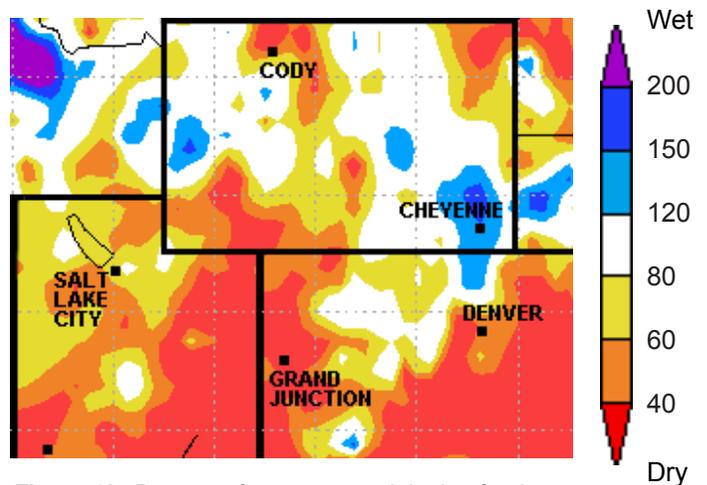


Figure 3b. Percent of average precipitation for the month of February 2006

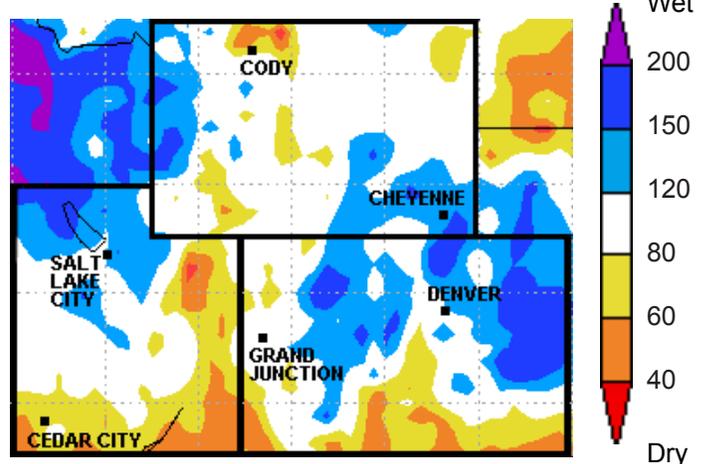


Figure 3c. Percent of average precipitation accumulated since the start of water year 2006. (Oct. 1 - Feb. 31, 2006).

On the Web

- For the most recent versions of these and maps of other climate variables including individual station data, visit: <http://www.hprcc.unl.edu/products/current.html>.
- For precipitation maps like these and those in the previous summaries, which are updated daily visit: <http://www.cdc.noaa.gov/Drought/>.
- For National Climatic Data Center monthly and weekly precipitation and drought reports for Colorado, Utah, Wyoming, and the whole U.S., visit: <http://wlf.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 3/7/06

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

The drought status of most of the Intermountain West region for the month of March remains essentially unchanged from February, with the exception of dryness persisting across southwestern **Utah**, leading to an expansion of D0 (abnormally dry conditions) into that area. In other areas of the west, the entire southwest the drought status has increased in intensity. Most of eastern Arizona has moved into D3 (extreme), and all of New Mexico has moved into D0. Southwest and northwest sectors of New Mexico have moved into D3. Portions of southern Texas and eastern Oklahoma have moved into D4 (exceptional) drought status. In contrast, much of the eastern central states have moved out of drought.

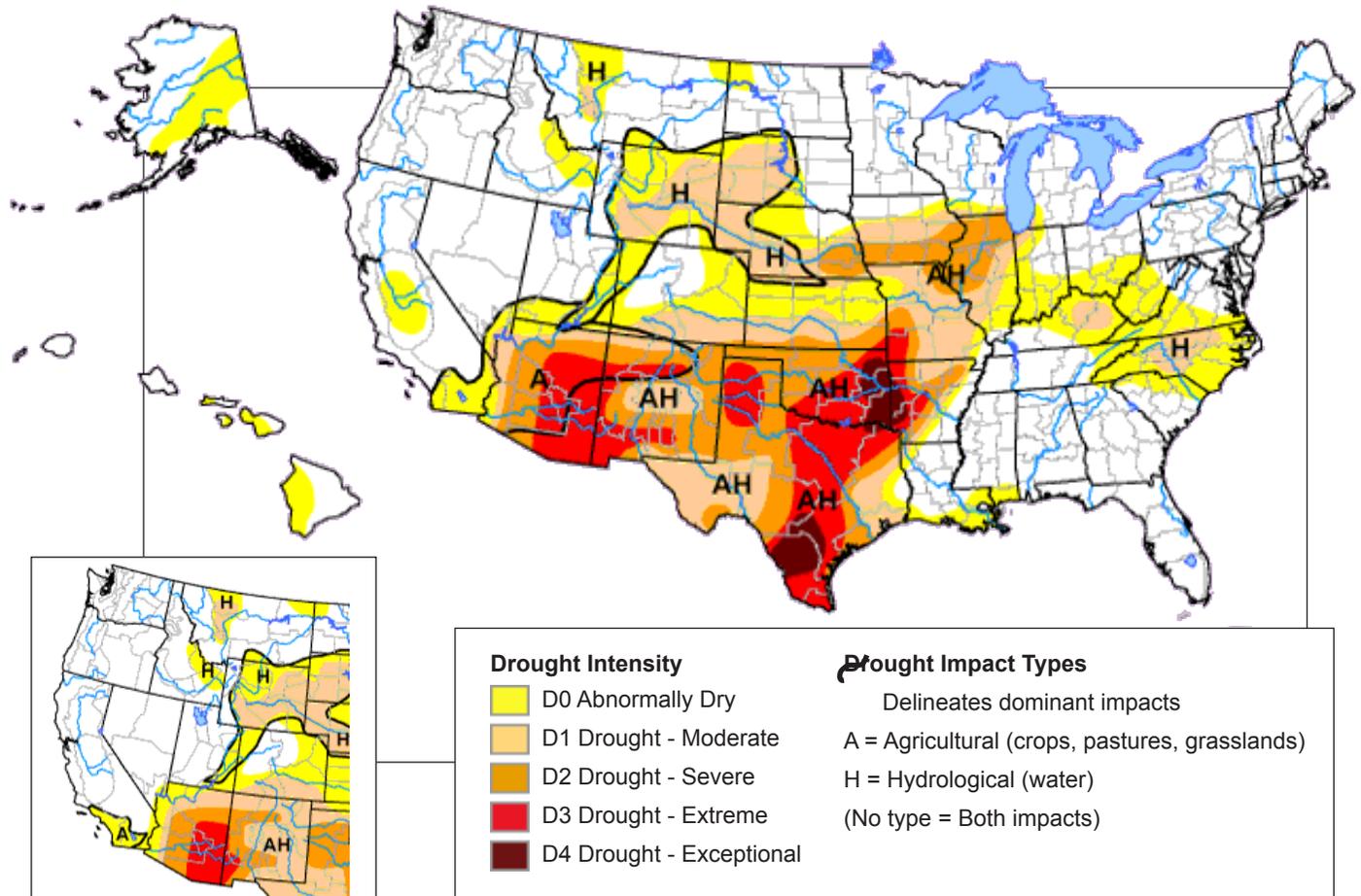


Figure 4. Drought Monitor released March 9, 2006 (full size) and last month February 9, 2006 (inset, lower left) for comparison.

Notes

The U.S. Drought Monitor (Figure 4) is released weekly (every Thursday) and represents data collected through the previous Tuesday. The inset (lower left) shows the western United States from the previous month's map.

