Intermountain West Climate Outlook

by The Western Water Assessment

Issued March 10, 2005

March 2005 Climate Summary

Hydrological Drought – Drought continues to worsen in the northwest, including Wyoming, but it is not as severe in the southwest, including Utah and Colorado. Climate outlooks favor the persistence of drought in Wyoming and a slight improvement in parts of Utah and Colorado.

Temperature – Temperatures were close to average in the Intermountain West region in February, with some areas cooler and some warmer than average. This differs from February of 2004, when the entire region was cooler than average.

Precipitation and Snowpack – Precipitation amounts for February in the Intermountain West were very low in northeastern Colorado and northern Wyoming, but southern Utah and southwestern Colorado received greater than normal precipitation amounts. Following these precipitation trends, the snowpack is above average in Utah, southwestern Colorado and southwestern Wyoming, with some places in southwestern Utah up over 150% of average. Northern Colorado and northern Wyoming snowpacks are lower than average, with parts of Wyoming at 50% of normal snowpack for this time of year.

Climate Forecasts – Climatologists are predicting a trend towards higher temperatures across much of the western U.S., which primarily reflects long term temperature trends. Climate models predict below median precipitation in the Pacific northwest and above average precipitation across the southwest, including Utah and Colorado, for the rest of the winter and into spring. This pattern also fits the traditional late winter/early spring El Niño pattern across the West.

El Niño – A gradual transition from weak El Niño conditions to neutral conditions within the next three months is expected.

In This Issue

Introduction to Western Water Assessment and the Intermountain West Climate Outlook.

The Western Water Assessment (WWA) is an integrated research project composed of scientists from NOAA, the University of Colorado and Colorado State University who produce information about climate variability and change.

By improving the level of knowledge and understanding about forecasts as well as climate phenomena, WWA hopes to develop a better dialogue between climate researchers, potential users, and operational providers of climate information, in order to better understand the need for climate information and to improve climate services.

The Intermountain West Climate Outlook (IWCO) is a product designed to provide the latest climate information in a simple compact document that water managers can easily understand. The IWCO focuses on the states of Wyoming, Utah and Colorado in an effort to help readers understand the climate of their region and the effects of climate on the availability of annual water resources. While the March IWCO presents information skewed towards Colorado water managers, future issues will have the broader regional scope.

Contact Us - We want to hear your questions and feedback! Please e-mail us at WWAoutlook@sciencepolicy.colorado.edu

The Intermountain West Climate Outlook is published monthly by Western Water Assessment in cooperation with CIRES, the Center for Science and Technology Policy Research, and the NOAA Climate Diagnostics Center.

April 2005 Snowpack Outlook for Colorado

By Shaleen Jain, NOAA Climate Diagnostics Center and University of Colorado at Boulder

Despite a dry February, the seasonal snowpack continues well above average the Rio Grande and San Juan/Animas River basins. Marked improvements occurred in the Gunnison River Basin snowpack – 84% in early February to 133% in early March. By contrast, the Yampa, Colorado Headwaters, and Platte basin snowpacks continue to be below average.

With April 1 approaching, there is strong interest in estimates of the April 1 snowpack, long the benchmark for planning and decisions for water-related resource management in Colorado.

Climatologically, March can deliver significant moisture in Colorado, particularly in the South Platte basin. Tropical Pacific sea surface temperatures ("SSTs") are the best known predictor of above average spring precipitation in Colorado, with warm temperatures correlated with above average March/April/May precipitation. Current tropical Pacific SSTs in the so called "NINO3" region indicate near neutral, or average, conditions. These average SSTs do provide some useful information to guide estimates of Colorado's expected water supply for this year.

Analysis of the 1968-2005 basin average snowpack for the eight major river basins in Colorado allows us to examine the range of likely April 1 outcomes consistent with the current levels of snowpack (as reported by Mike Gillespie at NRCS in early March). Figure 1 shows the expectations for April snowpack based on two cases: (1) likely snowpack estimates using only the observations in early March (red boxplots) and (2) likely snowpack estimates based on both the March observations and the inclusion of tropical Pacific climate information (green boxplots). March 1 observations are shown by filled circles. The bottom of each box shows the lower 33rd percentile, the middle line in the box shows the 50th percentile (median), and the top of the box indicates the upper 67th percentile of all the years used in each analysis. The dashed lines (the "whiskers") report the 10th and 90th percentile of the calculated spread.

Using the March observations only (red), the boxplots of April 1 snowpack show that the northern basins (North Platte, South Platte, and Yampa) will

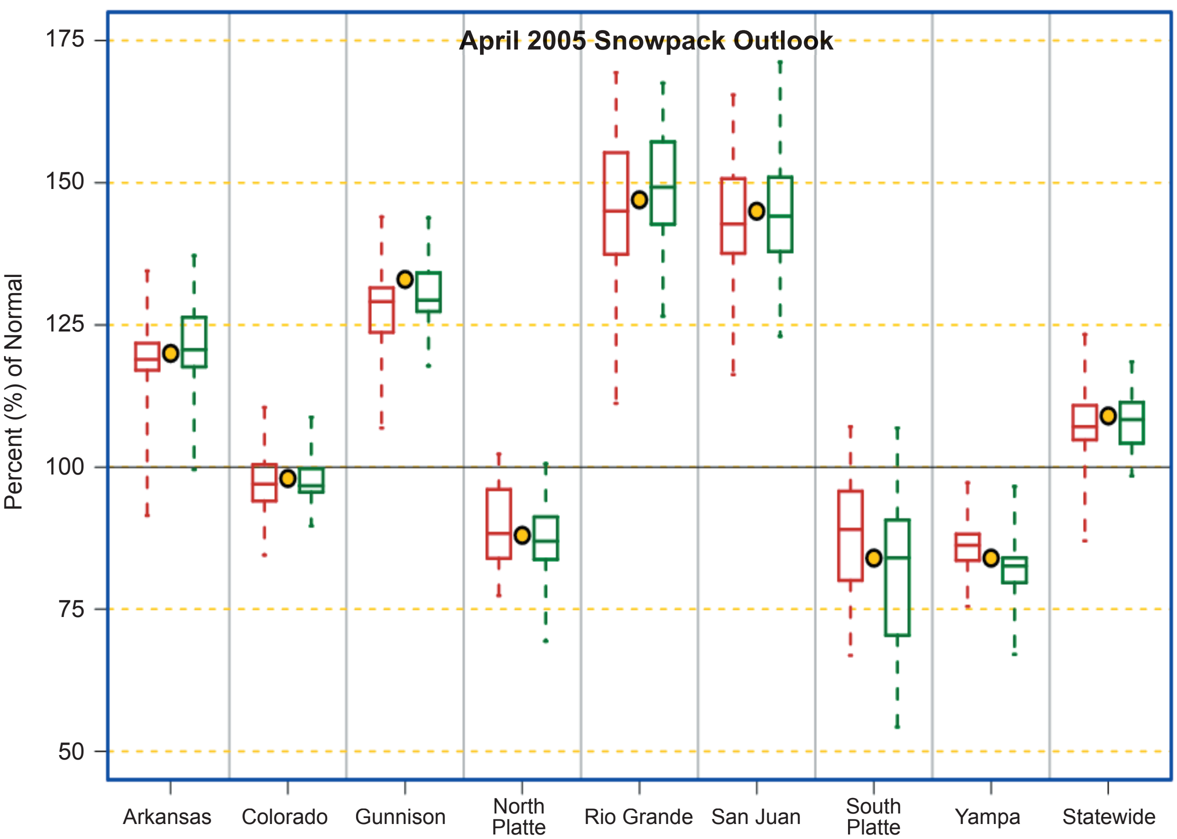


Figure 1: This graphic shows the predicted snowpacks as a percent of normal for each of the eight major river basins in Colorado and the whole state for April 1, 2005. Black circles filled with yellow represent the current snowpack, as of March 1, 2005. Snowpack predictions were calculated using only current conditions (red boxes) and current conditions, plus El Niño status (green boxes). The boxes show the lower tercile, median, and upper tercile probabilities (33rd, 50th and 67th percentiles respectively), and the "whiskers" report the 10th and 90th percentile of the calculated spread.

likely (33^{rd} to 67^{th} percentiles) stay below 100%. The Colorado Headwaters have been just under 100%, and will most likely remain in that territory. The southern basins appear likely to be in the 115-150% range. Note that the whiskers (10^{th} to 90^{th} percentiles) for all basins show a wide range of possible outcomes.

Using the March observations conditioned by the near-neutral tropical Pacific SSTs for the January/February period (green), the boxplots of April 1 snowpack do not appear to be markedly different from either the March snowpack measurements (black circles) or the April 1 estimates from observations alone (red boxplots). One noteworthy aspect for a number of basins is that the SST-conditioned estimates of April 1 snowpack show a general tightening of the likely (33^{rd} to 67^{th} percentile) outcomes. (South Platte and Arkansas appear to be exceptions). Tighter boxplots indicate that the SSTs downgrade the potential of unusually wet or dry March precipitation, thus narrowing the likely 33^{rd} to 66^{th} percentile values for April 1. The observational analysis presented here does not explicitly consider the losses in snowpack due to meteorological conditions causing early melt, wind-driven redistribution and losses, and losses to sublimation.

