# Intermountain West Climate Summary

by The Western Water Assessment
Issued December 13, 2005

## December 2005 Climate Summary

**Hydrological Conditions** – Overall, hydrologic conditions are near average for this time of year in the Intermountain West region, most reservoirs have near average contents. Snow fall has been higher than average in the northern part of the regions and lower than average in the south.

**Temperature** – Temperatures for the region were mostly above average for the month of November.

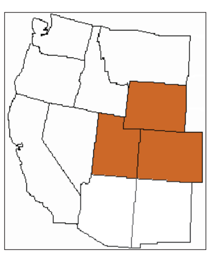
**Precipitation/Snowpack** – Precipitation was above normal in the northern part of the region and below normal in the southern part in November

**ENSO** – ENSO-neutral (or near-average) or weak La Niña conditions are likely during the next 6-9 months.

**Climate Forecasts** – ENSO is not a significant factor in temperature or precipitation forecasts during the upcoming few months; the forecasts reflect interdecadal trend more than any other factor.

## Update on Western Water Assessment

This is the eighth edition of the *Intermountain West Climate Summary* (IWCS), issued regularly by the Western Water Assessment (WWA) to provide the latest climate information to help readers understand the climate of their region and the effects of climate on the availability of annual water resources. The IWCS focuses on the states of Wyoming, Utah, and Colorado; Arizona and New Mexico are covered in a similar product issued by a the NOAA-funded Climate Assessment of the Southwest, available at: http://www.ispe.arizona.edu/climas/.



The WWA is one of several regional integrated climate assessment projects funded by NOAA, and includes researchers at NOAA, the University of Colorado and Colorado State University. The WWA participated this fall with the California Department of Water Resources in developing a publication, *Colorado River Basin Climate: Paleo, present, future,* for the Association of California Water Agencies and the Colorado River Water Users Association conferences the publication will soon be available on the WWA website. WWA researchers recently completed a study of the use of climate information in municipal drought planning which will be available soon on our web page (http://wwa.colorado.edu). Two new research projects at WWA include a study of Colorado River basin climate and the management of the Colorado Compact, and working with the City of Aurora, Colorado on determining which factors are most responsible for shaping residential water demand.

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**Contact Us** - Send questions or feedback, or to sign up for our summary e-mail announcement, please e-mail us at: WWASummary@wwa.colorado.edu.

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# A Roundtable Discussion of the Climate Outlook for the Intermountain West

The winter and spring seasonal forecasts issued by the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center (CPC) show the Southwest as having "equal chances" of above-average, near-normal or below-average precipitation (i.e., there's no forecast). Given this, WWA and CLIMAS sought the input of experts to contribute their insight to a roundtable discussion on how the region's snowpack and water supply might fare this winter and spring. The following is an abbreviated version of the discussion that took place on November 18th, 2005, focused on the Intermountain West. The order of some topics in that discussion has been changed and minor edits were made for clarity. For a version focusing on Arizona and New Mexico, see the December issue of the Southwest Climate Outlook (http://www.ispe.arizona.edu/climas/).

Roundtable Participants:
**Klaus Wolter**, PhD, Meteorologist, NOAA-CIRES Climate Diagnostic Center, Boulder, and research associate, WWA
**David Brandon**, Hydrologist in Charge, NOAA Colorado Basin River Forecast Center
**Jeff Smith**, Senior Hydrologist, NOAA Colorado Basin River Forecast Center
**Holly Hartmann**, PhD, assistant research scientist, Department of Hydrology and Water Resources, and investigator, CLIMAS, University of Arizona
**Melanie Lenart**, PhD, roundtable moderator and research associate, CLIMAS, University of Arizona

LENART: With the Climate Prediction Center seasonal forecasts that are coming out for winter precipitation, there's not much to say for the Southwest. From the CPC prognostic discussion, they feel that El Niño signal and the Madden-Julian Oscillation are both neutral as is the North Atlantic Oscillation. (The MJO is a fluctuation characterized by a 30- to 60-day cycle in tropical Pacific precipitation. This in turn affects global circulation patterns, including the jet stream over North America, which influences precipitation patterns and amounts in the Southwest over short time periods). Klaus, why do you see a potential La Niña?

WOLTER: I'm not saying that I'm expecting a La Niña event. However, the whole Pacific behavior in terms of what has happened with sea surface temperatures and precipitation patterns over Indonesia, the initial strong track into the Pacific Northwest, the coolness over Alaska-- they all point to more of a La Nina type setup than we've seen in about four years. The NOAA definition of a La Niña is a three-month running average of -.5$^{O}$C or lower sea surface temperatures, so it would be three months at least before we could definitely say we had a La Niña, although the atmosphere over the western hemisphere is acting like it's feeling one.

LENART: I noticed that CPC has Florida projected as dry, and the Southwest and Florida tend to have the same precipitation direction. They're both dry during La Niña years. Does that dryness have anything to do with the ENSO conditions you're describing?

WOLTER: No, I think that prediction came from a variety of factors other than ENSO status. The dry Arizona signal didn't come from La Niña-- it was from the warm tropical Atlantic, especially the Caribbean. The very active hurricane season, anchored low pressure over the Caribbean and promoted high pressure upstream in Arizona. The experimental forecast guidance I issued last month for January-March is a very simple dipole, with wetness in Utah and western Colorado and dryness in New Mexico and eastern Colorado (http://www.cdc.noaa.gov/people/klaus.wolter/SWcasts/index.html). Interestingly, I have a neutral condition for Arizona, which does reflect the current state of ENSO being almost neutral. If we

had a full-blown La Niña, I would definitely go dry in Arizona. Right now, it's too close to neutral to call.

LENART: Dave, given the forecasts for winter precipitation, what do you see in terms of streamflows?

BRANDON: We put out more of an "outlook" than a "forecast" this time of year (http://www.cbrfc.noaa.gov), since this early there's a lot of error involved. Before the '98 El Niño, our forecast would start on January 1st , but lately we've been looking earlier, e.g. in October or November to see if there are climate signals we can pick up. One of the things we look at is the antecedent streamflow of the system, or in other words what are the flows of the river in the fall compared to normal. We also have a soil moisture model which is probably the most important factor. Finally, although there's not much snowpack this early, we have 116 NRCS SNOTEL (Natural Resources Conservation Service snowpack telemetry) sites above Lake Powell that we look at. We combine all three of these factors and compare them to last year and other years' averages.

Obviously, it's very early in the season, but our outlook is slightly below average right now, and last year at this time we were a little bit above average. When we run these outlooks, the main thing we find is that we can be about 10 to 16 percent more accurate when averaged over many predictions than we would be just using the climatological averages for the last 30 years. A lot of that increased accuracy comes from the soil moisture model. If you've been in a very dry or wet period, the models reflect that well.

We also look at ENSO (El Niño Southern Oscillation) signals. We now have an operational procedure in which we look at CPC forecasts for the season and translate those into a shift in precipitation or temperature based on ENSO predictions. For example, we've found that in the last 15

(Continued on p. 3)

(Continued from p.2)

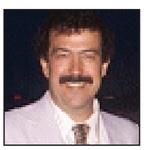
La Niñas, 14 were dry in Arizona. There isn't a strong ENSO signal right now, but that's something we're starting to look at: a trend towards a La Niña. Using these variables, we come up with an ensemble streamflow prediction and then run previous years through our model to check it.

LENART: From what you're saying, it sounds like you have some bad news for us in terms of your streamflow outlook this year.

BRANDON: Well, bad news is in the eyes of the beholder. There's a lot of error this early, but the current outlook for Lake Powell inflow indicates that it's going to be around 80 percent.

SMITH: That's around 6.5-6.7 million acre-feet from April to July. The average inflow into Lake Powell is about 7.9 million acre-feet.

BRANDON: In 2002, we had 1.1 million acre-feet, so it's relatively much better. When we ran the model last year at this time (November 2004), the prediction was a little higher, but we'd had a wet fall and early snow in the San Juan Mountains. Last year we were coming off a very dry period, and we were still predicting a little below normal. For water year 2005, we ended up just a bit above normal for the whole basin. So what you end up with is another story. There's a lot of weather between now and August. Even in April, we can still be 20% off from what the actual runoff will be between April and July.



SMITH: The weather between April and July can have huge swings. And the other issue is, frankly, we don't have the greatest data network in the world. There's certainly error between what we think the snow and soil moisture distribution is and what it really is.

BRANDON: So even on April 1, we can still have error in the streamflow forecasts.

LENART: I know that the CPC forecast for temperature showed that the West has a higher probability of being warm. Holly, how reliable are those for this area?

HARTMANN: Temperature forecasts in general are much more skillful than precipitation forecasts although precipitation forecasts, when available, are fairly good in Arizona and New Mexico for the winter season. By and large, the temperature forecasts are excellent for the entire Southwest's winter season. The CPC's forecast is calling for a temperature like that of the warmest 10 years out of the last 30. When you think about what those ten warm years have done to the snowpack, you get an appreciation of the implications for the water supply next spring and summer.