The U.S. Drought Monitor maps are based on expert assessment of variables including (but not limited to) the Palmer Drought Severity Index, soil moisture, streamflow, precipitation, and measures of vegetation stress, as well as reports of drought impacts. It is a joint effort of the several agencies; the author of this monitor is Douglas LeCompte of the NOAA Climate Prediction Center.

On the Web

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



Intermountain West Snowpack data through 3/1/06

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

The snowpack as of March 1, 2006 varies across the Intermountain West Region and throughout the states. Note that in some basins, such as the Arkansas and Gunnison basins in **Colorado**, sub-basins have dramatically different SWE as a percent of average. When these sub-basins are averaged together into climate divisions in the regional SPI (p. 9), or larger basins in the Colorado Surface Water Supply Index (p. 10), the resulting average gives an incomplete picture of variability across the basin. About half of the state of **Wyoming** is near or above average. The Green River basin in the west and the Upper North Platte River basin in the south both have 110% to 130% of average snowpack. The snowpack in the central basins and Lower North Platte River basin range from near average to 70% of average.

Utah and **Colorado** continue to show a distinct south-to-north gradient in snowpack levels, though southwest and central **Utah** has increased in snowpack to 50%-100%. The southern parts of both states have areas below 50% of average snowpack, while the northern mountains have areas where the snowpack is 130% to 150% of average. In **Colorado**, the dividing line is the Gunnison Basin on the west slope and the Arkansas basin on the east. Further south, in Arizona and New Mexico, all stations measure under 50% of average snowpack for this time of year (not shown). This gradient is characteristic of a La Niña pattern, the current phase of ENSO according to NOAA. (See page 16 for more ENSO information).

The recent storms of early March (after this map was created) have increased the snowpacks in the southern parts of **Colorado** and **Utah** to above 50% of average.

Notes

Snow water equivalent (SWE) or snow water content (SWC) refers to the depth of water that would result by melting the snowpack at the measurement site. SWE is determined by measuring the weight of snow on a "pillow" (like a very large bathroom scale) at the SNOTEL site. Knowing the size of the pillow and the density of water, SWE is then calculated from the weight measurement. Given two snow samples of the same depth, heavy, wet snow will yield a greater SWE than light, powdery snow.

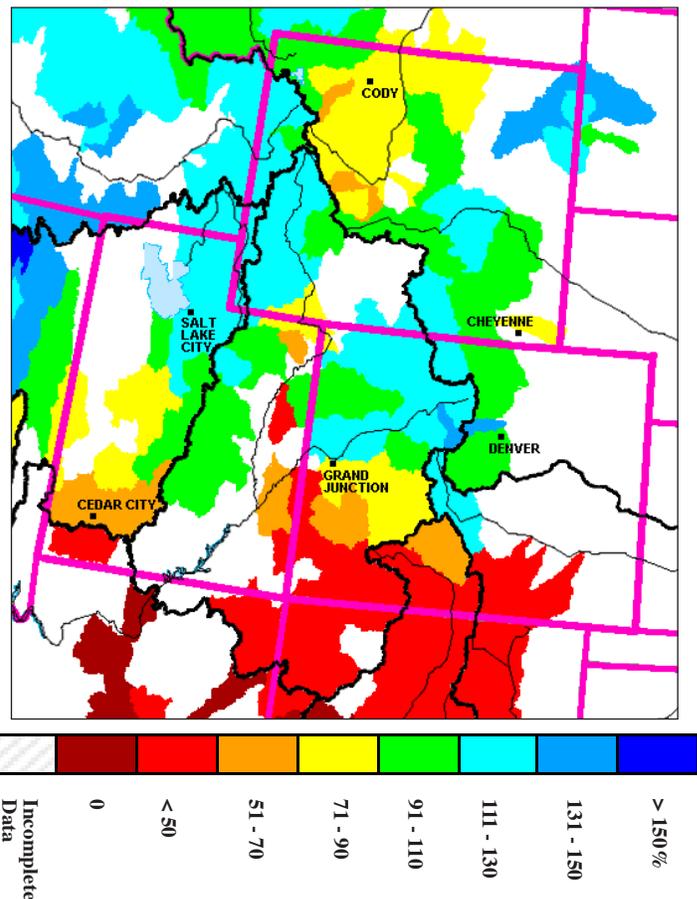


Figure 5. Snow water equivalent (SWE) as a percent of average for available monitoring sites in the Intermountain West as of March 1, 2006.

SWE is important in predicting 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 X for water supply 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. To see the locations of individual SNOTEL sites, see each state's water availability page.

On the Web

For graphs like this and snowpack graphs of other parts of the western U.S., visit: http://www.wcc.nrcs.usda.gov/snowcourse/snow_map.html.

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

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



Regional Standardized Precipitation Index data through 2/28/06

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

The Standardized Precipitation Index (SPI) can be used to monitor conditions on a variety of time scales. 3- and 6-month SPIs are useful in short-term agricultural applications and longer-term SPIs (12 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 December 2005) compared to the average precipitation of the same 12 consecutive months during all the previous years of available data.

The SPI remains mostly in the near normal or wet categories around the Intermountain West region, with the exception of southeastern **Colorado** as of the end of February 2006. Several climate divisions in **Colorado** and **Utah** are in dryer categories since the January Climate Summary, and several in **Wyoming** are in wetter categories. Most of **Colorado** is in the near normal category, while the Rio Grande and Arkansas basins in the south-central and southeastern parts of the state are moderately dry. Western **Colorado** moved from the moderately wet category to near normal. The eastern half of **Utah** is in the near normal category, while the western half is moderately wet or very wet. The SPI numbers of the southeast division, south central division, and the northern mountains in **Utah** all decreased so that they are in dryer categories than in January. About half of **Wyoming**'s climate divisions are in the near normal category

and the other half are in wet categories. **Wyoming** is the only state that saw any increase in SPI numbers from January. The wettest divisions are in the northern part of the state with the Snake, Big Horn, Powder/Missouri/Tongue, and Cheyenne/Niobrara divisions all in the very wet categories. These divisions, as well as the Lower Platte division all increased their SPI number since January and moved into wetter categories.

Notes

The Standardized Precipitation Index (SPI) is a simple statistic generated from accumulated precipitation totals for consecutive months compared to the historical data for that station. Near normal SPI means that the total precipitation for the past 12 months is near the long-term average for one year. An index value of -1 indicates moderate drought severity and means that only 15 out of 100 years would be expected to be drier. An index value of -2 means severe drought with only one year in 40 expected to be drier. (courtesy of the Colorado Climate Center)