Shaleen Jain is a research scientist at the NOAA Climate Diagnostic Center and his work focuses on statistical based streamflow forecasts. His other research interests include Hydroclimatology, Climate-related Hydrologic Risk, Dendrohydrology, Integrative Hydrologic Science, Statistical Analysis of Environmental Data, and Climate Information for Water Applications.

New Research Spotlight

Increased Variability in Annual Streamflows in Four North American River Basins

Research by: Shaleen Jain, Martin Hoerling and Jon Eischeid of the NOAA-CIRES Climate Diagnostics Center in Boulder, Colorado

Article by Jessica Lowrey, NOAA-CIRES Climate Diagnostic Center and the University of Colorado at Boulder

Climate researchers at NOAA's Climate Diagnostic Center (CDC) have found that annual streamflows in four western North American rivers have behaved more synchronized in recent decades, with larger amplitude swings between low and high flows. A recent paper by Jain and colleagues to appear in the Journal of Climate explores the question of reliability of runoff and synchroneity of annual stream flows in the Fraser, Colombia, Upper Colorado and Sacramento-San Joaquin River Basins.

Water managers and reservoir operators in western North America depend on water stored in the winter snowpack to provide water supplies for both cities and agriculture throughout the whole year. To ensure sufficient water supplies each year, these managers often use historical streamflow and runoff regimes, along with estimates of current snowpack to determine how to operate dams and canals to prevent either shortages or floods. A long-term change in the reliability of spring runoff could pose challenges for water managers in the future. Furthermore, if all three river basins in the U.S. experience either anomalously high or low flows in the same year, it could be more difficult for the U.S. Government to provide adequate drought relief or flood mitigation in each basin.

All four of the river basins in this study are snowmelt dominated, meaning the annual runoff is highly correlated to snowpack. The question becomes what climate states control snowpack growth; and whether these have lead-time predictability, for example seasons ahead. Climate researchers want to understand the causal mechanism of these states because the Pacific Ocean affects winter precipitation amounts in North America. To do this, researchers monitor both the Pacific sea surface temperature and the atmospheric pressure above the Pacific Ocean, and determine if there are pre-cursor patterns in these variables that correspond to patterns of winter snowfall and annual streamflows in the western U.S. For example, ENSO has been long-known to affect western North American climate. Jain and colleagues hypothesize that a mean warming of tropical oceans, as has occurred post 1970, may also be affecting the four western North American river basins.

Jain and his colleagues at CDC want to go beyond understanding the correlation between climate and streamflow to understanding how changes in the ocean-atmospheric circulation patterns cause changes in weather events. In addition, they want to predict how long term changes in the climate affect weather and streamflows in western North America so they can help water managers make better operational and long-term planning decisions for the future.

This paper was published in the March 2005 edition of the Journal of Climate. Jain, S., M. Hoerling, and J. Eischeid, 2005: "Decreasing Reliability and Increasing Synchroneity of Western North American Stream Flow." *Journal of Climate*: **18**(5), 613-618.

Temperature through 2/27/05

Sources: Western Regional Climate Center, High Plains Regional Climate Center

The Intermountain West was not consistently warmer or cooler than average for the month of February 2005 (figures 2a-b). The northern mountains in Colorado and the western mountains in Wyoming saw temperatures of 2-8°F cooler than average, but the rest of the region was either close to average or slightly warmer than average. The February temperatures in western Colorado, eastern Utah and most of Wyoming were 2-8°F above average. Continued warmer than average weather in the mountains could cause the snowpack to start melting earlier than normal and shorten the runoff season.

Last year at this time most of the region was experiencing cooler than average temperatures of at least 2°F below average, with the exception of northeastern Wyoming (figure 2c). According to the High Plains Regional Climate Center, for the plains region, February was the coldest month of the winter in 2004.

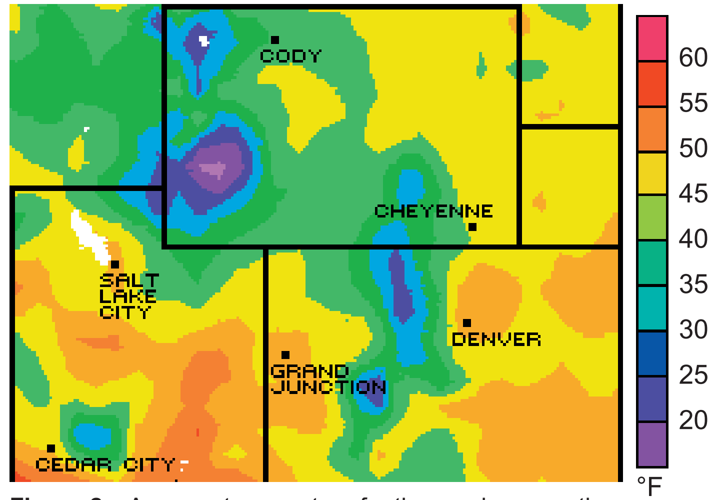


Figure 2a. Average temperature for the previous month in °F (January 29, 2005- February 27, 2005).

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.

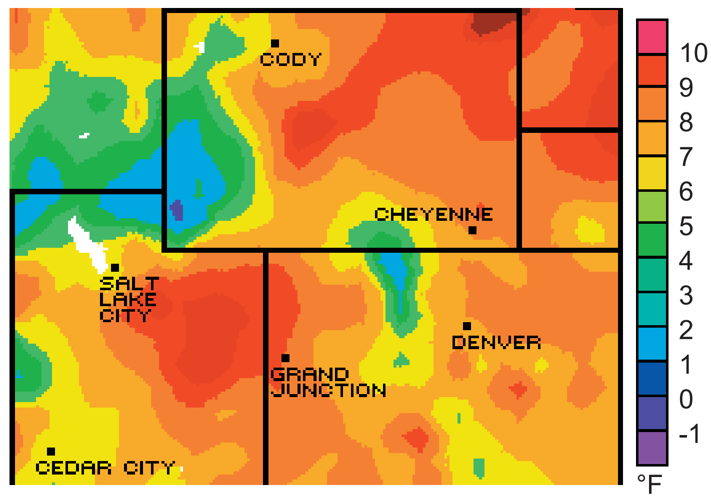


Figure 2b. Departure from average temperature for the previous month in °F (January 29, 2005- February 27, 2005).

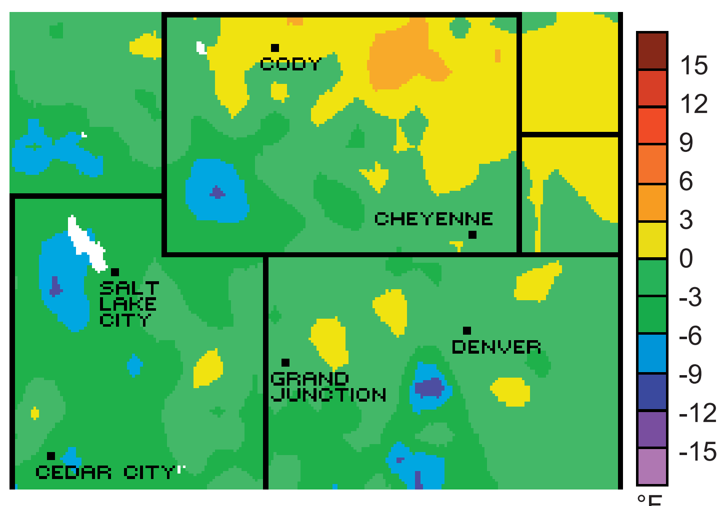


Figure 2c. Last year's departure from average temperature in °F (February 2004).

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 2/28/05

Sources: NOAA Climate Diagnostic Center, NOAA Climate Prediction Center

Precipitation in the Intermountain West region falls primarily as snow in February, and snowpack and snow water equivalent (SWE) depend on elevation. In the plains, however, some precipitation does fall as rain this time of year. The northwest and central mountains in Wyoming and the mountains in Colorado both received 1-3 inches of precipitation, while western Utah received 1-2 inches (figure 3a). For northern Wyoming those amounts were 30-80% of normal, with the lowest levels in north-central Wyoming (figure 3b). Likewise, precipitation totals for northeastern Colorado were less than 50% of normal. According to the National Weather Service, however, the snowpack in all of the Colorado River Basin is greater than it was last year at this time. In fact, some basins have a 50% greater snowpack than they did last year. (See http://www.crh.noaa.gov/gjt/ESF022505.htm for the NWS article and see page 7 for more information about the mountain snowpack.)