LENART: Wasn't temperature an issue in 2002, where temperatures took some of the snow and sublimated, or evaporated, it?

WOLTER: That was the wind more than anything-- it was warm, but it was also very windy.

HARTMANN: And wind is not something in the CPC's forecast—the focus is on temperature.

BRANDON: I think that March 2002 was one of the warmest and driest on record and nobody's going to forecast that this early. That really was an oddball month, when the wind knocked 20% off the snowpack. Temperature really becomes important in that transition time between March and May where you can have large temperature fluctuations. It's not so much the temperature as it is how fast the temperature changes, and hence how fast the snowpack melts. Obviously, we put temperature in our model.

LENART: So if the temperature increases and melts the snow quickly, that can cause more streamflow.

BRANDON: Right- it causes more runoff rather than letting it soak slowly into the soil.

LENART: So it must be difficult to work out what temperature is going to do and whether its effect will be positive or negative?

BRANDON: When you get into the dynamic situation of trying to forecast, say, next week, we can get a better handle on that now than we could 15 years ago.

LENART: When trying to assess now what the temperatures are going to be in that key March-May period, is that based more on trend, or are other things involved?

HARTMAN: Trend is a large component of that, especially in the longer range forecast. The trend is based on what's called an optimal climate normal (OCN) derived from data from the last 10-15 years. That's an ideal period for looking at long-term trends. Although in a particular region there may be other periods that would work better, nationwide they've decided on 10-15 years.

WOLTER: The OCN seems to work really well for temperatures and often shows global change. The spring CPC temperature forecast is driven by trend, period. It is by far the strongest component- nothing else goes that far. A lot of the tools used latch onto the same temperature signal so you can get a trend-based prediction several different ways.

BRANDON: I have a final comment, which is this is why it's very difficult to take all this information and put it into streamflow numbers. Klaus has good information and a lot of people are looking at it, but it's difficult to turn into numbers.

LENART: So despite the CPC forecast for equal chances, there's a general feeling here that things might be a little bit drier and we might not get as much streamflow at least compared to last year if not the average.

BRANDON: Yes, especially in the Upper Colorado.

HARTMAN: In the face of uncertain seasonal forecasts, you can't expect to have a forecast all the time this far in advance. It's only really when you get strong signals from ENSO that you have something to utilize. Since the seasonal forecast is more of a forecast of opportunity, people who need to make decisions would be well advised to think about conditions that cause them problems and prepare for those rather than relying on a forecast to tell them what to do.

LENART: Thank you all very much.

# Temperature through 11/30/05 Source: High Plains Regional Climate Center

The average temperatures for the month of November in the Intermountain West region ranged from 20-30°F in the mountains of western **Wyoming** and north central **Colorado** to 45-50°F in small parts of southeast **Colorado** and extreme southwest **Utah** (Figure 2a).

Throughout most of the tri-state region, the temperatures were 0-6°F above average with some large areas in eastern **Wyoming**, northeastern **Colorado**, and along the Front Range of **Colorado** between 6-10° F above average. Only very small regions in the mountains of north central **Colorado** and northwestern **Wyoming** were below average by 0-2°F (Figure 2b).

November 2004 temperatures were much closer to average than 2005 for the entire region, ranging primarily within 4°F of average. West central and southwest **Utah** and southeast **Colorado** had the largest regions of cooler than average temperatures by 0-6°F (Figure 2c). Temperatures for much of northern **Wyoming** were 2-6° above average.

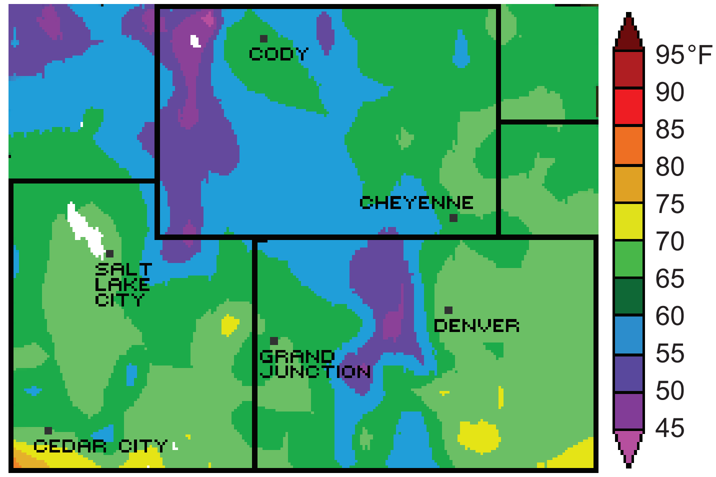



**Figure 2a.** Average temperature for the month of November 2005 in °F.

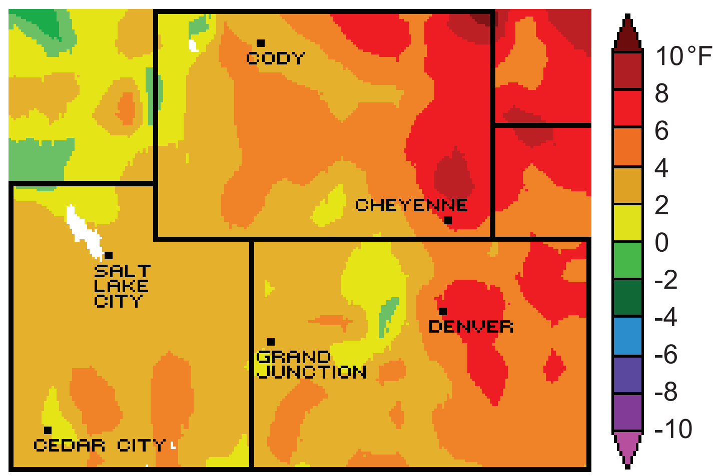



**Figure 2b.** Departure from average temperature for the month of November 2005 in °F.

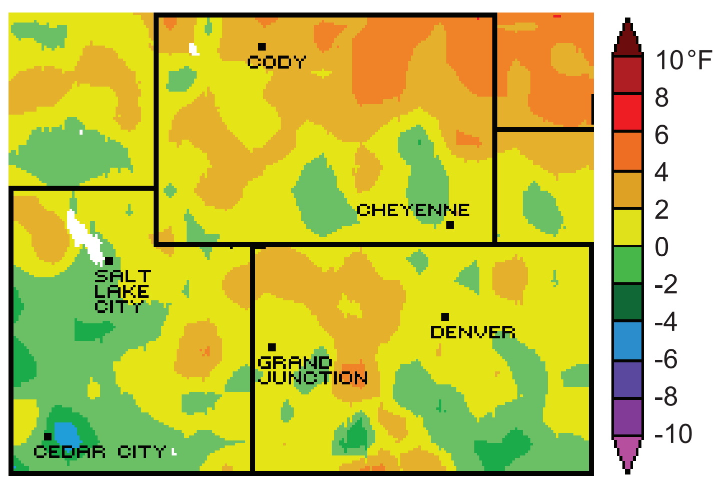



**Figure 2c.** Departure from average temperature in °F for last year, November 2004.

## Notes

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

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

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

## 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 11/30/05 Source: NOAA/ESRL/PSD Climate Diagnostics Center, NOAA Climate Prediction Center

Precipitation in the Intermountain West region falls primarily as snow in November and snowpack and snow water equivalent (SWE) depend on elevation. Most of the precipitation in November fell in the north-central mountains of **Colorado**, the central and northwestern mountains of **Wyoming** and the north –central mountains of **Utah** (Figure 3a). These areas received from 1to 3+ inches of precipitation last month, and this was 12% to 200% of average (Figure 3b). The driest parts of the region were in southeastern **Colorado** and south-central **Utah** where they only received 0 to 0.25 inches of precipitation, which was about 40% of average.

Overall since the start of the water year in October, **Utah** has been drier than both **Wyoming** and **Colorado** (Figure 3c). **Utah**'s precipitation totals are below average in most of the southern part of the state and the rest of the state is around average. **Wyoming** has received above average precipitation in the northwestern and southeastern parts of the state, with the rest of the state about average. **Colorado** is the only state in the region where about 2/3 of the state has received above average precipitation since the start of water year 2006. The highest levels of precipitation compared to average were in the eastern plains where the precipitation was over 200 percent of average.

## Notes

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2005 we are in the 2006 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 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 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.