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

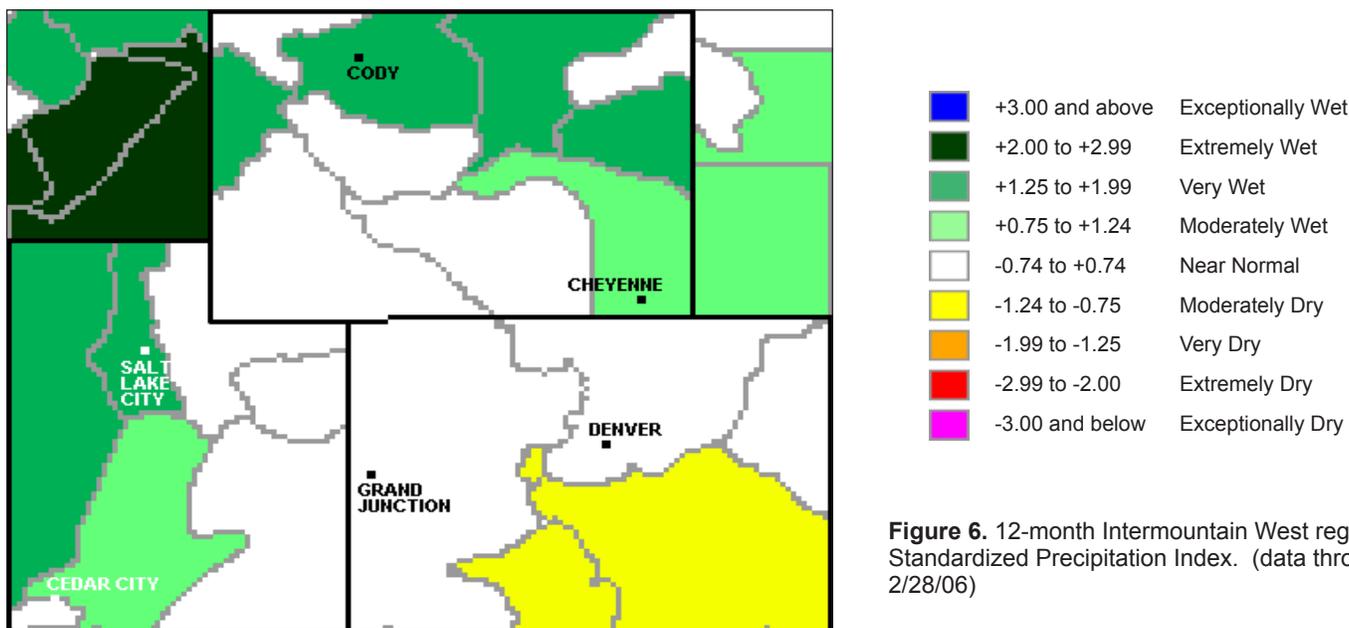


Figure 6. 12-month Intermountain West regional Standardized Precipitation Index. (data through 2/28/06)

On the Web

- For information on the SPI, how it is calculated, and other similar products for the entire country, visit <http://www.wrcc.dri.edu/spi/spi.html>.
- For information on past precipitation trends, visit: <http://www.hprcc.unl.edu/products/current.html>.



Colorado Water Availability March 2006

Source: USDA Natural Resources Conservation Service

According to the NRCS, snowpack percentages declined sharply in all Colorado basins due to a dry February. The Colorado, Yampa and White, North Platte, and South Platte basins all remain above average, but they have declined from 132% to 134% of average in January to 103% to 115% of average as of March 1st. The Arkansas and Gunnison basins are now 88% and 84% of average, respectively. The southern part of Colorado continued to see lower than average snowfall and snowpack levels are near record lows for the Rio Grande and combined San Juan, Animas, Dolores, and San Miguel basins. The Rio Grande basin only has 40% of average snowpack, the lowest it has been since 1977. The San Juan, Animas, Dolores, and San Miguel basins have 46% of average snowpack, which is similar to the conditions those basins last experienced in 2002 (Figure 7a).

The Surface Water Supply Index (SWSI) is another useful measure of water availability related to streamflows, reservoir levels, and groundwater levels. Like the SWE map, the Colorado SWSI map shows more water supplies in the north and less in the south (Figure 7b). The Yampa, White, North Platte, South Platte, Gunnison, and Arkansas basins are in the near normal category. However, the snowpack in the Arkansas basin is not uniform across the basin. The SWE in the northern part is above average and below average in the southwestern part (see snowpack map on page 8). The Colorado basin is the only basin with abundant supplies and the San Juan, Animas, Dolores, and San Miguel combined basins along with the Rio Grande basin are facing moderate drought. The NRCS expects extremely low streamflow volumes for the southern part of Colorado unless they get an exceptionally wet spring.

Notes

Figure 7a shows the SWE as a percent of normal (average) for SNOTEL sites in Colorado. Figure 7b shows the Surface Water Supply Index (SWSI), developed by the Colorado Office of the State Engineer and the USDA Natural Resources Conservation Service. SWSI is used as an indicator of mountain-based water supply conditions in the major river basins of the state and is based on snowpack, reservoir storage, and precipitation for the winter period (November through April). During the winter period, snowpack is the primary SWSI component in all basins except the South Platte Basin where reservoir storage is given the most weight. The SWSI values in Figure 7b were computed for each of the seven major basins in Colorado for March 1, 2006, and reflect conditions through the month of February 2005.

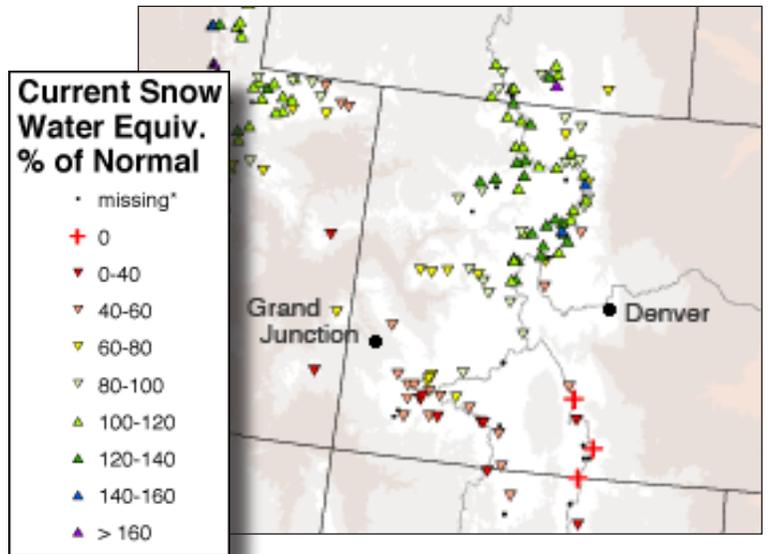


Figure 7a. Current snow water equivalent (SWE) as a percent of normal for SNOTEL sites in Colorado as of March 6, 2006. **This is provisional data.** For current SNOTEL data and plots of specific sites, see <http://www.cbrfc.noaa.gov/snow/snow.cgi> or <http://www.wcc.nrcs.usda.gov/snow/>.

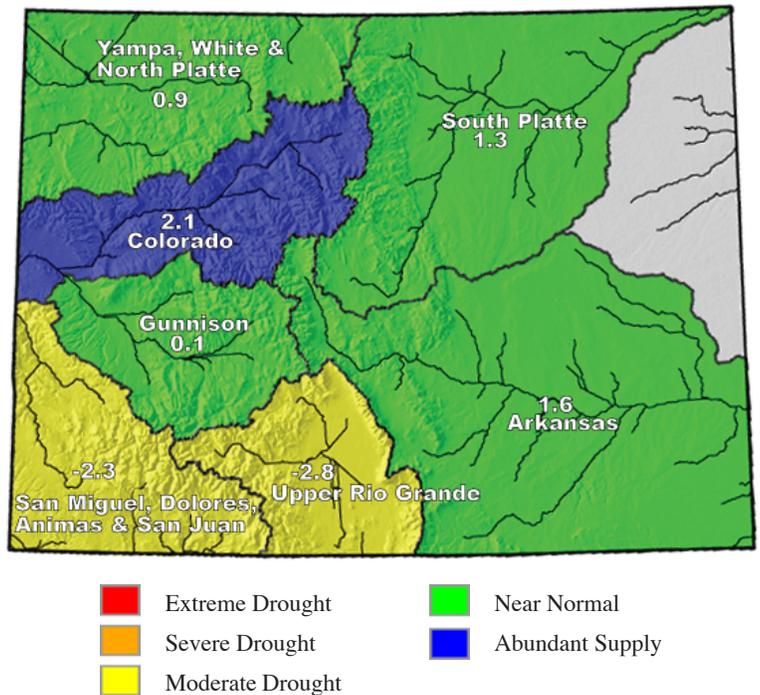


Figure 7b. Colorado Surface Water Supply Index. The map shows the projected water availability by basin for spring and summer 2006, based on current conditions as of March 1, 2006.