The precipitation since the start of the water year in October 2004 as a percent of normal has not changed very much since the January Climate Outlook was released in late January. All of Utah, western and southwestern Colorado, and southwestern Wyoming have had greater than 120% of normal precipitation, with parts of southwestern and central Utah up to 200% of normal. The rest of Colorado and southeastern Wyoming have had close to normal precipitation and there are pocket of northern Wyoming that have had up to 40% less than normal precipitation (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

Daily precipitation maps: http://www.cdc.noaa.gov/Drought/.

More precipitation maps: http://www.hprcc.unl.edu/products/current.html, http://www.wrcc.dri.edu/recent_climate.html.

NOAA precipitation/drought reports: http://lwf.ncdc.noaa.gov/oa/climate/research/2002/perspectives.html.

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

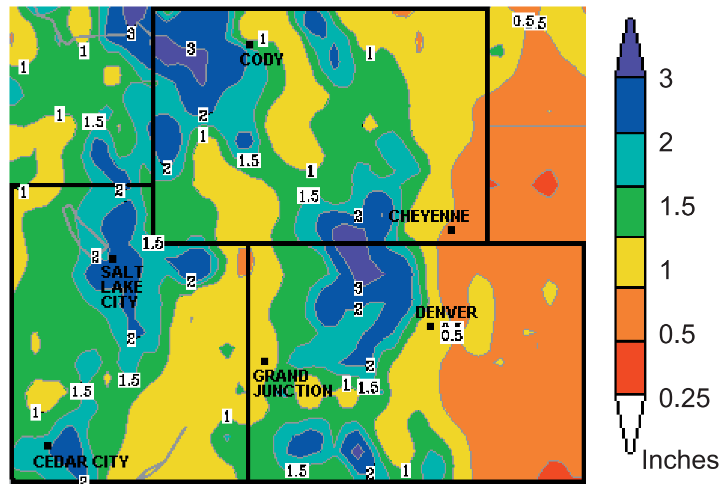


Figure 3a. Average precipitation for the previous month in inches (February 2005).

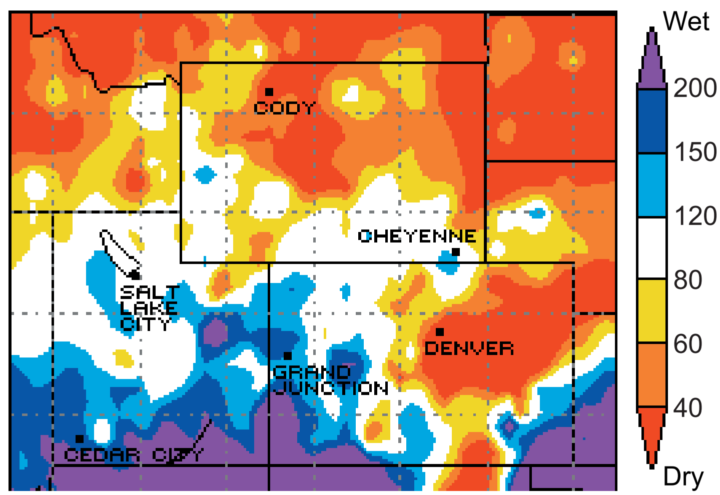


Figure 3b. Percent of normal precipitation for the previous month (January 30, 2004- February 28, 2005).

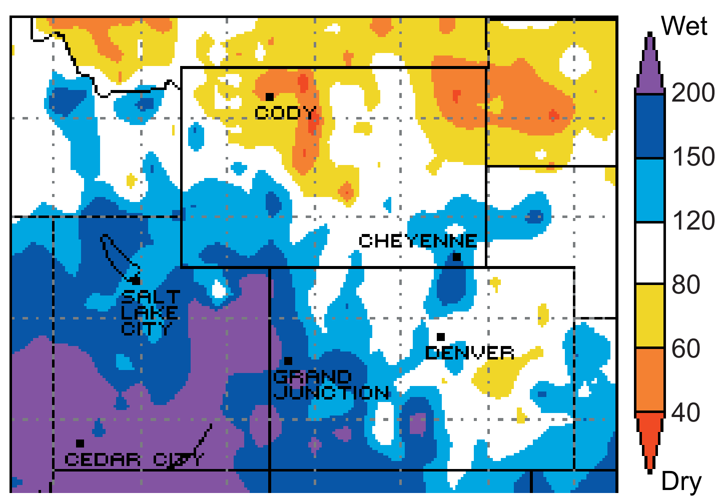


Figure 3c. Percent of average precipitation accumulated since start of water year (October 1, 2004- February 28, 2005).

U.S. Drought Monitor released 3/05/05

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

The western U.S. experienced a di-polar shift in drought conditions in the last month, i.e. the drought severity increased in the north and decreased in the south (figure 4). In the Intermountain West region, the changes were concentrated over Wyoming, which became drier, like the rest of the Great Plains and northern Rocky Mountains. The impacts indicators in southeast Wyoming were changed from H to AH to reflect dryness both in the short term and long term. Modeled soil moisture indices continued to show deteriorating conditions. As a result, D2 pushed eastward into west central Wyoming. Vegetation was extremely stressed in the Bighorn Basin of northern Wyoming, where D3 and D4 were expanded slightly.

While lower than normal precipitation in February caused parts of eastern Colorado and western Utah to develop into D0 drought status, most of Colorado and Utah did not change and remain in a D0 or D1 drought. However, February precipitation along the Colorado River in eastern Utah was above normal and therefore that area improved from a D2 to a D1 drought status.

Notes

The U.S. Drought Monitor 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 Richard Heim and Candace Tankersley, of NOAA's National Environmental Satellite and Informational Data Service (NESDIS) and National Climatic Data Center (NCDC).

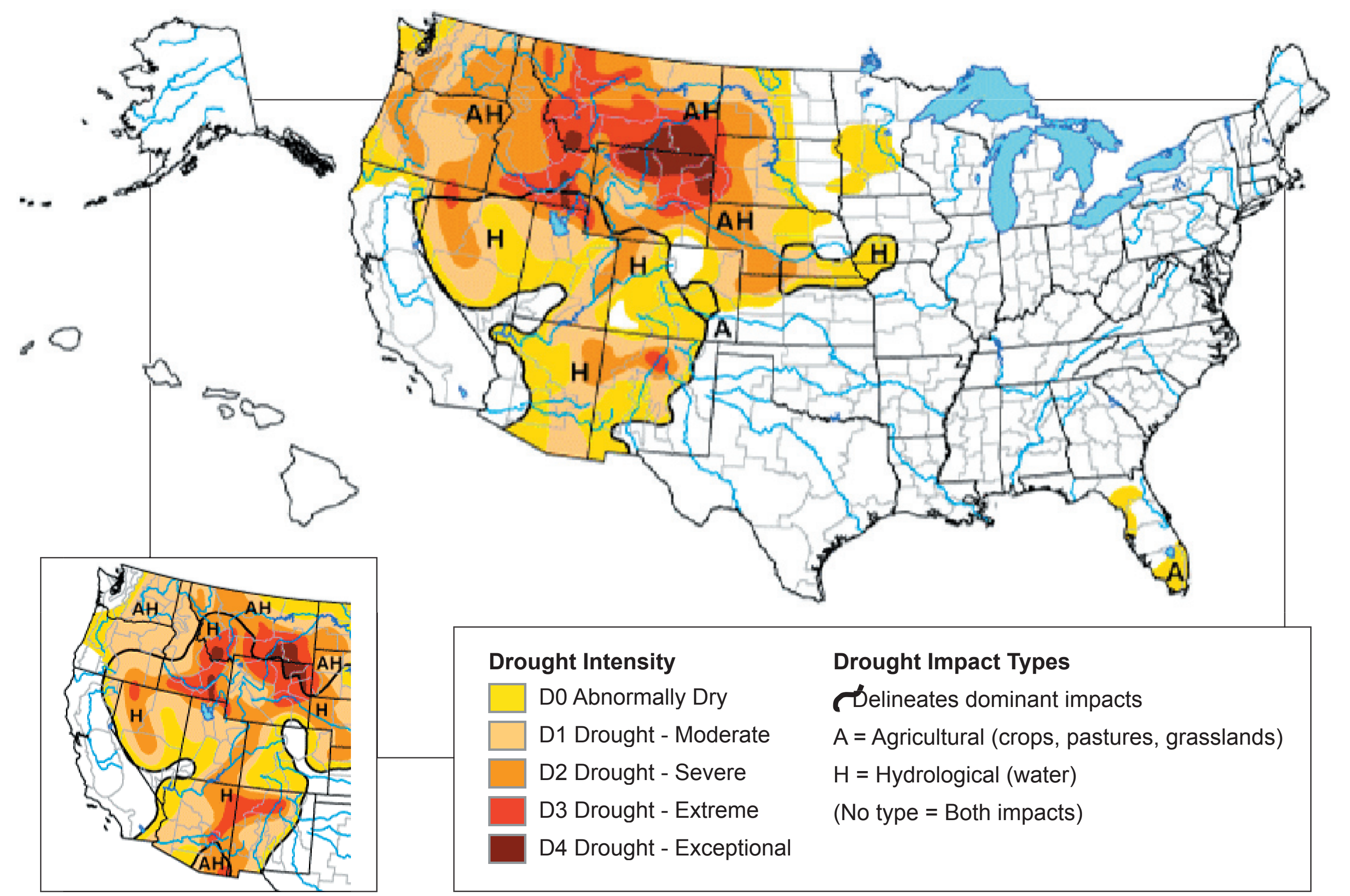


Figure 4. Drought Monitor released March 3, 2005 (full size) and last month February 1, 2004 (inset, lower left) for comparison.