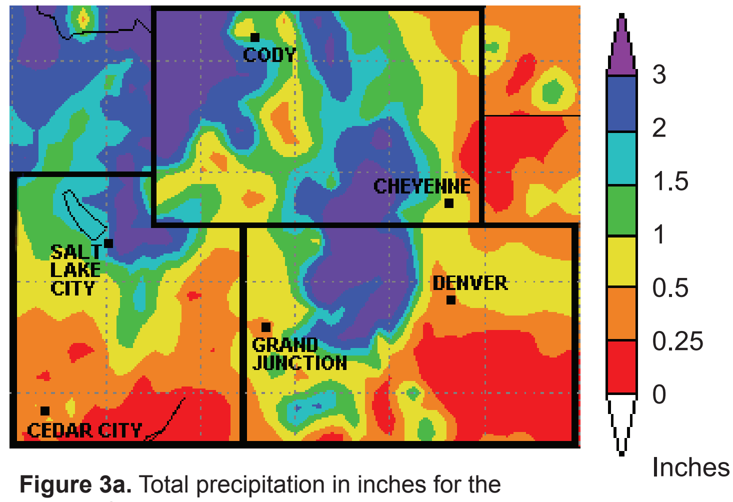



**Figure 3a.** Total precipitation in inches for the month of November 2005.

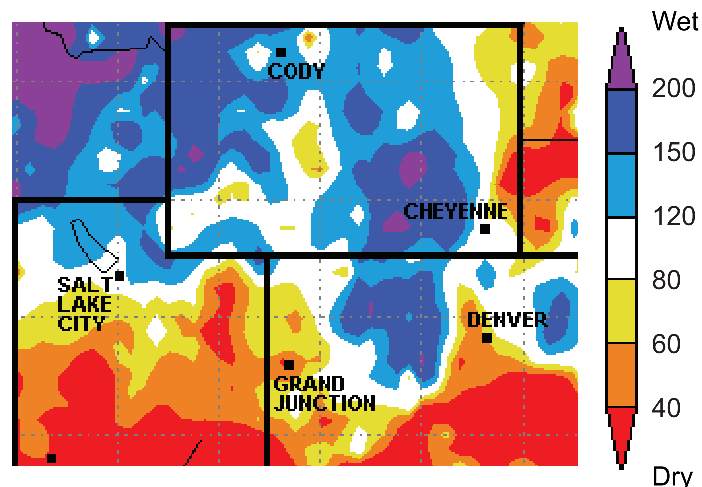



**Figure 3b.** Percent of average precipitation for the month of November 2005.

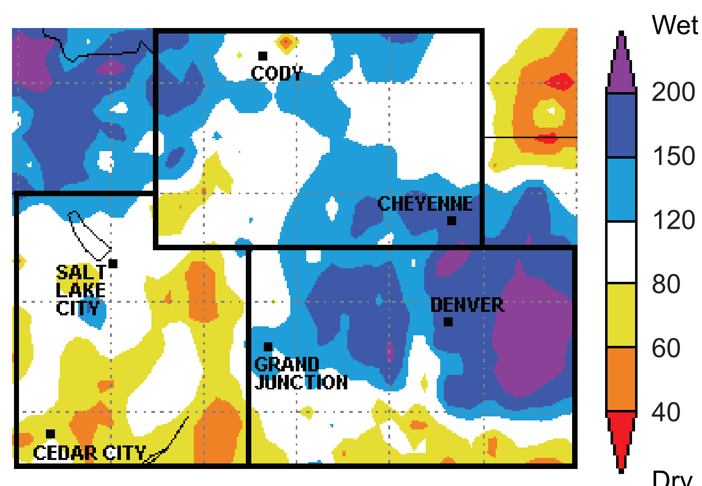



**Figure 3c.** Percent of average precipitation accumulated during the 2004 water year (Oct. 1, 2005 - Nov. 30, 2005).

## 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 precipitation maps like 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 hole U.S., visit: http://lwf.ncdc.noaa.gov/oa/climate/research/2002/perspectives.html.

# U.S. Drought Monitor conditions as of 10/04/05

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

This month the Drought Monitor shows most of **Colorado** and **Utah** no longer in drought status, while **Wyoming** is still in D0 (abnormally dry) in the northwest and D1 (moderate drought) in the rest of the state (Figure 4). There have not been any major changes in the drought status in the Intermountain West region since last month (see inset), but **Wyoming** moved entirely out of D2 (severe drought) since the last issue of this summary in October. While most of **Colorado** and **Utah** are not in drought status, the swath of D0 drought remains along the Colorado River. According to the Drought Monitor, this status is due to the low reservoir contents in Lake Powell, not due to lack of precipitation in recent months.

## Notes

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

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

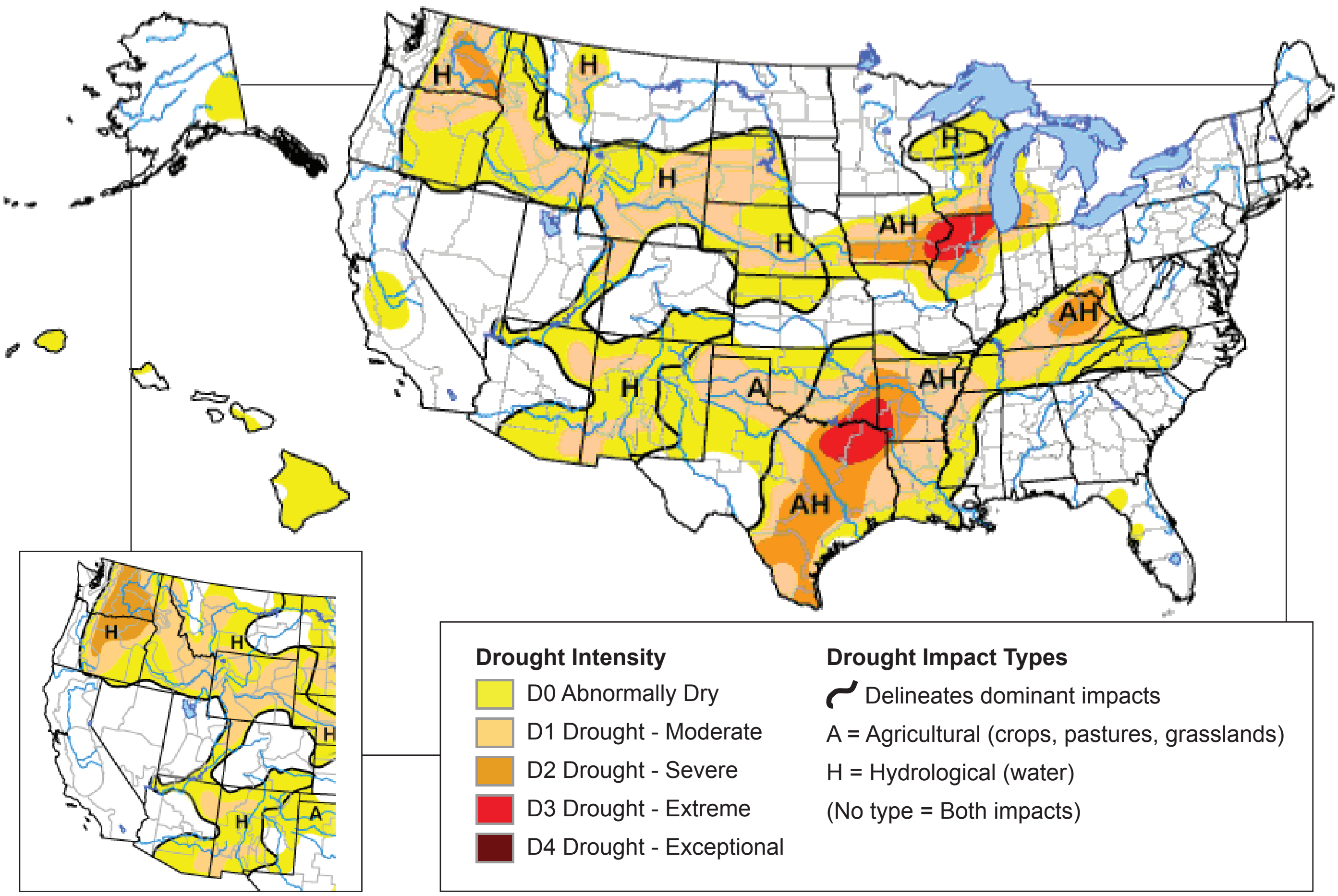



**Figure 4.** Drought Monitor released December 8, 2005 (full size) and last month November 8, 2005 (inset, lower left) for comparison.