On the Web

- For current maps of SWE as a percent of normal like in Figure 7a, go to: <http://www.wcc.nrcs.usda.gov/gis/snow.html>.
- For the current SWSI map, go to: http://www.co.nrcs.usda.gov/snow/fcst/state/current/monthly/maps_graphs/index.html.
- For current streamflow information from USGS, visit: <http://water.usgs.gov/waterwatch/>.
- For monthly reports on the water supply conditions and forecasts for major river basins in Colorado, go to http://www.co.nrcs.usda.gov/snow/snow/snow_all.html and click on "Basin Outlook Reports."



Wyoming Water Availability March 2006

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

Overall snowpack values in western Wyoming are higher than the eastern part of the state, as of March 1st (Figure 8a). The south-central mountains of the Upper North Platte basin and the western mountains of the Upper Snake, Upper Bear, Big Sandy and Lower Green River basins generally have above average snowpack levels, ranging from 100% - 140% of average SWE. The central mountains bordering the Big Horn and Powder River basins only have 80% - 120% of average SWE. Some stations in the Big Horn Wind River basins have less than 40% of average SWE.

The Surface Water Supply Index (SWSI) values show similar patterns of spatial distribution to the snowpack map (Figure 8b). The driest basins are the Wind and Powder Rivers, which are both in the mild to moderate drought categories. Other basins facing a mild drought include the Big Horn, Lower North Platte and Green River basins. The Upper Snake, Upper Bear, Big Sandy, and Lower Green River basins all moved from dry or drought categories in January to the slightly wet to moderately wet category this month.

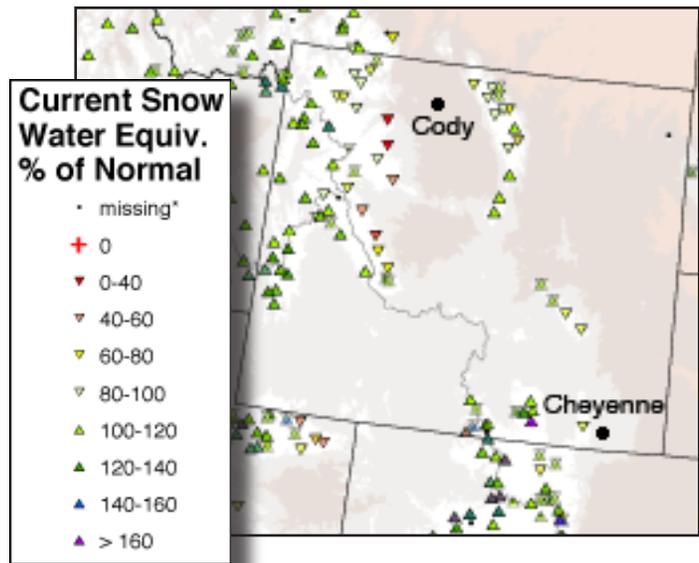


Figure 8a. Current snow water equivalent (SWE) as a percent of normal for SNOTEL sites in Wyoming as of March 6, 2006. **This is provisional data.** For current SNOTEL data and plots of specific sites, see <http://www.wcc.nrcs.usda.gov/snow/>.

Notes

Figure 8a shows the SWE as a percent of average for each of the major river basins in Wyoming. According to WY NRCS, “The Surface Water Supply Index (SWSI-Figure 8b) 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.”

Legend

- > 4.0 Extremely Wet
- 3.0 Very Wet
- 2.0 Moderately Wet
- 1.0 Slightly Wet
- 0.5 Incipient Wet Spell
- 0.0 Near Normal
- 0.5 Incipient Dry Spell
- 1.0 Mild Drought
- 2.0 Moderate Drought
- 3.0 Severe Drought
- < - 4.0 Extreme Drought

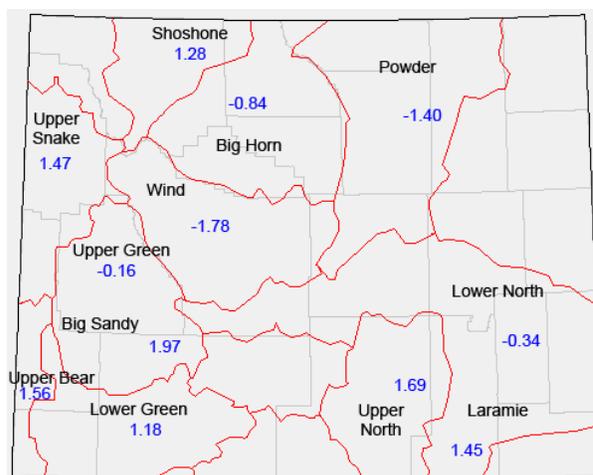


Figure 8b. Wyoming Surface Water Supply Index (data through 3/1/06)

On the Web

- Information on current Wyoming snowpack, SWE, and SWSI, along with more data about current water supply status for the state, can be found at: <http://www.wrds.uwyo.edu/wrds/nrcs/nrcs.html>.
- The Palmer Drought Index is found on NOAA's drought page: www.drought.noaa.gov.
- For current streamflow information from USGS, visit: <http://water.usgs.gov/waterwatch/>



Utah Water Availability March 2006

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

Weather patterns in Utah this winter continue to bring more snow to the northern mountains and less to the southern mountains (Figure 9a). Overall, February was drier than average (see page 6, Figure 3b) and snowpacks declined about 20% on average. NRCS SNOTEL measurements reported snowpacks ranging from 44% of average in the southwestern part of the state to over 140% of average in the north. The Bear, Weber, and Provo River basins are all in the near normal range, but the Virgin River basin only has a 26% of accumulating enough snow to have an average runoff year.

The Utah Surface Water Supply Index (SWSI) reflects the pattern to the SNOTEL sites, with more water available in the northern part of the state. The southern basins are low with the Moab, Upper Sevier, Lower Sevier, and Virgin basins below zero and the Beaver River basin just slightly above zero. With the exception of the Bear basin, which has the lowest SWSI at -2.4, the northern basins are above average. While the snowpack is above average in the Bear River basin, the reservoirs are still low due to the drought of previous years. The SWSI in Weber, Provo, West Uintah, Price, and San Rafael basins continue to have SWSI of 2 or greater. According to the NRCS, a dry fall and early winter reduced the soil moisture values across the state, which could negatively impact spring runoff.