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 3/07/05

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

Snowpack totals in **Colorado**, as of March 1 are 109% of average, compared to 114% of average last month. Snowpack totals across the southwestern basins are about 110% to 120% of their average seasonal maximum water equivalent, due to continued above-average precipitation for January and February. Further east and north, snowpack percentages decrease significantly. Those basins reporting the lowest percent of average accumulations for March 1 include the South Platte and Yampa-White, which are only 80% and 84% of average, respectively. At this point in the snow accumulation season, it is unlikely that snowpack totals will reach average levels by season's end across northern Colorado. (See page 2 predictions of April 1 snowpacks in Colorado)

The snowpack totals for **Utah** range from 103% in the Bear River basin to 237% in the southwestern part of the state. Most areas in northern Utah are 10% to 20% higher than last year at this time, but the Uintah Basin and everything south of Salina have 150% to 200% of the Snowpack totals of last year. While many outcomes remain possible in these areas, it is prudent to begin preparation for potentially high snowmelt streamflow this spring. Contrasting the higher than normal snowpack in the mountains are the snowpack totals at low elevations across the state, which are below average. Therefore, any outcome is still possible in northern Utah, including continued drought conditions. (See page 15 for streamflow outlooks.)

The snowpack levels in **Wyoming** range from less than 25% of normal in the northeast corner of the state to above 150% of normal in the Green River Basin in the southwest part of the state. The majority of the state has snowpack levels that are between 50% - 90% of normal and these levels correspond to the below average amount of precipitation that the northern part of the state has received since the start of the water year in October. (See page 5 for current precipitation conditions.)

Notes

Snow water equivalent (SWE) or snow water content (SWC) is calculated from measurements of snowpack depth, temperature, precipitation, soil moisture content, and soil saturation. 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 15 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.

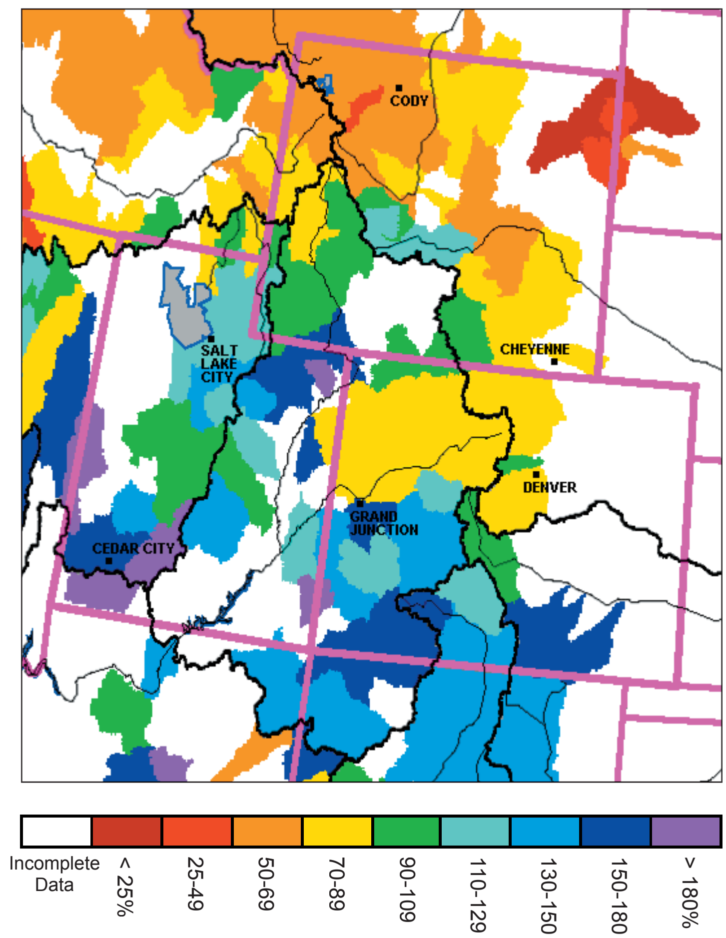


Figure 5. Snow water equivalent (SWE) as a percent of average for available monitoring sites in the Intermountain West as of March 1, 2005.

On the Web

Graphs like this and snowpack graphs of the western U.S.: http://www.wcc.nrcs.usda.gov/snowcourse/snow_map.html.

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.

Colorado Water Availability Status released 2/25/2005

Source: Colorado Climate Center at Colorado State University

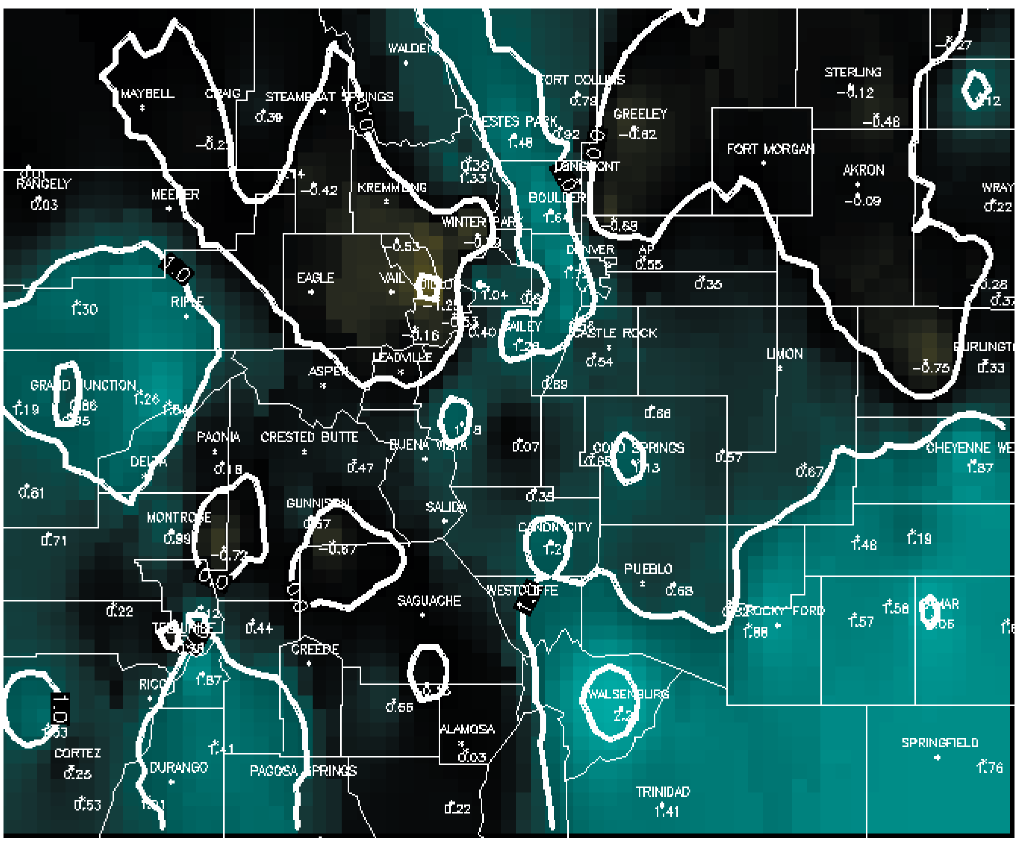
The Standardized Precipitation Index (SPI) can be used to monitor conditions on a variety of time scales. 3- and 6-month SPIs are useful in short-term agricultural applications and longer-term SPIs (12 months and longer) are useful in hydrological applications. The 12- month SPI for Colorado (Figure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

The SPI has not changed very much since December 2004. In most of Colorado, the SPI is in the "near normal" category, at zero SPI (black) and above (blue-green areas). Higher positive SPIs in the northern Front Range and the southeast corner of the state (darker green shading) indicate the wet conditions that prevailed in the previous calendar year. Some areas remain in dry conditions, including some parts of the northwestern plains, the central mountains, and the northwest (yellow shading).

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.

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.