## On the Web

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

# Reservoir Status

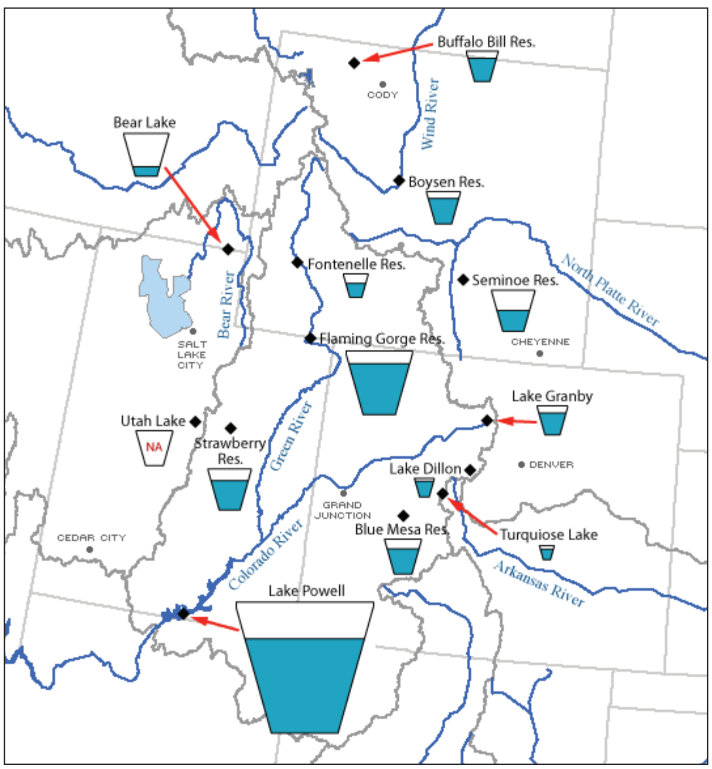
Source: Denver Water, U. S. Bureau of Reclamation, Northern Colorado Water Conservancy District, Natural Resources Conservation Service, and Central Utah Water Conservancy District

The majority of inflow to most western reservoirs is from snowmelt in April-July, and then the water levels slowly decrease over the fall and winter as municipalities, industries and agriculture use the water. Between the end of September and the beginning of December, contents of all the reservoirs decreased, with the exception of slight increases at Lake Granby in **Colorado** and Bear Lake in **Utah** (Figure 5). On the other hand, most reservoirs have the same or increased contents as a percent of average for this time of year. **Utah**'s Strawberry Reservoir increased their percent of average by 4%, **Wyoming**'s Flaming Gorge Reservoir increased by 5% and Colorado's Blue Mesa Reservoir increased by 8%. The NOAA Colorado Basin River Forecast Center is expected to issue the first outlook for Lake Powell in December 2005, followed by water supply outlooks for other reservoirs in early January 2006. See http://www.cbrfc.noaa.gov/

## Notes

The size of each "tea-cup" in Figure 5 is proportional to the size of the reservoir, as is the amount the tea-cup is filled. The first percentage shown in the table is the current contents divided by the total capacity. The second percentage shown is the percent of average water in the reservoir for this time of year. Reservoir statuses are updated at different times, so for the most recent information, see the websites listed in the "On the Web" box.

The percent of average is the current storage divided by the average storage for that day, going back to when the specific reservoir started filling. Averages with (*) were hand calculated by using raw data from the USBR, whereas the other averages were calculated by the organization that keeps the data for those reservoirs.




| Reservoir | Current Water (KAF) | Total Capacity (KAF) | % Full | % of Average |
|---|---|---|---|---|
| **Colorado** | | | | |
| Blue Mesa Res. | 581.6 | 829.5 | 70% | 102% |
| Lake Dillon | 234.8 | 254.0 | 92% | 105% |
| Lake Granby | 429.9 | 539.8 | 80% | 115% |
| Turquiose Lake | 102.0 | 129.4 | 79% | 100% |
| **Utah** | | | | |
| Bear Lake | 243.5 | 1,302.0 | 19% | 36% |
| Lake Powell | 11,934.2 | 24,322.0 | 49% | 74% |
| Strawberry Res. | 834.3 | 1,106.5 | 75% | 130% |
| Utah Lake | Not Available this Month | | | |
| **Wyoming** | | | | |
| Boysen Res. | 613.1 | 741.6 | 83% | 112% |
| Buffalo Bill | 467.0 | 644.1 | 72% | 153% |
| Flaming Gorge Res. | 3,108.4 | 3,749.0 | 83% | 112% |
| Fontenelle Res. | 210.4 | 344.8 | 61% | 101% |
| Seminoe Res. | 419.6 | 1,017.3 | 41% | 70% |

KAF = Thousands of Acre Feet

**Figure 5.** Tea-cup diagram of several large reservoirs in the Intermountain West Region. All reservoir content data is from between November 30 and December 7, 2005.

## On the Web

- Lake Dillon, operated by Denver Water: http://www.water.denver.co.gov/indexmain.html
- Turquoise Lake, Boysen Reservoir, and Seminoe Reservoir, operated by the U.S. Bureau of Reclamation (USBR) – Great Plains Region: http://www.usbr.gov/gp/hydromet/teacup_form.cfm
- Lake Granby is part of the Colorado-Big Thompson project, operated by Northern Colorado Water Conservancy District and the USBR Great Plains Region: http://www.ncwcd.org/datareports/data_reports/cbt_wir.pdf
- Blue Mesa Reservoir, Lake Powell, Flaming Gorge Reservoir, and Fontenelle Reservoir operated by the USBR – Upper Colorado Region: http://www.usbr.gov/uc/wcao/water/basin/tc_cr.html.
- Strawberry Reservoir, operated by the Central Utah Water Conservancy District: http://www.cuwcd.com/operations/currentdata.htm
- Utah Lake, operated by the Utah Division of Water Rights, and Bear Lake, operated by Utah Power: http://www.wcc.nrcs.usda.gov/cgibin/resv_rpt.pl?state=utah

# Regional Standardized Precipitation Index data through 11/30/2005

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

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

The SPI varies around the Intermountain West region as of the end of November 2005. **Colorado** is mostly near normal, except the Rio Grande basin in the south-central part of the state, which is moderately dry. **Wyoming** varies from near normal in the west, southwest, east and southeast to being dry or wet in other parts of the state. The Upper Platte climate division in south-central Wyoming and the Yellowstone division in the northwest are moderately dry, while the north-central part of the state ranges from abnormally to moderately moist. **Utah** continues to be moist with most of the state very moist. The south-central climate division along the Colorado River is exceptionally moist, but the northeastern part of the state is either near normal or only abnormally moist.

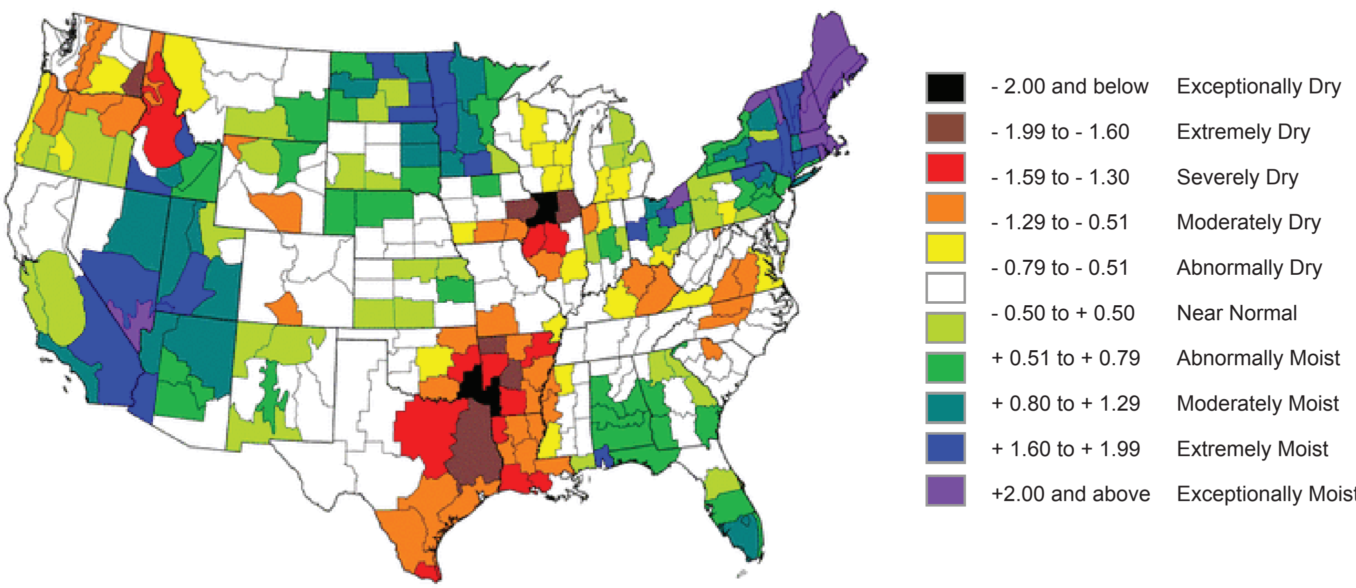



**Figure 6.** 12-month Intermountain West regional Standardized Precipitation Index. (data through 11/30/05)

## Notes

*This month we present the SPI from the NOAA National Climatic Data Center, instead of the one usually presented from the Western Regional Climate Center. Both products are based on the same data, but the categories are defined differently.*

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

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

## On the Web

- For the SPI product presented this month from the National Climatic Data Center, see http://lwf.ncdc.noaa.gov/oa/climate/research/prelim/drought/spi.html
- 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 December 2005

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

The percent of normal SWE in Colorado varies through out the state (Figure 7a). Along the continental divide the northern mountains have had a lot of snow since October and have from 100% to above 160% of normal snowpack. On the other hand, the southern mountains on both sides of the Rio Grand basin, have 60% to less than 40% of normal SWE.