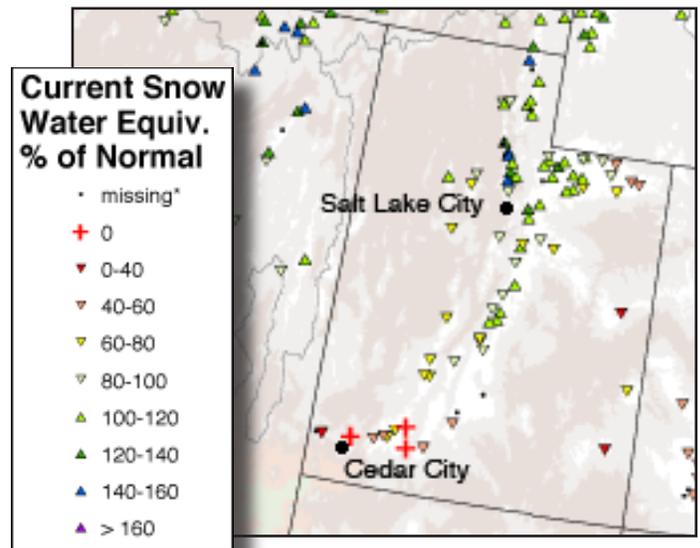
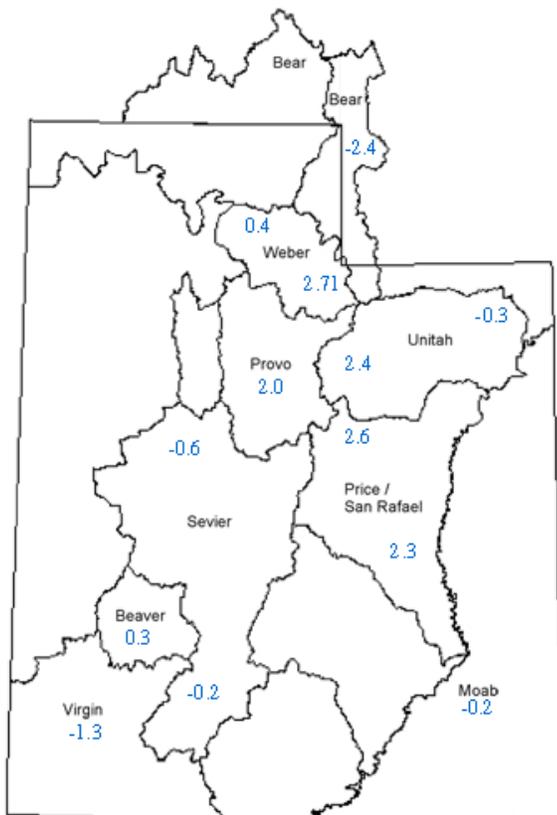


Figure 9a. Current snow water equivalent (SWE) as a percent of normal for SNOTEL sites in Utah as of March 6, 2006. **This is provisional data.** For current SNOTEL data and plots of specific sites, see <http://www.cbrfc.noaa.gov/snow/snow.cgi> or <http://www.wcc.nrcs.usda.gov/snow/>



Notes

Figure 9a shows the SWE as a percent of normal (average) for SNOTEL sites in Utah. According to 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 (Figure 9b) are scaled from +4.1 (abundant supply) to -4.1 (extremely dry) with a value of zero (0) indicating median water supply as compared to historical analysis. SWSI’s are calculated in this fashion to be consistent with other hydroclimatic indicators such as the Palmer Drought Index and the [Standardized] Precipitation Index.” See page 9 for the SPI.

Figure 9b. Utah Surface Water Supply Index (data through 3/01/06).

On the Web

- For current maps of SWE as a percent of normal like in Figure 9a, go to: <http://www.wcc.nrcs.usda.gov/gis/snow.html>.
- The Utah SWSI, along with more data about current water supply status for the state, can be found at: <http://www.ut.nrcs.usda.gov/snow/watersupply/>.
- The Palmer Drought Index is found on NOAA’s drought page: www.drought.noaa.gov
- For current streamflow information from USGS, visit: <http://water.usgs.gov/waterwatch/>



Temperature Outlook April - August 2006

Source: NOAA Climate Prediction Center

According to the NOAA Climate Prediction Center, the southwestern and southern U.S. including much of the Intermountain West, has an increased risk of above average temperatures in April 2006 (Figure 10a) and forecast periods through the spring of 2006 (Figures 10b-d). All of Utah, Wyoming, and Colorado are included through the April 2006 forecast period, and much of Utah and Colorado are included through the summer forecast periods (Figure 10b-d). The temperature probabilities for the April 2006 have been revised from the corresponding outlook issued last month, with the outlook now favoring a much larger area of above normal temperatures with higher probabilities over much of the South mainly because of dry conditions and many forecast tools.

Although La Niña conditions are expected to continue for the next three to six months its effect on the climate of the North American region, including the Intermountain West, for the next season or two is expected to be weak. For a discussion of the predictive signals that usually influence seasonal forecasts, see Precipitation Outlook page in the December 2005 Summary, which can be found on the WWA home page.

The outlooks for the 2005-2006 winter to date have been in the above-average category, and these outlooks have verified, i.e., average temperatures were in the upper tercile for much of the intermountain west for the December 2005-February 2006 forecast period (see box on page 1 and NOAA press release, <http://www.noaanews.noaa.gov/stories2006/s2591.htm>).

Notes

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

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

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

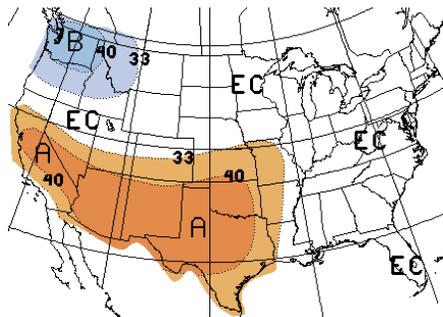


Figure 10a. Long-lead national temperature forecast for April 2006. (released Mar. 16, 2006)

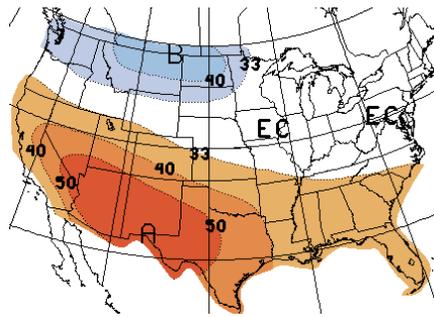


Figure 10b. Long-lead national temperature forecast for Apr. - Jun. 2006. (released Mar. 16, 2006)

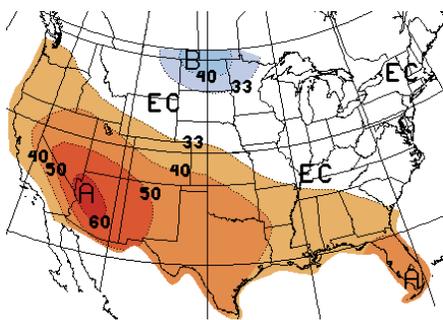


Figure 10c. Long-lead national temperature forecast for May - Jul. 2006. (released Mar. 16, 2006)

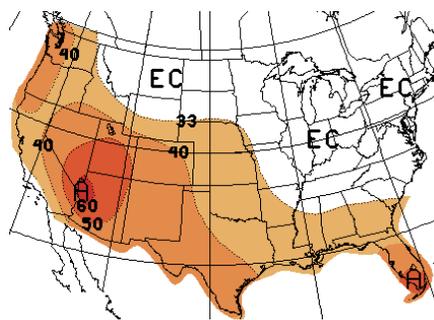
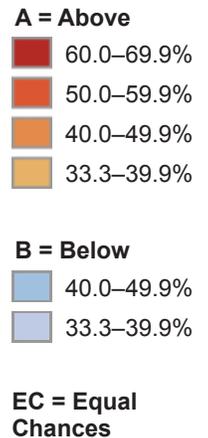


Figure 10d. Long-lead national temperature forecast for Jun. - Aug. 2006. (released Mar. 16, 2006)



On the Web

- For more information and the most recent forecast images, visit: http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html. Please note that this website has many graphics and may load slowly on your computer.
- The CPC "discussion for non-technical users" is at: <http://www.cpc.noaa.gov/products/predictions/90day/fxus05.html>
- For IRI forecasts, visit: http://iri.columbia.edu/climate/forecast/net_asmt/.
- More information about temperature distributions at specific stations in Colorado, Utah, Wyoming, and across the West can be found at the Western Regional Climate Center, <http://www.wrcc.dri.edu/CLIMATEDATA.html>.