Less than -3	Very Extreme drought
-2 to -3	Extreme
-1.5 to -2	Severe
-1 to -1.5	Moderate
-1 to 1	Normal conditions
1 to 1.5	Wet
1.5 to 2	Very Wet

Figure 6a. Standardized Precipitation Index for the last 12 months, ending in January 2005. (released 2/25/2005)

On the Web

For the current SPI map and surface water projections, visit: http://ccc.atmos.colostate.edu/standardizedprecipitation.php.
For maps and more information on the methodology behind SPI: http://ulysses.colostate.edu/standardizedprecipitation.php

Colorado Water Availability Status (continued) released 3/10/05

Source: Colorado Division of Water Resources, State Engineer

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. Anomalously high snowfall amounts in February allowed the Dolores, the Rio Grande and the Gunnison River Basins to improve their supply status and they are all in the abundant supply category now. On the other hand, anomalously low snowfall in the South Platte, Yampa and Upper Colorado River Basins caused their surface water supply outlook to decrease. While the South Platte and Upper Colorado River Basins are still in the near normal range, the Yampa River Basin is facing moderate drought conditions. The Arkansas River Basin has kept the same supply out look value since January, which is slightly below zero, but still near normal.

Notes

The Surface Water Supply Index (SWSI), developed by the Colorado Office of the State Engineer and the USDA Natural Resources Conservation Service, is used as an indicator of mountain-based water supply conditions in the major river basins of the state 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 6b were computed for each of the seven major basins in Colorado for March 1, 2005, and reflect conditions during the month of February 2004.

Surface Water Supply Index March 1, 2005

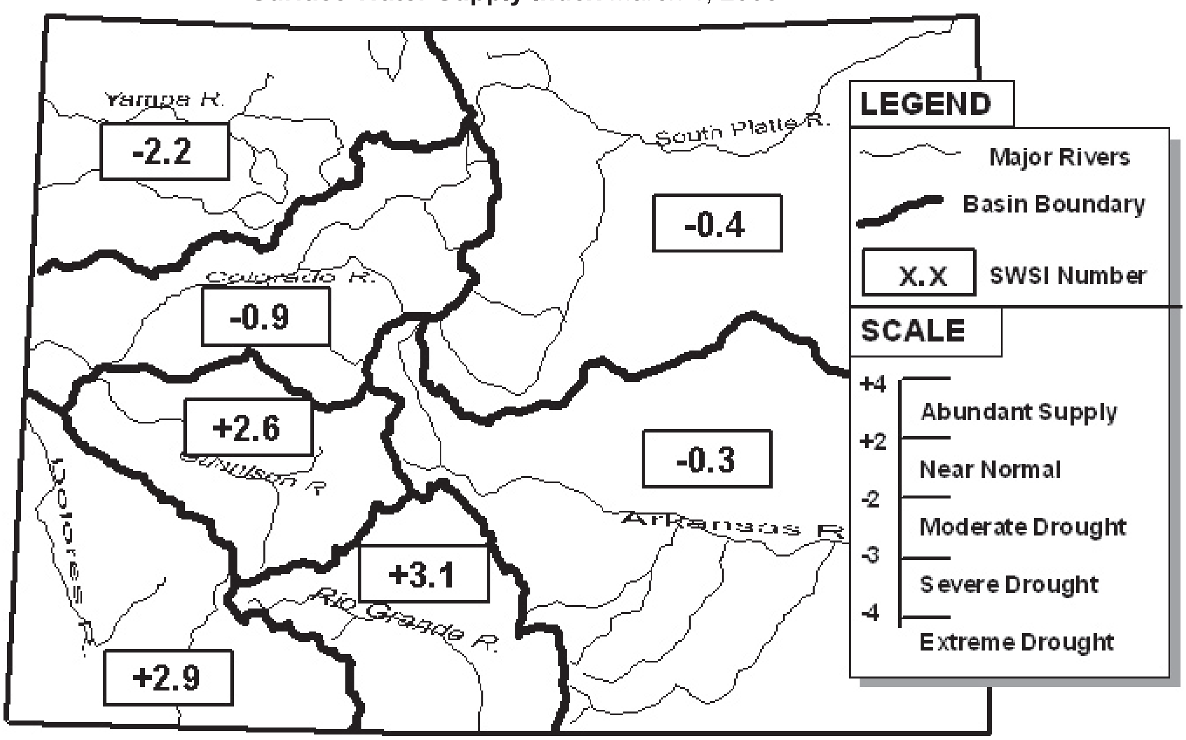


Figure 6b. Surface Water Supply Index. The map shows the projected streamflows by basin for spring and summer 2005, based on current conditions as of March 1. (released 3/10/05)

On the Web

For the current SWSI map, visit: http://www.co.nrcs.usda.gov/snow/watersupply/.

The Colorado Water Availability Task Force will hold its next meeting of the year on March 18th 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

Temperature Outlook March-July 2005

Source: NOAA Climate Prediction Center

The long-lead temperature forecasts from the NOAA Climate Prediction Center (CPC) show increased chances of above-average temperatures (in the upper third of temperatures observed since 1970) for much of the western United States through the March-July forecast period (figures 7a-d). The one-month forecast for March (figure 7a) is based on models predicting a persistence of a high pressure pattern over the Western U.S. during the first two weeks of March. The forecast for above-average temperatures continues for the latter periods (figures 7b-d), although most of Wyoming is not included in the area forecasted for above average temperatures after March-April- May.

The influence of El Niño is expected to wane in the late spring, and the outlook for late spring primarily reflects long term temperature and precipitation trends. There is an observed trend towards higher temperatures across much of the Western U.S., and this trend is a large part of the basis for the seasonal forecast.

Notes

These 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 percent chance of above-average, a 33.3 percent chance of near-average, and a 26.7-33.3 percent chance of below-average temperature. A shade darker brown indicates a 40.0-50.0 percent chance of above-average, a 33.3 percent chance of near-average, and a 16.7-26.6 percent 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.

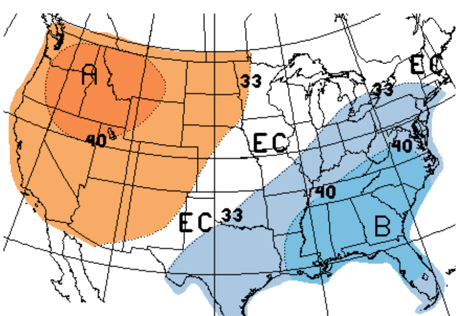


Figure 7a. Long-lead national temperature forecast for March 2005. (released February 28, 2005)

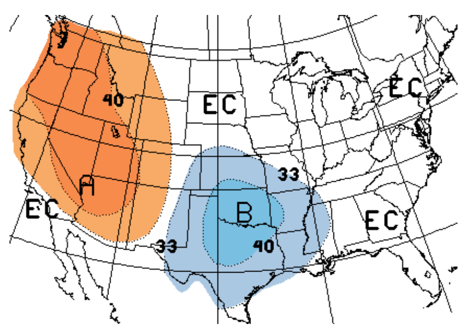


Figure 7b. Long-lead national temperature forecast for March – May 2005. (released February 17, 2005)

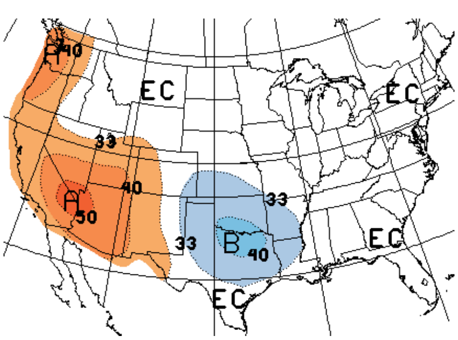


Figure 7c. Long-lead national temperature forecast for April – June 2005. (released February 17, 2005)

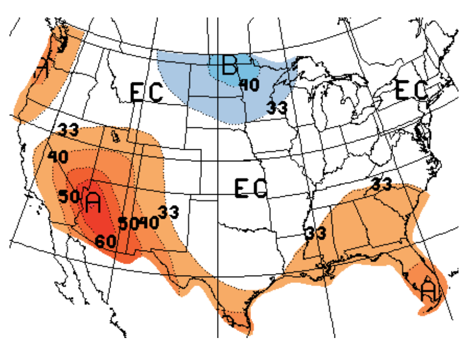


Figure 7d. Long-lead national temperature forecast for May – July 2005. (released February 17, 2005)

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

B = Below
- 40.0–49.9%
- 33.3–39.9%

EC = Equal Chances

On the Web

For more information and the most recent forecast images, visit: http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html. Note: website has many graphics and may load slowly on your computer. For IRI forecasts, visit: http://iri.columbia.edu/climate/forecast/net_asmt/.

Precipitation Outlook March - July 2005

Source: NOAA Climate Prediction Center

The tools used at the NOAA Climate Prediction Center (CPC) indicate that March 2005 (figure 8a) is expected to be similar to much of the previous winter, that is, below median precipitation in the Pacific northwest and above average precipitation across the southwest. This pattern also fits the traditional late winter/early spring El Niño pattern across the West. The long-lead precipitation forecasts (figure 8c-d) predict increased chances of above-average precipitation (in the upper third of precipitation observed since 1970) through the March-April-May forecast period for the southwestern U.S., including most of Colorado and Utah but not Wyoming, and increased chances of below-average precipitation in the Pacific Northwest.