The Fremont Pass area is one of the places in Colorado's northern mountains that has had a lot of snow this year (Figure 7b). As of December 5th, the SWE is about 10 inches (green line) or about 50% of the average total SWE for one water year. The average SWE for this date is only 4.5 inches (blue line) , which is about what this site had last year at this time (red line).

## Notes

Figure 7a shows the SWE as a percent of normal (average) for SNOTEL sites in Colorado. Figure 7b shows a plot of SWE for a selected SNOTEL site, Fremont Pass (FMTC2). This site is used by the CBRFC to predict natural runoff into the Blue River and Dillon Reservoir. Note that it is very early in the winter/snow fall season, so this data may not accurately reflect the water availability for Colorado.

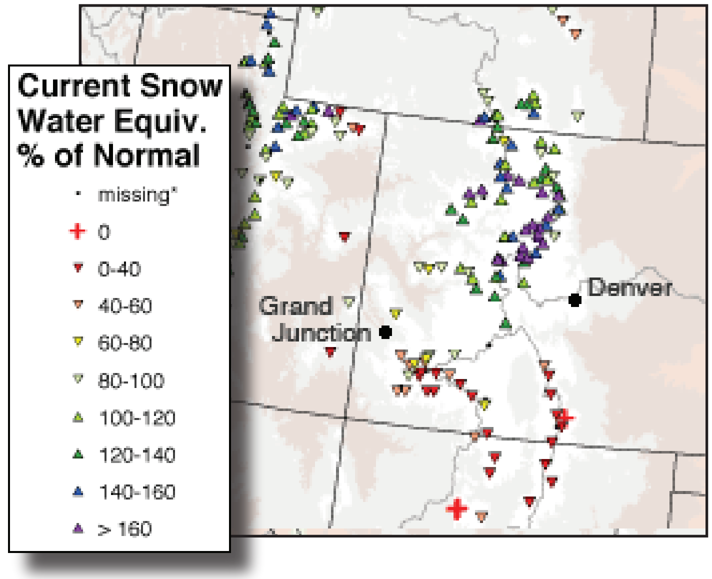



**Figure 7a.** Currrent snow water equivalent (SWE) as a percent of normal for SNOTEL sites in Colorado as of December 5, 2005. **This is provisional data.**

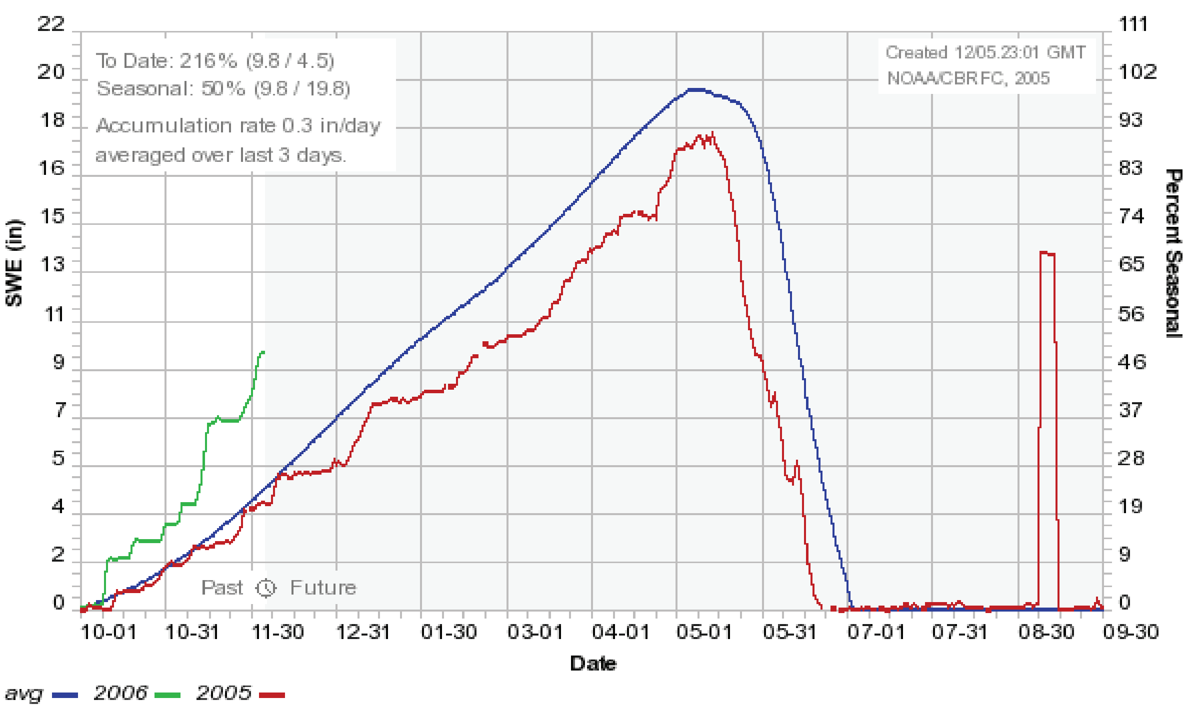



**Figure 7b.** A plot of SWE as of Dec. 5, 2005, for one SNOTEL site (Fremont Pass) throughout the 2005 (red line) and 2006 (green line) water years. The blue line shows the average SWE for the Fremont Pass SNOTEL site.

## 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 current SNOTEL data and plots like Figure 7b, see http://www.cbrfc.noaa.gov/snow/snow.cgi? or http://www.wcc.nrcs.usda.gov/snow/.
- For the current SWSI map, and for the latest "Colorado Water Supply Conditions" Report from the State Engineer, go to: http://water.state.co.us/pubs/swsi.asp.
- For current streamflow information from USGS, visit: http://water.usgs.gov/waterwatch/.

# Wyoming Water Availability December 2005

Source: Wyoming Resources Data System, USDA Natural Resources Conservation Service, and the Colorado Basin River Forecast Center

Most of Wyoming has average or above average SWE in the beginning of December 2005 (Figure 8a). The exceptions are the Shoshone/Big Horn/Wind River basins in the north-central part of the state that have 78% - 87% of average SWE and the Belle Fouche/Cheyenne basins in the northeast that only have 70% of average SWE. The basins with the highest SWE are in the southern part of the state, which follows the pattern from last year. The Upper bear and Little Snake basins have over 120% of average SWE and the South Platte basin has over 130% of average SWE.

The CBRFC uses six SNOTEL sites in the Upper Green River Basin to predict inflows to Fontenelle Reservoir. The average SWE of these sites is 4.5 inches, or about average for this time of year. This SWE represents about 30% of the total SWE for the water year.

## Notes

Figure 8a shows the SWE as a percent of average for each of the major river basins in Wyoming. Figure 8b shows a plot of SWE for six selected SNOTEL sites above Fontenelle Reservoir (LOPW4, KNDW4, NFLW4, EKPW4, TRPW4, and GRVW4). Note that it is very early in the winter/snow fall season, so this data may not accurately reflect the water availability for Wyoming.

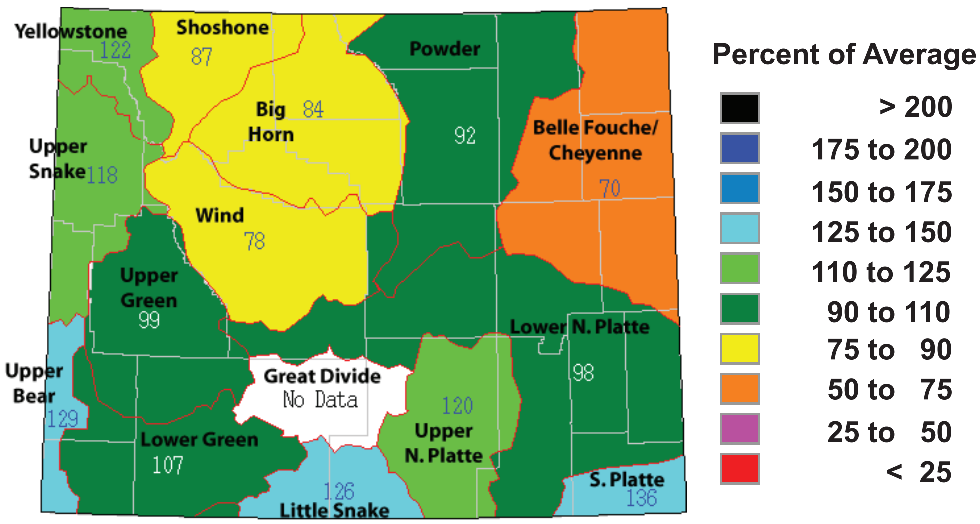



**Figure 8a.** Snow Water Equivalent (SWE) as a percent of average for the major river basins in Wyoming as of December 5, 2005.