Precipitation Outlook April - August 2006

Source: NOAA Climate Prediction Center

The spring seasonal precipitation forecast issued March 26th by the NOAA Climate Prediction Center (CPC) show the Intermountain West as having “equal chances” of above-average, near-normal or below-average precipitation for the April 2006 forecast period (figure 11a) and spring forecast periods (Figure 11b-d). However, the precipitation outlook for April-June 2006 calls for drier than normal conditions over most of the southeast and in the western portions of the central and southern Plains. These drier conditions may extend into southern Utah and Colorado. There is an indication of above normal precipitation in northwest Colorado and western Wyoming in the August-October forecast periods (not shown). Forecast methodologies are unable to make any other predictions for the region through the forecast period due to a lack of strong predictive signals from ENSO or other sources.

A slightly enhanced summer monsoon is forecast for the May-July 2006 and following forecast periods for Arizona due to hints from a forecast tool based on soil moisture, which is currently very dry in the Southwest (not shown, see CPC web page). A wet monsoon is also suggested by some of the dynamical models... and composites of summers following past seasons with La Niña or deficient cold-season snow pack in the great basin.

Although La Niña conditions are expected to continue for the next three to six months, its effect on the climate of the North American region, including the Intermountain West, for the next season or two is expected to be weak. For a discussion of the predictive signals that usually influence seasonal forecasts, see Precipitation Outlook page in the December 2005 Summary, which can be found on the WWA home page.

Notes

The seasonal precipitation outlooks in Figures 11a-d predict 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 drier 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 precipitation outlook, areas with light brown shading display a 33.3-39.9% chance of below-average, a 33.3% chance of near-average, and a 26.7-33.3% chance of below-average precipitation. A darker brown shade indicates a 40.0-50.0% chance of below-average, a 33.3% chance of near-average, and a 16.7-26.6% chance of below-average precipitation, and so on. Correspondingly, green shades are indicated for areas with a greater chances of above average precipitation.

Equal Chances (EC) indicates areas for which the models cannot predict the precipitation 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.

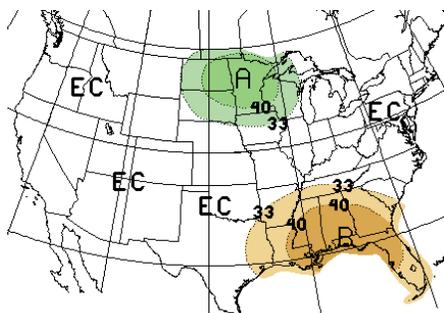


Figure 11a. Long-lead national precipitation forecast for April 2006. (released Mar. 16, 2006)

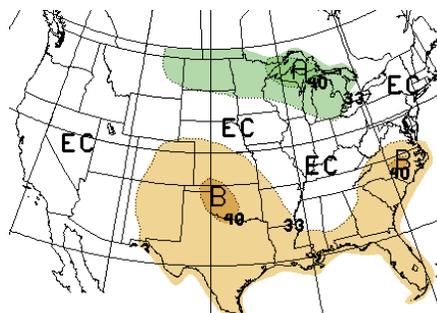


Figure 11b. Long-lead national precipitation forecast for Apr. - Jun. 2006. (released Mar. 16, 2006)

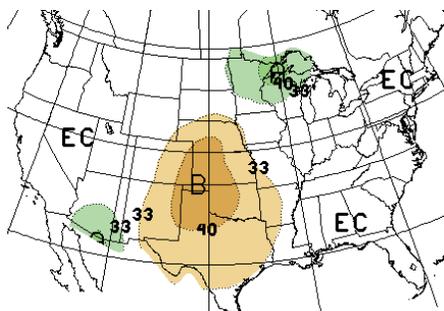


Figure 11c. Long-lead national precipitation forecast for May - Jul. 2006. (released Mar. 16, 2006)

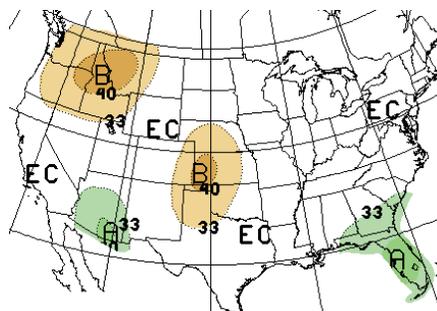


Figure 11d. Long-lead national precipitation forecast for Jun. - Aug. 2006. (released Mar. 16, 2006)

- 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 information and the most recent CPC forecast images, visit: http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html. Please note that this website has many graphics and may load slowly on your computer.
- The CPC “discussion for non-technical users” is at: <http://www.cpc.ncep.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>.
- The CDC experimental guidance product, including a discussion and executive summary, is available on the web at: <http://www.cdc.noaa.gov/people/klaus.wolter/SWcasts/index.html>



Seasonal Drought Outlook through June 2006 Source: NOAA Climate Prediction Center

The Seasonal Drought Outlook predicts intensification of drought in some areas and improvements in other areas of the Intermountain West region for the period of April through June 2006 (Figure 12). According to NOAA’s Climate Prediction Center (CPC), extreme southern **Colorado** is in moderate drought now (D1 on the Drought Monitor, see page 7), but an early March storm brought relief to parts of the region and generated the first significant precipitation in several months. Additional drought relief is expected during the first few weeks of the outlook period. Despite the short-term relief, there are indications that the spring will be dry and warm for **Colorado** (See pages 13 and 14 for temperature and precipitation outlooks). As a result, the drought is expected to persist, with possible further expansion from the Great Plains into eastern **Colorado**.

Drought conditions are not indicated for **Utah** and parts of **Wyoming** can expect improvement. NOAA CPC predicts ongoing

ing drought with some improvement for parts of south-central and eastern **Wyoming**, with the northeast corner expected to see the most decrease in drought status in the next three months.

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.