El Niño is expected to wane, and impacts in the long-lead outlooks for seasons beyond March-April-May 2005 are expected to be negligible. The precipitation forecast for lead times forecast for April-June-July and beyond (Figure 8c-d) is for "equal chances," meaning there is no confidence in making a forecast for increased chances of conditions in any tercile (wet, near normal or dry) for any part of the U.S.

Notes

These outlooks 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 percent chance of occurring. The middle tercile is considered the *near-average* (or normal) precipitation range. The forecast indicates the likelihood of the precipitation being in one of the wetter or cooler terciles--*above-average* (A) or *below-average* (B)--with a corresponding adjustment to the opposite category; the near-average category is preserved at 33.3 likelihood, unless the anomaly forecast probability is very high.

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

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.

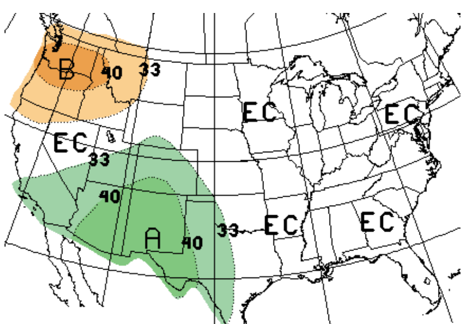


Figure 8a. Long-lead national precipitation forecast for March 2005. (released February 28, 2005)

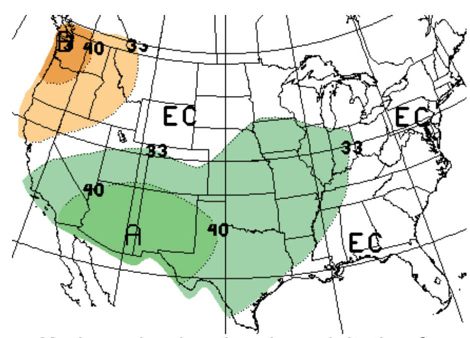


Figure 8b. Long-lead national precipitation forecast for March – May 2005. (released February 17, 2005)

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

B = Below
40.0–49.9%
33.3–39.9%

EC = Equal Chances

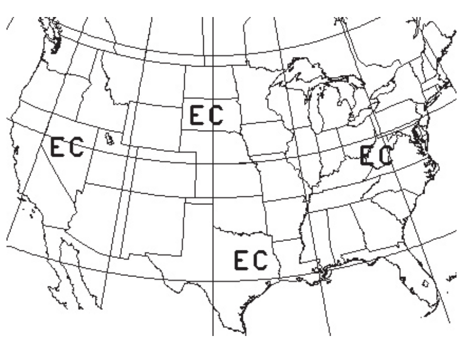


Figure 8c. Long-lead national precipitation forecast for April – June 2005. (released February 17, 2005)

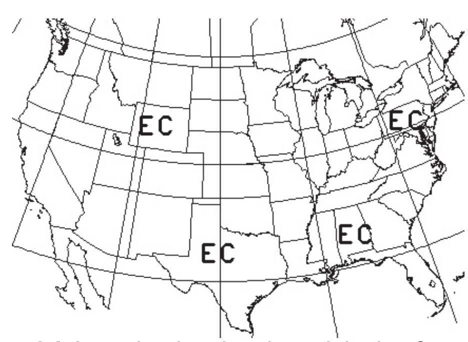


Figure 8d. Long-lead national precipitation forecast for May – July 2005. (released February 17, 2005)

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. Note: Website has many graphics, it may load slowly on your computer. For IRI forecasts, visit: http://iri.columbia.edu/climate/forecast/net_asmt/.

Seasonal Drought Outlook through May 2005

Source: NOAA Climate Prediction Center

NOAA's Climate Prediction Center (CPC) predicts that drought will persist throughout the northwestern U.S., but portions of the southwest should see limited improvement of drought conditions in the next few months (figure 9). In the southwest, some large reservoirs remain below normal, but they are starting to recover. Lake Mead's elevation rose 9 feet from January 1 through mid-February, although the lake was still some 80 feet below capacity. CPC is predicting above normal precipitation for the southwestern U.S., including most of Colorado and Utah through the spring months (see page 11, figures 8a-b). On the other hand, drought is expected to persist much across southern Montana and northern Wyoming, but seasonal rain and snow could provide limited drought relief in these areas. Because drought has persisted so long over the High Plains, normal precipitation would tend to ameliorate conditions but not lead to full recovery. Therefore, above-normal precipitation would be needed for major improvement.

Notes

The delineated areas in the Seasonal Drought Outlook (Figure 9) 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.

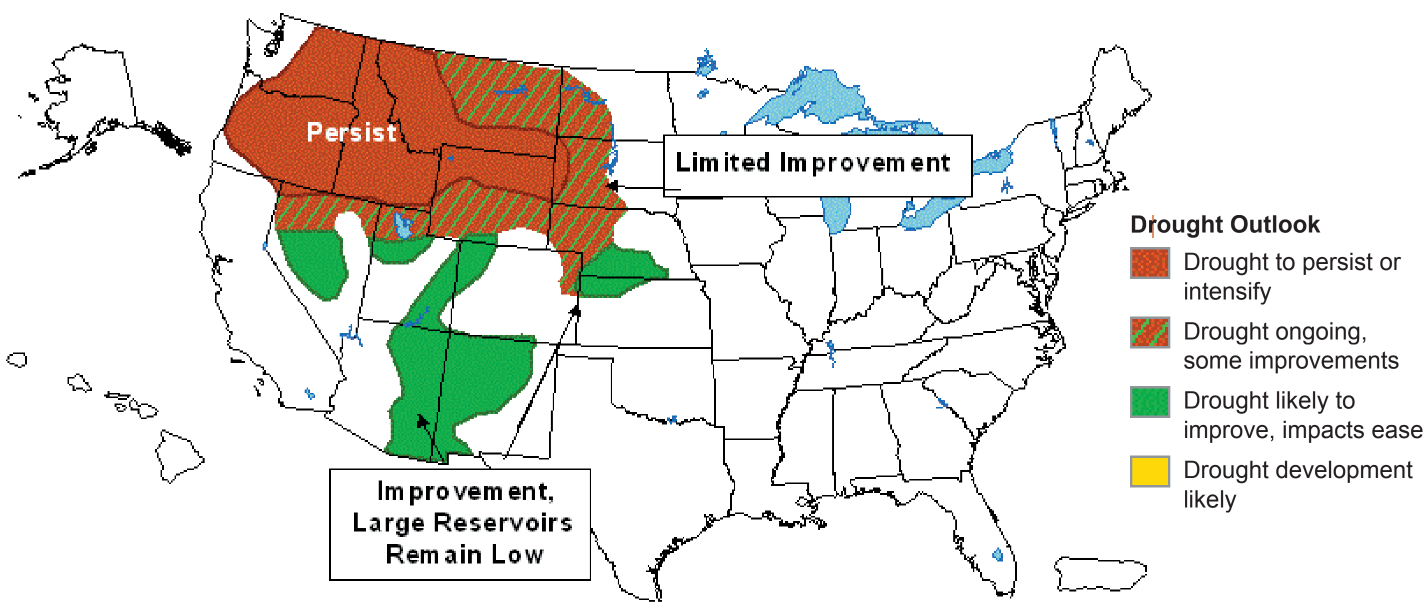


Figure 9. Seasonal Drought Outlook through March 2005 (release date February 17, 2005).

On the Web

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

El Niño Status and Forecast

Sources: NOAA/National Weather Service National Centers for Environmental Prediction, NOAA Climate Diagnostic 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). The record of SST's since 1982 (Figure 10a) shows that recent SST conditions are slightly above this threshold, although this event is weak compared to the El Niño events in 1997-97 and 1983-84.

Notes

An El Niño event is a periodic warming of surface ocean waters in the eastern tropical Pacific along with a shift in convection in the western Pacific further east than the climatological average. These conditions affect weather patterns around the world. El Niño episodes occur roughly every 4-5 years and can last up to 12-18 months.

Figure 10a shows the standardized three-month running average values of the SST anomaly for the Niño 3.4 region of the eastern tropical Pacific Ocean from January 1982 – January 2005. The SST is associated with climate effects in the Intermountain West. Values greater than 0.5 represent La Niña conditions, which are associated with dry winters and sometimes with wet summers. Values less than -0.5 represent El Niño conditions, which are associated with wet winters.

Figure 10b shows multiple forecasts for SST in the Niño 3.4 region for nine overlapping 3-month periods from date 2005 to date 2005. The International Research Institute for Climate Prediction (IRI) compiles these model outputs into one graph, so one can see how the model predictions differ. 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. Thirdly, forecasts made at some times of the year generally have higher skill than forecasts made at other times of the year--namely, they are better when made between June and December than when they are made 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.