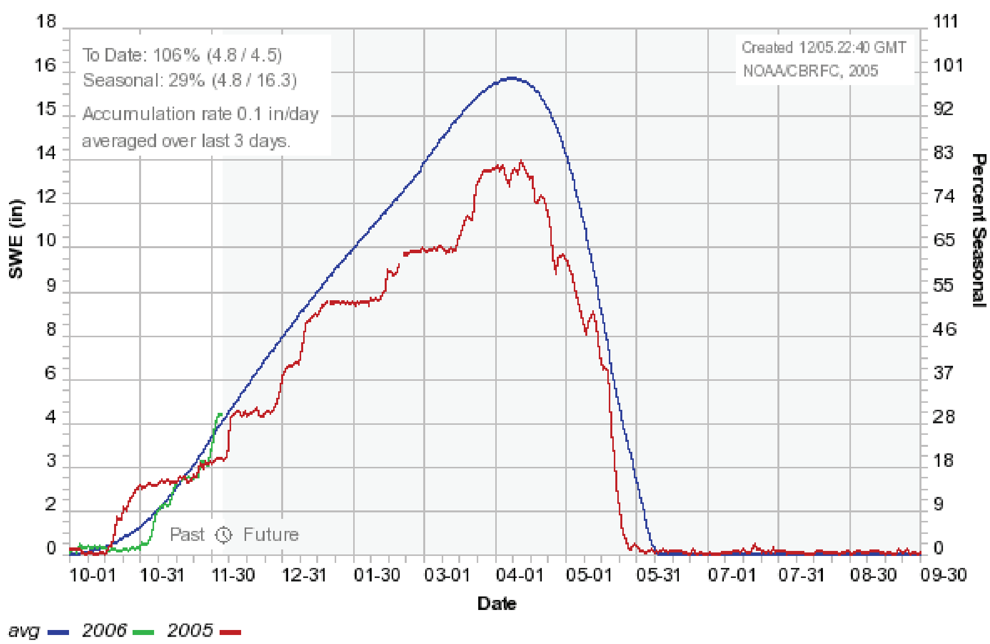



**Figure 8b.** A plot of SWE as of Dec. 5, 2005, for several SNOTEL site (see notes) above Fontenelle Reservoir throughout the 2005 (red line) and 2006 (green line) water years. The blue line shows the average SWE for these SNOTEL sites.

## On the Web

- The Wyoming SWSI, along with more data about current water supply status for the state, can be found at: http://In formation 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.
- For current SNOTEL data and plots like Figure 8b, see http://www.cbrfc.noaa.gov/snow/snow.cgi? or http://www.wcc.nrcs.usda.gov/snow/.
- The Wyoming Drought Status is found at: http://www.wrds.uwyo.edu/wrds/wsc/dtf/drought.html.
- The Palmer Drought Index is found on NOAA's drought page: www.drought.noaa.gov.
- For current streamflow information from USGS, visit: http://water.usgs.gov/waterwatch/

# Utah Water Availability December 2005

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

The current SWE as a percent of normal varies through out the state of Utah as of December 5, 2005 (Figure 9a), but in general the northern mountains have had more snow than the southern mountains, like in Colorado. The north-central mountains, parts of the Bear, Weber, Provo and Uintah River basins, generally have from 100% - 160% of normal SWE. On the other hand some southern SNOTEL sites as well as the western and eastern most sites have 0% - 40% of normal SWE. This snowfall pattern is opposite from most of last year, when the southwestern part of the state saw the highest SWE numbers and percent of normal.

The two SNOTEL stations above Strawberry Reservoir got a slow start on snow fall this winter, but due to some storms at the end of November/beginning of December the SWE is now a the average mark (Figure 9b). These sites have about 3.5 inches of SWE, which is about 20% of the total average SWE for the year.

## Notes

Figure 9a shows the SWE as a percent of normal (average) for SNOTEL sites in Utah. Figure 9b shows a plot of SWE for two selected SNOTEL sites above Strawberry Reservoir (STDU1 and DSTU1). These sites are used by the CBRFC to predict natural runoff into Strawberry Reservoir. Note that it is very early in the winter/snow fall season, so this data may not accurately reflect the water availability for Utah.

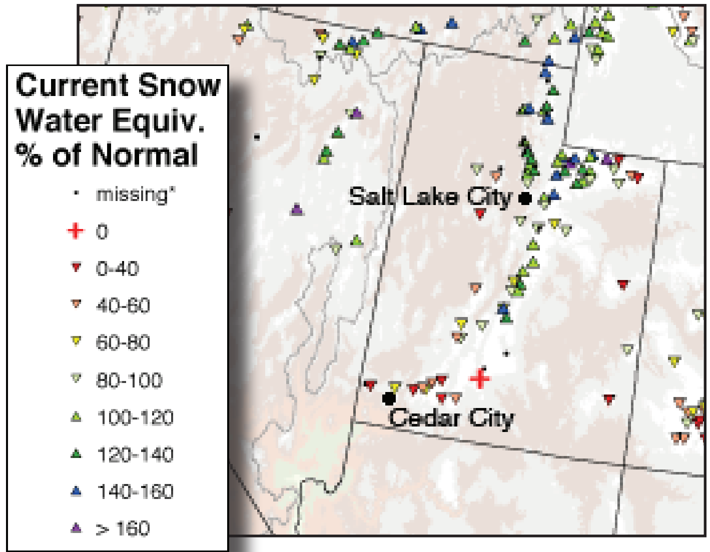



**Figure 9a.** Current snow water equivalent (SWE) as a percent of normal for SNOTEL sites in Utah as of December 5, 2005. **This is provisional data.**

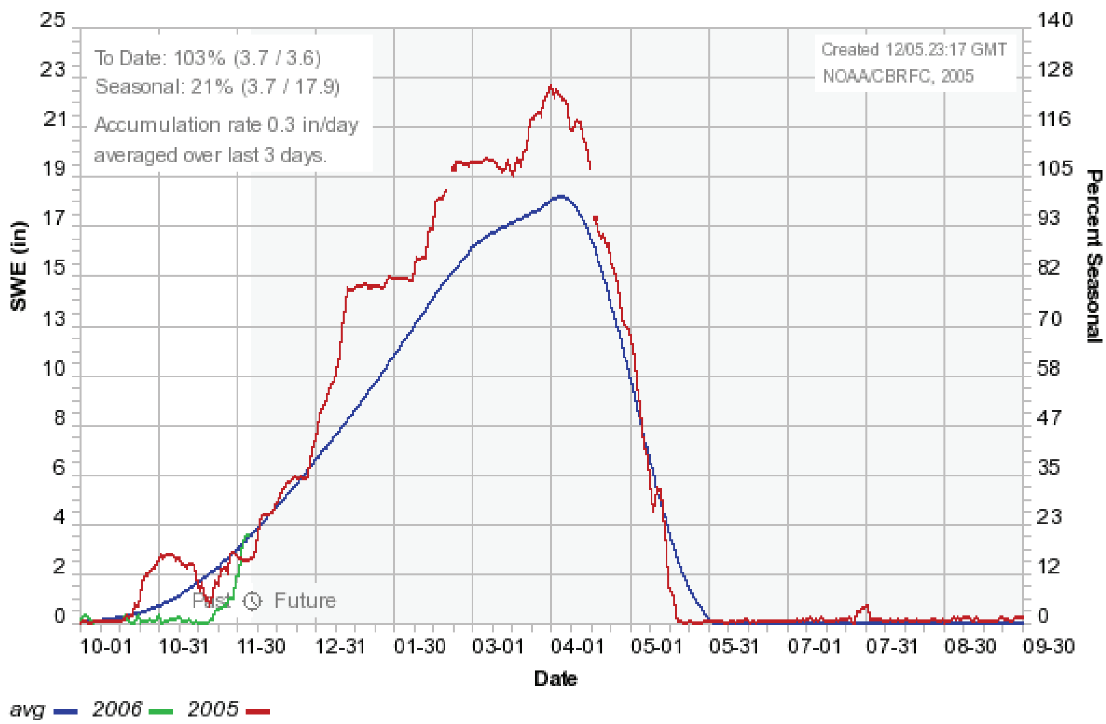



**Figure 9b.** A plot of SWE as of Dec. 5, 2005, for two SNOTEL site (see notes) above Strawberry Reservoir throughout the 2005 (red line) and 2006 (green line) water years. The blue line shows the average SWE for these SNOTEL sites.