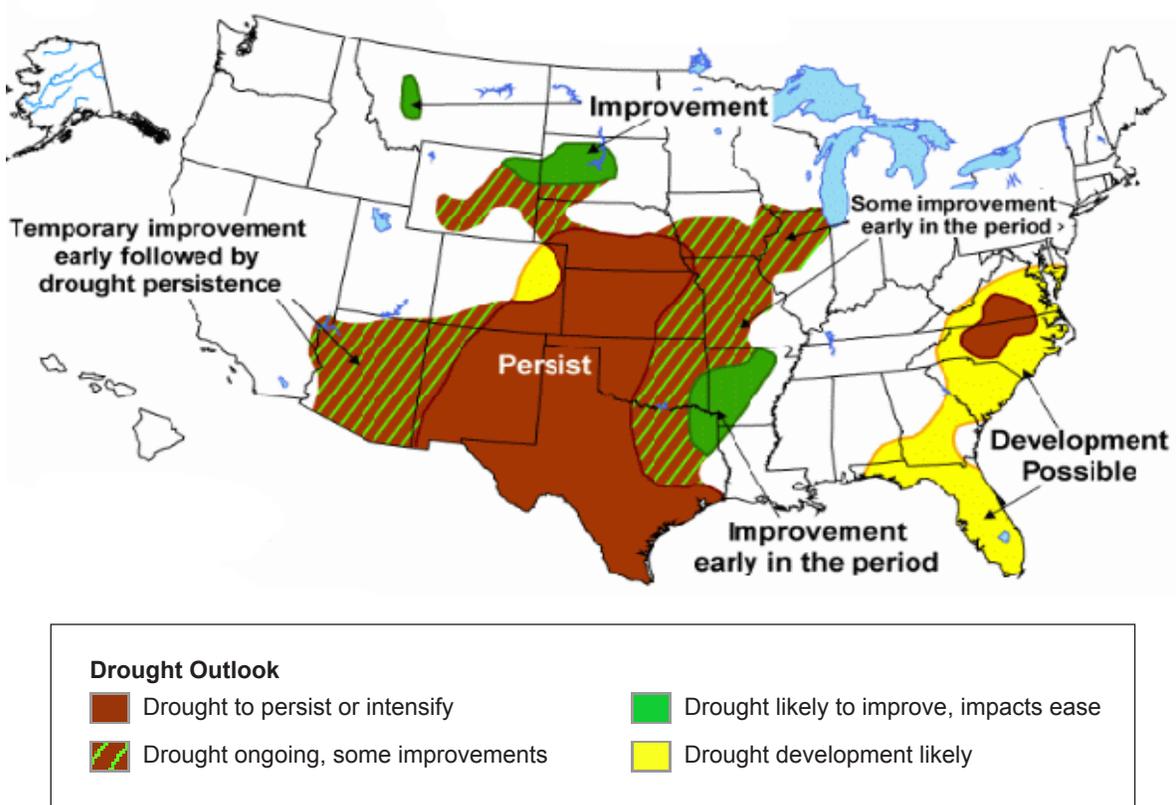


Figure 12. Seasonal Drought Outlook through June 2006 (release date March 16, 2006).

On the Web

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



El Niño Status and Forecast

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

According to the NOAA CPC *ENSO Diagnostic Discussion* issued March 9th, La Niña conditions – cold sea surface temperature (SST) anomalies in the eastern tropical Pacific -- are likely to continue during the next 6-9 months. Weak La Niña conditions have developed during the past few months as SST anomalies in the central equatorial Pacific became increasingly negative through January and February (Figure 13a), but now appear to have “bottomed out.” Patterns of anomalous atmospheric circulation and precipitation are also consistent with La Niña. Although La Niña conditions are expected to continue for the next three to six months its effect on the climate of North America for the next season or two may be weak.

The forecast for ENSO is based on a number of dynamical and statistical models projecting SSTs. The range of possible SSTs in the region defining ENSO is shown in a graph produced by the International Research Institute for Climate and Society (IRI, Figure 13b). This figure plots the temperatures in the “Niño 3.4” region from model forecasts issued during late January and early February 2006, and shows a considerable range of possible sea surface temperature conditions for the coming 10 months. Most forecasts indicate continuation of weak La Niña conditions over the next season or two, then transitioning to ENSO-neutral conditions by mid-2006. In mid-March 2006, weekly SST observations in the NINO3.4 region negative SST anomalies of -0.7C. Overall, tropical Pacific oceanic and atmospheric conditions point to weak La Niña conditions, with a tendency for a return toward the average during northern spring 2006.

Notes

Two graphics in Figure 13a produced by NOAA show the observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. This data is from the TOGA/TAO Array of 70 moored buoys spread out over the Pacific Ocean, centered on the equator. These buoys measure temperature, currents and winds in the Pacific equatorial band and transmit data in real-time. NOAA uses these observations to predict short-term (a few months to one year) climate variations.

Figure 13b shows multiple forecasts for SST in the Niño 3.4 region for nine overlapping 3-month periods from September 2005 to July 2006. “Niño 3.4” refers to the region of the equatorial Pacific from 120°W to 170°W and 5°N to 5°S, which is one basis for defining ENSO sea surface temperature anomalies. Initials at the bottom of the graph represent groups of three months (e.g. SON = Sept-Nov). The expected skills of the models, based on historical performance, are not equal to one another. The skills also generally decrease as the lead-time increases. Forecasts made at some times of the year generally have higher skill than forecasts made at other times of the year. They are better when made between June and December than between February and May. Differences among the forecasts of the models reflect both differences in model design and actual uncertainty in the forecast of the possible future SST scenario.

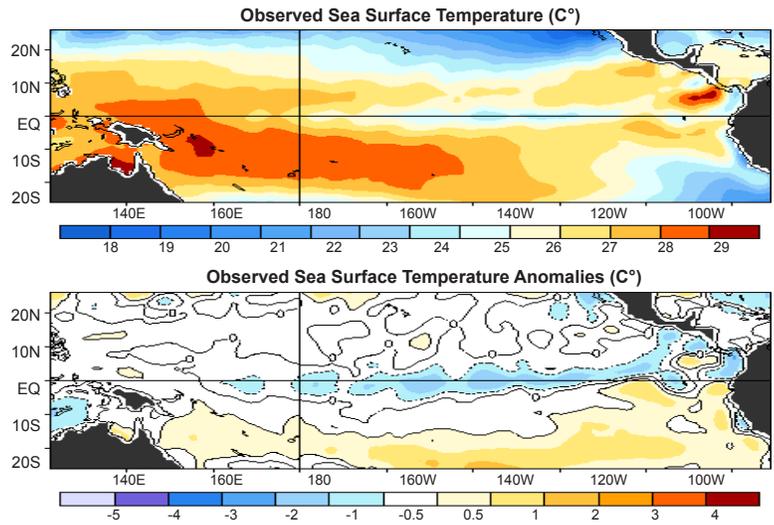


Figure 13a. Two graphics showing the observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. The Niño 3.4 region encompasses the area between 120°W-170°W and 5°N-5°S. The graphics represent the 7-day average centered on March 8, 2006.

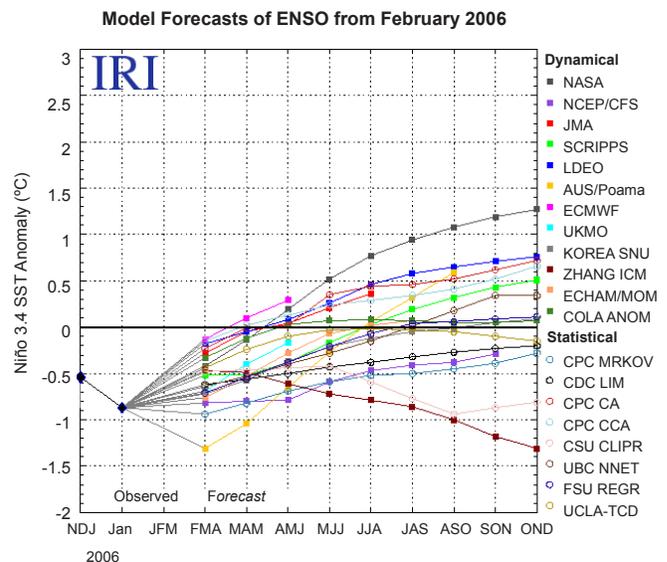


Figure 13b. Forecasts made by dynamical and statistical models for sea surface temperatures (SST) in the Niño 3.4 region for nine overlapping 3-month periods from February to December 2006 (released February 16, 2006). Forecasts are courtesy of the International Research Institute (IRI) for Climate and Society.

On the Web

- For a technical discussion of current El Niño conditions, visit: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ens0_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/ens0.shtml#current>.
- For more information about El Niño, including the most recent forecasts, visit: <http://iri.columbia.edu/climate/ENSO/>.