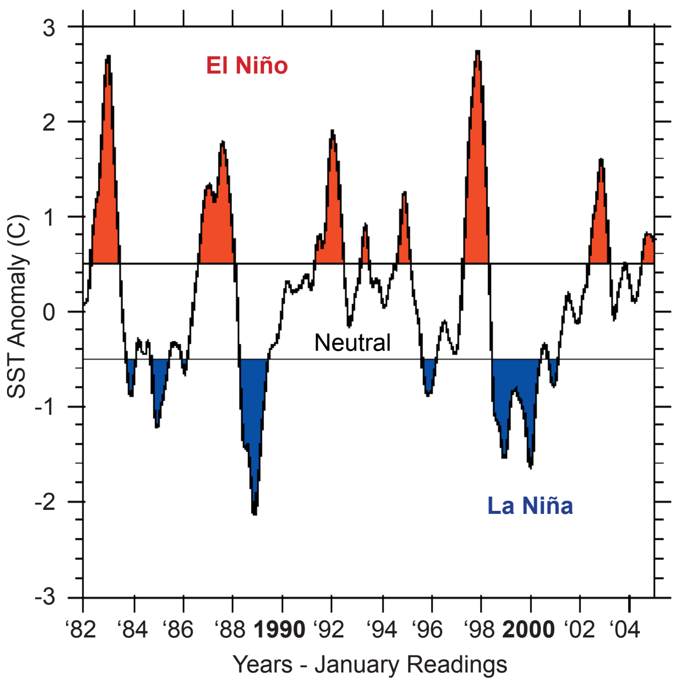


Figure 10a. The anomaly values of the sea surface temperature (SST) for the Niño 3.4 region of the Pacific Ocean from January 1982- January 2005. El Niño/La Niña occurs when the temperature anomaly (or departure form average) is greater than 0.5 (red) or less than –0.5 (blue) respectively. Values between these thresholds are normal or neutral.

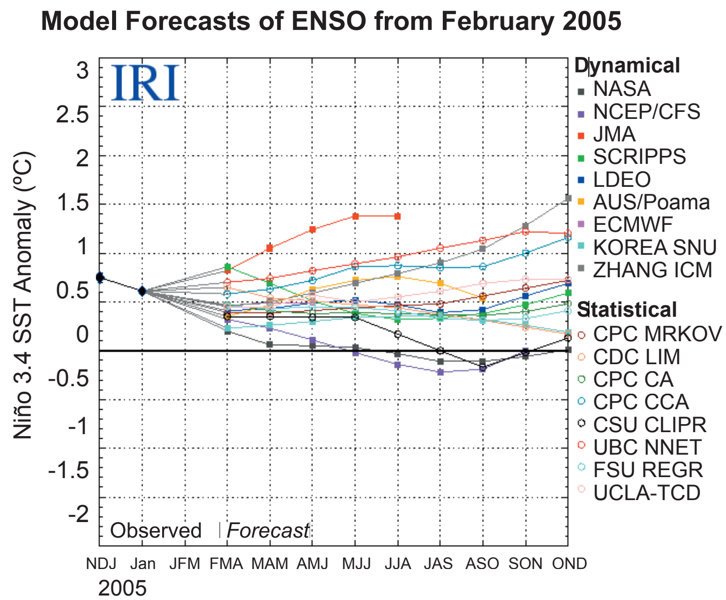


Figure 10b. Forecasts made by dynamical and statistical models for sea surface temperatures (SST) in the Niño 3.4 region for nine overlapping 3-month periods from January 2005 to December 2005. (released February 17, 2005) The initials on the horizontal axis represent clusters of three months (eg. SON = Sept.-Oct.-Nov.).

On the Web

For more information about El Nino and to access graphics similar to those found on these pages, visit: http://iri.columbia.edu/climate/ENSO/.

El Niño Status and Forecast continued

Sources: International Research Institute for Climate Prediction, NOAA Climate Prediction Center

According to the NOAA CPC, sea surface temperature (SST) anomalies decreased in all of the Niño regions during February 2005. However, positive sea surface temperature (SST) anomalies greater than +1°C (~1.8°F) persisted in portions of the central and western equatorial Pacific (figure 10c). By late February 2005, positive equatorial SST anomalies greater than +0.5°C (~0.9°F) were found from 155°E eastward to 165°W. The pattern of anomalous warmth in the equatorial Pacific in recent months and the most recent 5-month running mean value of the Southern Oscillation Index (-0.5) indicate that a weak warm El Niño episode is in progress, centered in the mid-Pacific. However, the recent decrease in SST anomalies throughout the equatorial Pacific suggests that a return to ENSO-neutral conditions may be taking place.

A diverse suite of SST prediction tools indicate that there will be a gradual transition from weak El Niño conditions to neutral conditions within the next three months (figure 10b). At the long range, these models suggest a possible recovering of El Niño again.

Notes

Figure 10c 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 an 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 it transmits data around the world in real-time. NOAA uses these observations to predict short-term (a few months to one year) climate variations.

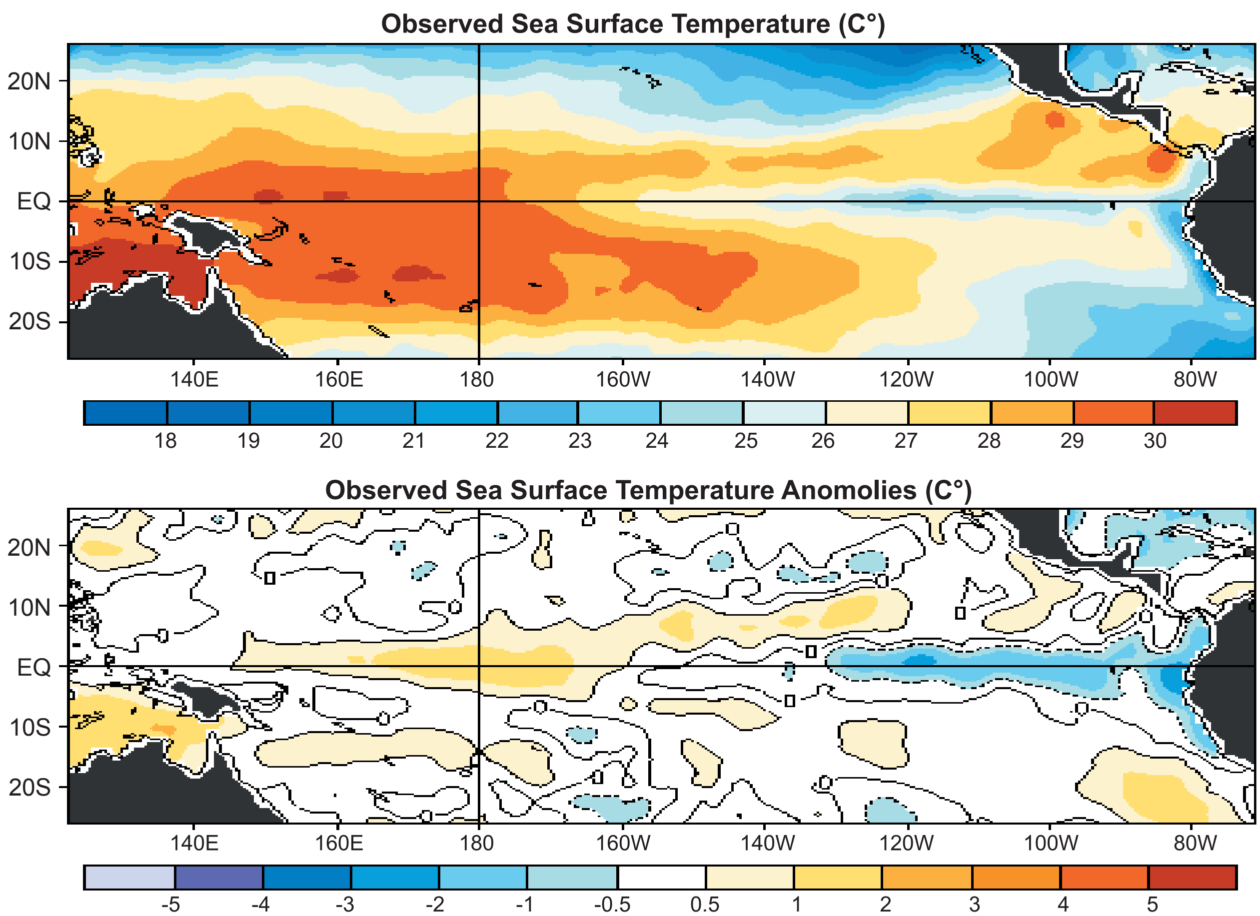


Figure 10c. Two graphics showing the observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. The Niño 3.4 region encompasses the area between 120°W-170°W and 5°N-5°S. The graphics represent the 7-day average centered on March 2, 2005.

On the Web

Technical discussion of current El Niño conditions: 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.