## 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.
- For current SNOTEL data and plots like Figure 9b, see http://www.cbrfc.noaa.gov/snow/snow.cgi? or http://www.wcc.nrcs.usda.gov/snow/.
- 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/.
- For current streamflow information from USGS, visit: http://water.usgs.gov/waterwatch/
- For current streamflow information from USGS, visit: http://water.usgs.gov/waterwatch/

# Temperature Outlook December 2005 – April 2006

Source: NOAA Climate Prediction Center

According to the NOAA Climate Prediction Center, a large area of the U.S., including much of the Intermountain West, has an increased risk of above average temperatures in December 2005 (Figure 10a) and forecast periods through the spring of 2006 (Figures 10b-c). All of **Utah**, **Wyoming**, and **Colorado** are included in this area of increased risk through the Jan-March 2006 forecast period, and much of the region through summer forecast periods (not shown). The DJF forecast includes a significant change from last month's DJF forecast in that there is a much larger area and higher probabilities for above average temperatures for the northern Great Plains.

A new forecast tool is being used which combines several statistical models and a 15-member ensemble mean from dynamic models - using the known skill of the various tools to form a weighted average. Verification of the tool over forecasts from the 1995-2005 period indicate that the tool should significantly improve temperature forecasts over the continental U.S, including the Intermountain West.

ENSO is not a significant factor in temperature or precipitation forecasts during the upcoming few months; the forecasts reflect inter-decadal trend more than any other factor. See the Precipitation page for a discussion of the main factors influencing CPC seasonal forecasts

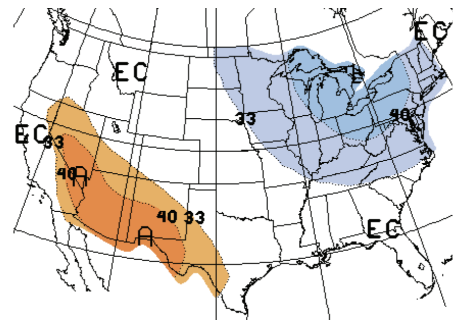



**Figure 10a.** Long-lead national temperature forecast for Dec. 2005. (released Nov. 30, 2005)

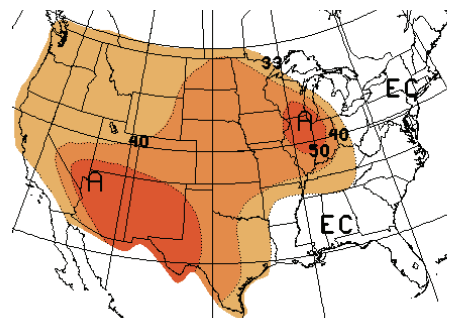



**Figure 10b.** Long-lead national temperature forecast for Dec. 2005– Feb. 2006. (released Nov. 17, 2005)

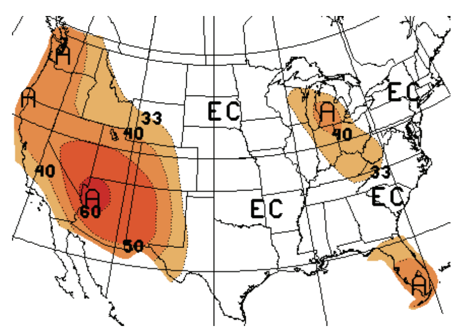



**Figure 10c.** Long-lead national temperature forecast for Jan. – Mar. 2006. (released Nov. 17, 2005)

**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**

## Notes

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

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

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

## 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 December 2005 – April 2006

Source: NOAA Climate Prediction Center

The winter and spring seasonal precipitation forecasts issued November 17th 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 Dec 2005-Feb 2006 (Figure 11a) and winter forecast periods (Figure 11b-c). Forecast tools are unable to make any predictions for the region through the May-July 2006 forecast period due to a lack of strong predictive signals from ENSO or other sources.

What are the predictive signals that usually influence seasonal forecasts? According to the CPC, major factors include: 1) the El Niño/Southern Oscillation or ENSO; 2) trends – the difference between the most recent 10- or 15-year mean of temperature or precipitation for a given location and time of year and the 30-year climatology period (currently 1971-2000); 3) tropical 30-60-day oscillations which may affect climate within a season – these are fluctuations in tropical Pacific precipitation, which in turn affects the jet stream over North America, and may influence precipitation patterns and amounts in the western U.S.; 4) the North Atlantic Oscillation (NAO); and 5) persistently dry or wet soils in the summer and snow and ice cover in the winter. Currently, ENSO and tropical 30-60-day oscillations are neutral or weak and are expected to have little or no impact on the climate in the near-term (see ENSO Status, page 15). Trends influence this forecast and their impacts are especially large in forecast leads beyond 0.5 months (i.e., forecasts for Jan-March, Feb-April, and March-May periods). The impact of the NAO this winter is uncertain because the NAO is currently near its neutral phase and also because we are currently able to predict only a small fraction of the climate variability associated with the NAO.

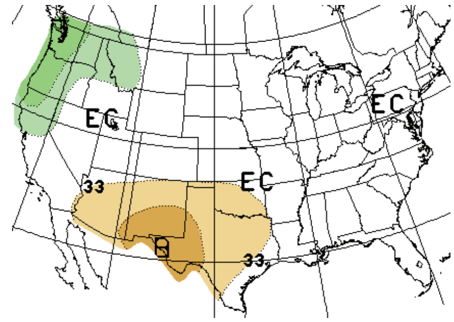



**Figure 11a.** Long-lead national precipitation forecast for December 2005. (released Nov. 30, 2005)

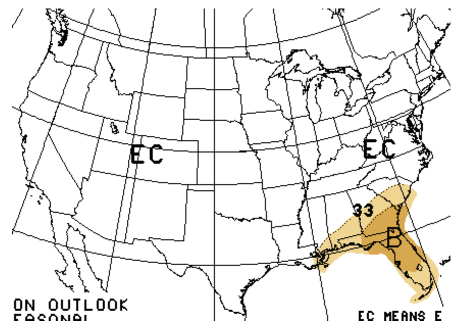



**Figure 11b.** Long-lead national precipitation forecast for Dec. 2005 – Feb. 2006. (released Nov. 17, 2005)

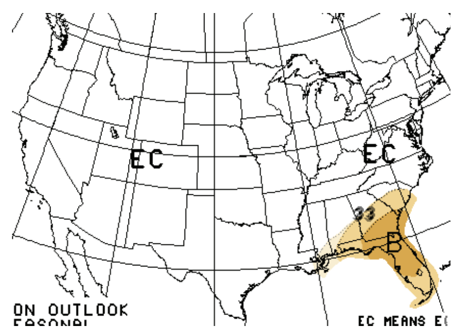



**Figure 11c.** Long-lead national precipitation forecast for Jan. – Mar. 2006. (released Nov. 17, 2005)

| A = Above | B = Below | EC = Equal Chances |
|---|---|---|
| 40.0–49.9% | 40.0–49.9% | |
| 33.3–39.9% | 33.3–39.9% | |

## Notes

The seasonal precipitation outlook in Figures 11a-c predicts the likelihood (chance) of above-average, near-average, and below-average precipitation, but not the magnitude of such variation. The numbers on the maps refer to the percent chance that precipitation will be in one of these three categories, they do not refer to inches of precipitation.

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

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

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

**On the Web**

- For more information and the most recent CPC forecast images, visit: http://www.cpc.ncep.noaa.gov/products/predictions/ multi_season/13_seasonal_outlooks/color/churchill.html. Please note that this website has many graphics and may load slowly on your computer.
- The CPC "discussion for non-technical users" is at: http://www.cpc.noaa.gov/products/predictions/90day/fxus05.html
- For IRI forecasts, visit: http://iri.columbia.edu/climate/forecast/net_asmt/.
- More information about temperature distributions at specific stations in Colorado, Utah, Wyoming, and across the West can be found at the Western Regional Climate Center, http://www.wrcc.dri.edu/CLIMATEDATA.html.
- 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 February 2006

Source: NOAA Climate Prediction Center

The NOAA Seasonal Drought Outlook issued December 2, 2005, projects improvement (decreasing drought status) in the northern Rockies, including western Wyoming. More limited improvement is foreseen in central Wyoming, with little change expected in eastern Wyoming. For areas from the Rockies westward to the Pacific Coast, substantial precipitation during the cold half of the year is critical. So far, the 2005-2006 water year is off to a good start in most areas currently experiencing moderate to severe drought (as depicted in the Drought Monitor). However, the water recharge season is only about 8 weeks old, and with a vast majority of the season still to come, the current short-term wetness will mean little if below-normal precipitation occurs during the next few months. Therefore, precipitation from the Rockies westward during this forecast period is critical and will be closely monitored.