Water Supply Outlook for the 2006 runoff Season

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

The water supply outlook for the Intermountain West Region as of March 1 (Figure 14) remains similar to the water supply outlook in the January Climate Summary. Water supplies across the region are projected to be average or above average in northern **Colorado**, southern **Wyoming** and most of eastern **Utah**. There were some decreases in these areas since January and none of the basins are projected to receive over 129% of average water supplies. Southern **Colorado** and southern and western **Utah** remain below average. Parts of the Sevier, Virgin and Escalante River basins in **Utah** and parts of the Arkansas, Rio Grande and combined San Juan, Animas, Dolores, and San Miguel River basins in **Colorado** are projected to have water supplies below 50% of average.

Early March storms (after the data for this map were collected) increased snowpack conditions in the southwestern parts of both **Utah** and **Colorado**, particularly the Virgin River basin in **Utah** and the San Juan Mountains of **Colorado**. This increased accumulation should increase their water supply outlooks as well.

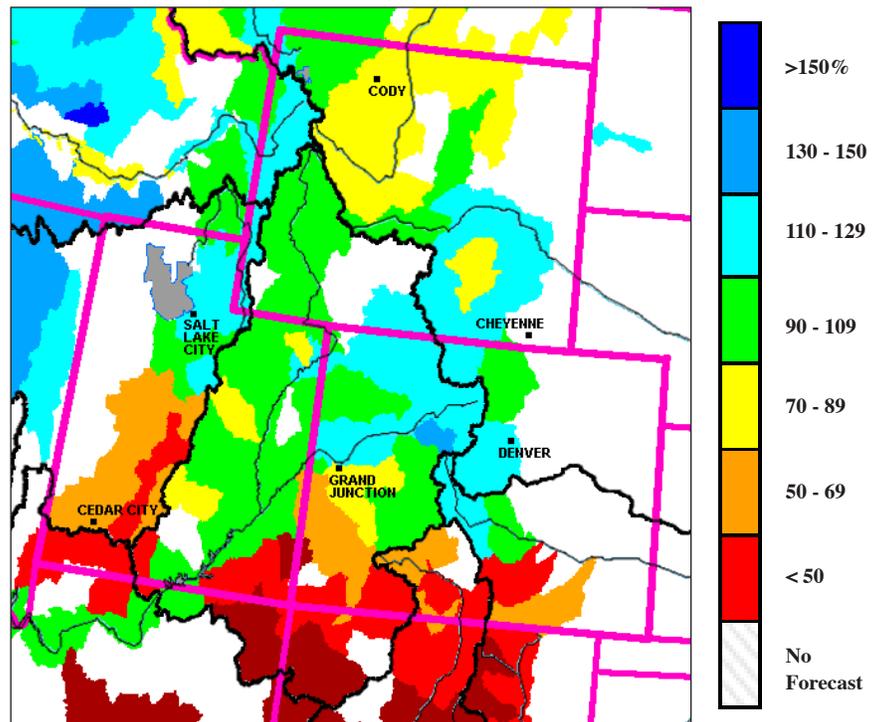


Figure 14. NRCS map showing the expected natural streamflows for spring and summer in the Intermountain West region as a percent of average streamflows. (data through March 1, 2006)

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 14 shows the forecasts of natural runoff, based principally on measurements of precipitation, snow water equivalent, and antecedent runoff (in

fluenced 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.

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/>



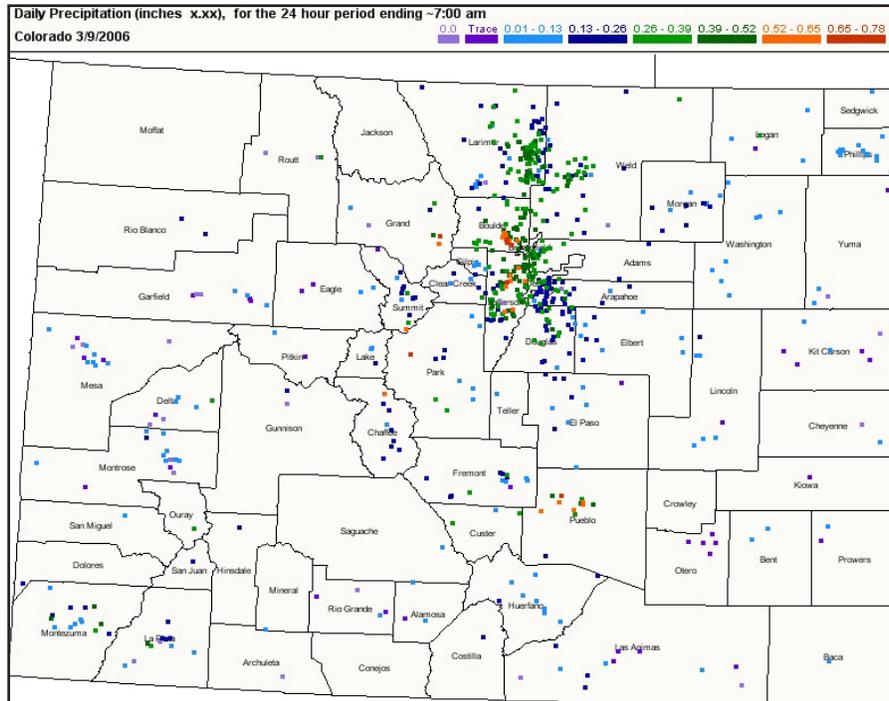


Figure 15c: Map showing the location of CoCoRaHS volunteers’ weather stations in Colorado. This map also shows precipitation data collected on March 9, 2006.

avoid them, units of observation, and how to deal with the difficulties of measuring hail and the challenges of melting, settling and drifting snow. By providing high quality, accurate measurements on the internet, the observers are able to supplement existing official weather networks with very detailed local data from their neighborhoods. Data collected in Colorado since 1998 show that to be able to accurately map rainfall patterns from summer convective storms, a density of at least one station per 3-4 square kilometers is needed. Over sparsely populated rural areas at least one station per 100 square kilometers is desirable. Volunteers are strongly encouraged to attend group training sessions lead by CoCoRaHS staff or trained trainers. CoCoRaHS staff are working to implement a simple certification process that will assure that all volunteers entering data on the website have learned the basic elements of observation.

Volunteer participation is now increasing spontaneously, mostly by word of mouth, with new applications arriving every day. Volunteers can report by phone, but most enter data on-line using an interactive web site: <http://www.cocorahs.org>. Current observations as well as past data are immediately available in map and table form for participants, project scientists, and the public to view (Figure 15c).

One of the very satisfying parts of CoCoRaHS, for both the staff and volunteers, is seeing how scientists use the data. Several dozen organizations have become CoCoRaHS local or regional sponsors because accurate and timely precipitation measurements provide valuable data that help thier organizations. Examples of some current sponsors and data users include:

- NOAA’s National Weather Service uses reports of heavy rain and hail to help issue severe weather warnings or to verify local forecasts.
- The US Dept. of Agriculture utilize rain, hail and snow reports to assess crop conditions, determine drought severity, and predict crop production and yield.
- The U.S. Bureau of Reclamation is supporting the expansion of CoCoRaHS in order to track precipitation patterns and snow melt more carefully in order to provide better forecasts of stream levels and flow volumes.

Many other local and state agencies and business are also interested in using and helping collect local rainfall data including several state natural resource departments, local water and storm water utilities, agricultural organizations, and local conservation districts. Anytime there is a storm, there are many organizations who benefit from CoCoRaHS data by knowing precisely where the moisture fell.

References: Cifelli, R., N. Doesken, P. Kennedy, L.D. Carey, S.A. Rutledge, C. Gimmestad and T. Depue, 2005: The Community Collaborative Rain, Hail, and Snow Network: Informal education for scientists and citizens. *Bull. Amer. Meteor. Soc.*, Vol. **86**, 8(Aug), 1069-1077.