Streamflow Outlooks for the 2005 runoff season (released 3/7/05)

Source: USDA Natural Resources Conservation Service Water and Climate Center

Streamflow outlooks for the Intermountain West region continue to project higher than average runoff for most of Utah and southern Colorado. Parts of southern and southeastern Utah, including the Coal Creek basin could experience flooding this spring if the snow keeps falling and the temperatures remain cool through March. However, due to lower than average precipitation in northern Colorado and most of Wyoming, these areas can expect lower than normal spring runoffs of up to 50% less than average in some places.

Notes

The forecasts of natural runoff in figure 11 are 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, all 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.

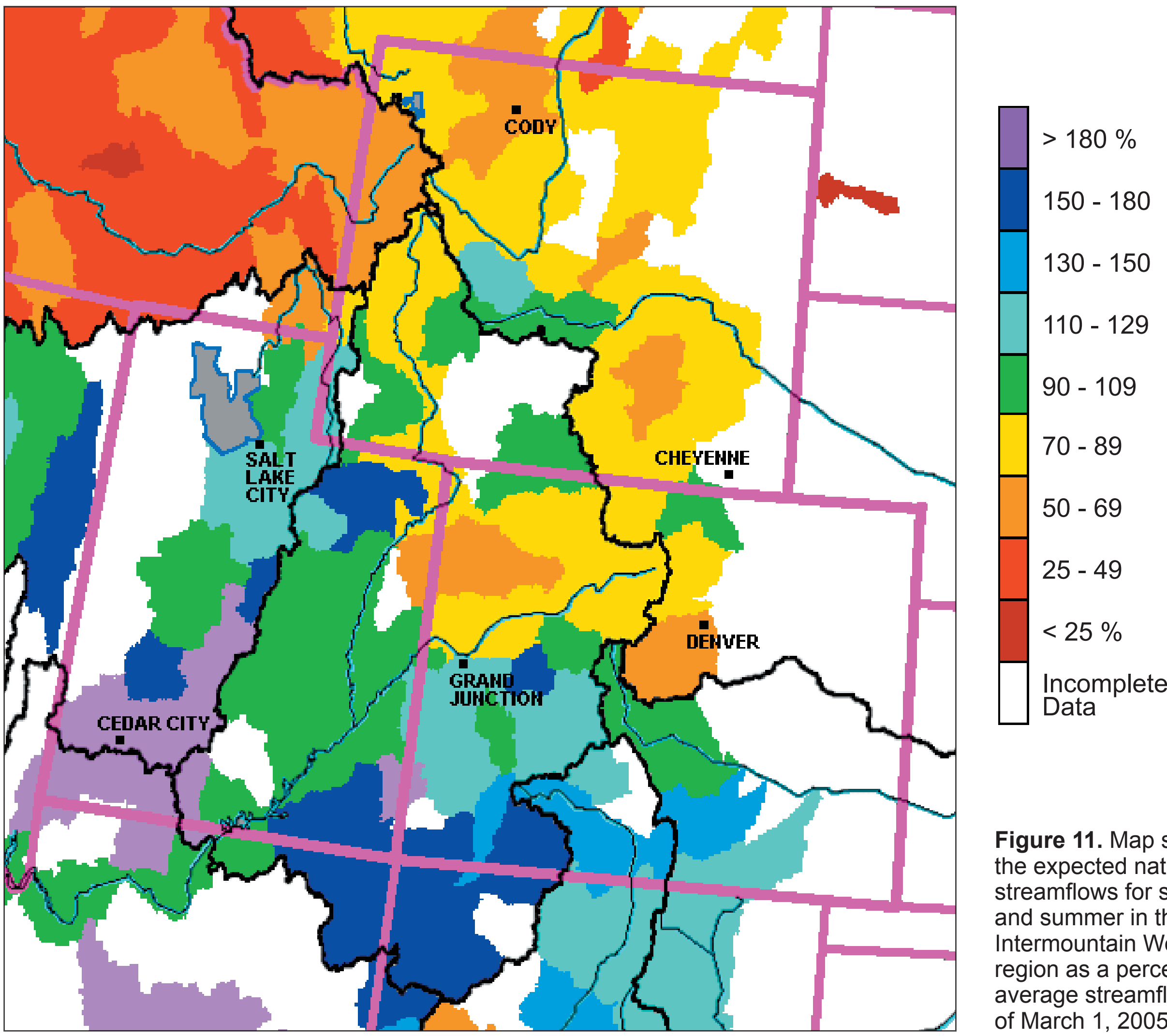


Figure 11. Map showing the expected natural streamflows for spring and summer in the Intermountain West region as a percent of average streamflows as of March 1, 2005.

On the Web

For more information about water supply forecasts based on snow accumulation and access to the graph on this page, visit: http://www.wcc.nrcs.usda.gov/wsf/.

The following websites are for individual River Forecast Centers, operated by NOAA:
Colorado Basin (includes Great Basin): http://www.cbrfc.noaa.gov/
Missouri Basin (includes South Platte and North Plate: http://www.crh.noaa.gov/mbrfc/
West Gulf (includes Rio Grande): http://www.srh.noaa.gov/wgrfc/

NOAA Climate Prediction Center: A History

By Jessica Lowrey, NOAA-CIRES Climate Diagnostic Center and the University of Colorado at Boulder

Overview

The Climate Prediction Center (CPC) is one of the National Centers for Environmental Prediction (NCEP), which is an arm of the NOAA's National Weather Service (NWS). Other NCEP offices include the Space Environment Center, Storm Prediction Center, Tropical Prediction Center, and the Ocean Prediction Center. These centers provide a wide variety of national and international weather guidance products to National Weather Service field offices, government agencies, emergency managers, private sector meteorologists, and meteorological organizations and societies throughout the world. Therefore, NCEP is the starting point for nearly all weather forecasts in the United States.

The mission of CPC is to *serve the public by assessing and forecasting the impacts of short-term climate variability, emphasizing enhanced risks of weather-related extreme events, for use in mitigating losses and maximizing economic gains*.

CPC's products include operational predictions of climate variability, real-time monitoring of climate and the required databases, and assessments of the origins of major climate anomalies. The products cover time scales from a week to seasons, extending into the future as far as technically feasible, and cover the land, the ocean, and the atmosphere, extending into the stratosphere. CPC forecasts include several official forecasts reprinted in the Intermountain West Climate Outlook. The Seasonal Temperature and Seasonal Precipitation Outlooks and found on pages 10 and 11 and the U.S. Seasonal Drought Outlook is on page 12.

Some of CPC's activities include preparing long-range outlooks (with lead times from one week to one year) and developing and operating systems for verification of its forecasts. CPC communicates its forecasts via the internet, National Weather Service offices and the media. **CPC's website** is located at **http://www.cpc.noaa.gov/indexnew.html**. By applying dynamical, empirical, and statistical techniques to improve and extend the range of climate outlooks, CPC tests new forecast methods and models and conducts extensive research into new forecast methods.

CPC also conducts applied research to identify the important physical factors responsible for climate fluctuations, monitors the state of the coupled ocean-atmosphere climate system, and develops statistical and physically-based climate prediction techniques. CPC participates in research projects such as the North American Monsoon Experiment (See http://www.ofps.ucar.edu/name/).

Products

Seasonal forecasts are one of many types of products that CPC produces. For example, CPC observes and monitors many aspects of climate and weather such as stratospheric ozone, which it uses to create UV forecasts. It also conducts a variety of assessments including assembling, analyzing, interpreting and disseminating current global climate data, which other NOAA offices can use to diagnose and predict future climate scenarios. Finally, CPC assesses climate impacts on society and has an active outreach program to educate the public on the climate system so people can have a better understanding of possible climate impacts. Some highlights of CPC's outreach efforts include a climate glossary and an El Niño-Southern Oscillation tutorial. (See box below for more CPC products.)

Jessica Lowrey is an associate scientist at the NOAA-CIRES Climate Diagnostics Center and the University of Colorado in Boulder, CO. Her recent work includes evaluating the utility science-policy assessments and helping water resource managers understand and use climate information.

CPC Products

Expert Assessments

- U.S. Hazards Assessment
- U.S. Drought Assessment (Drought Monitor, Seasonal Drought Outlook)
- U.S. Degree Days Assessment
- Global Climate Assessment
- ENSO Assessment and Diagnostic Discussion

Outlooks & Forecasts

- Monthly and Seasonal Temperature and Precipitation Outlooks
- Extended Range Outlooks (Temperature and Precipitation out 6-10 and 8-14 days, and Excessive Heat Outlook)
- Special Outlooks (Palmer Drought, UV Daily Forecast, Soil Moisture Outlook, Degree Day Outlooks, Probability of Exceedance Outlooks and Verification of Outlooks)

Observations & Monitoring

- U.S. Climate Data and Maps
- Global Climate Data and Maps
- Pacific Island Climate Data and Maps
- Monitoring Model Forecast and Performance

Outreach & Educational Materials

- Climate Glossary
- Meetings, Presentations and Publications