## 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.

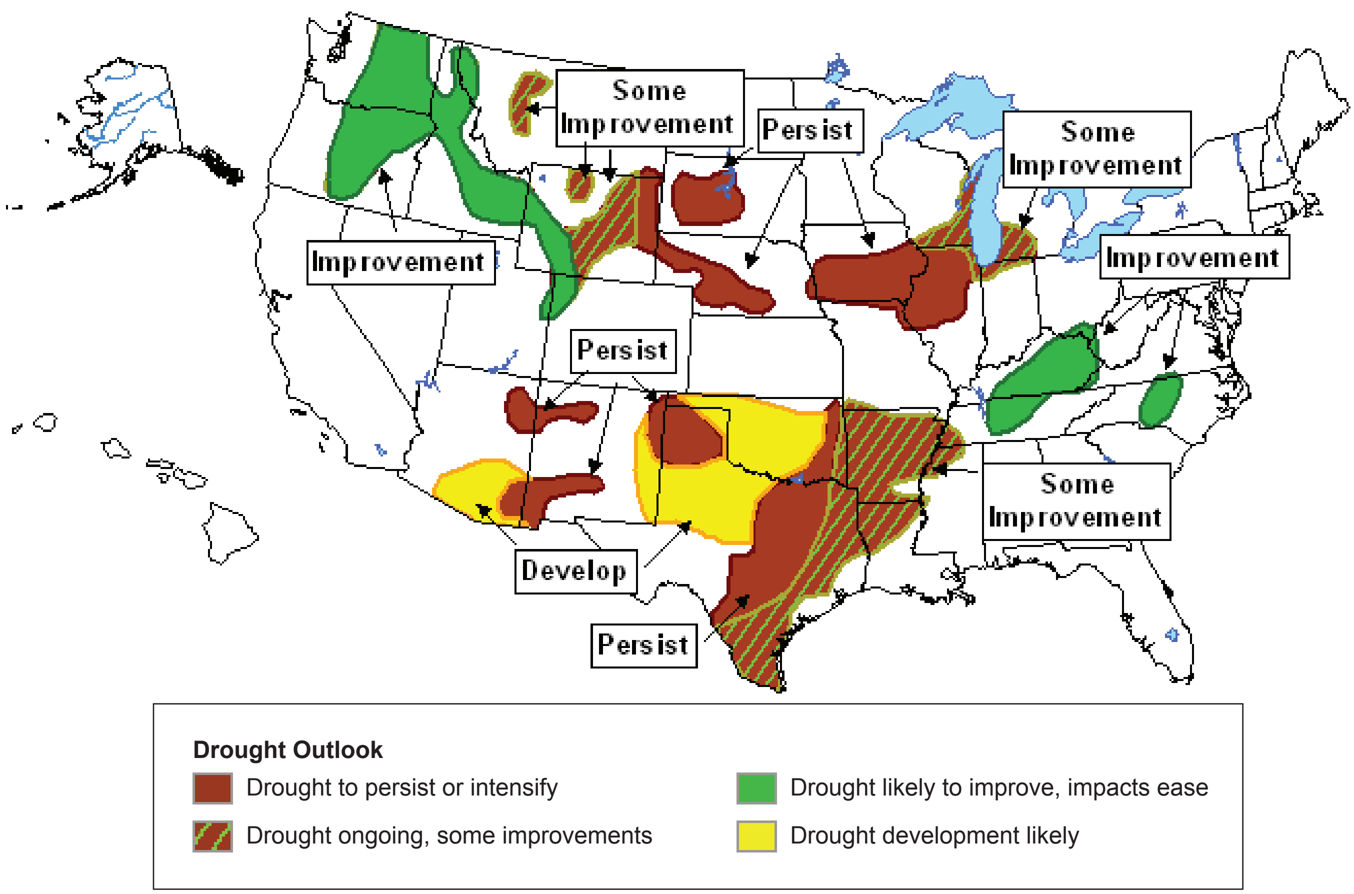



**Figure 12.** Seasonal Drought Outlook through February 2006 (release date December 2, 2005).

## On the Web

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

# El Niño Status and Forecast

Source: NOAA Climate Prediction Center

According to the NOAA CPC ENSO Diagnostic Discussion issued December 8, 2005, ENSO-neutral (or near-average) or weak La Niña conditions are likely during the next 6-9 months. During the last several months SSTs and subsurface temperature anomalies have decreased in the eastern tropical Pacific, and in the Niño 3.4 region that is the basis of the official forecasts (Figure 13a). During the same period persistent stronger-than-average low-level equatorial easterly winds – an atmospheric indicator of ENSO conditions -- were observed over the central Pacific, while near-average patterns of convection and sea level pressure occurred over most of the tropical Pacific. Collectively, oceanic and atmospheric observations suggest a trend toward La Niña conditions. The most recent statistical and coupled model forecasts indicate either a continuation of ENSO-neutral conditions or the development of a weak La Niña. Although the range of model forecasts indicates some uncertainty (Fig. 13b), and the potential for an El Nino, the combination of current conditions and recent observed trends in SSTs do not support the development of El Niño.

The official NOAA ENSO index peaked most recently in July 2004, and has declined since (Figure 13a). In April 2005, CPC said that El Niño conditions were weakening, not strengthening, and projected neutral conditions for summer 2005, which did occur. ENSO anomalies have not been a significant factor in creating precipitation and temperature anomalies since spring of 2004. Recent ENSO-neutral conditions were not a factor in CPC seasonal outlooks issued November 17th, but La Niña may become a factor in coming months if anomalous conditions continue and strengthen.

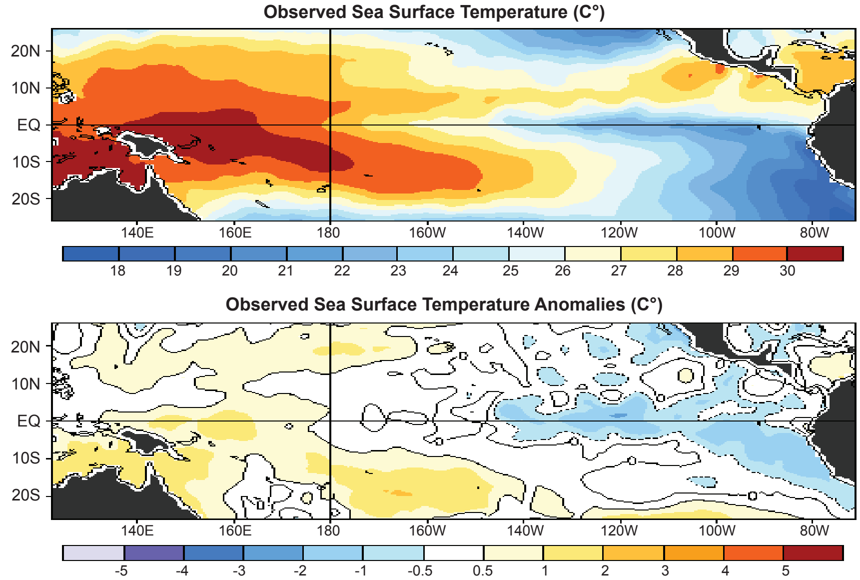



**Figure 13a.** Two graphics showing the observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. The Niño 3.4 region encompasses the area between 120°W-170°W and 5°N-5°S. The graphics represent the 7-day average centered on November 30, 2005.

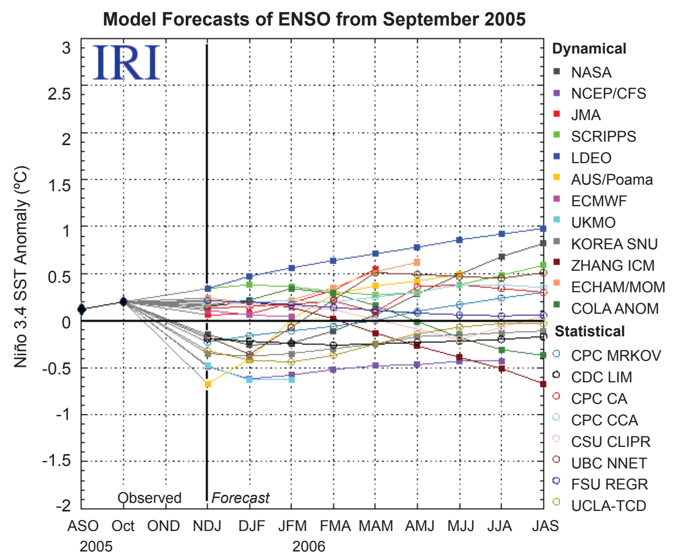



**Figure 13b.** Forecasts made by dynamical and statistical models for sea surface temperatures (SST) in the Niño 3.4 region for nine overlapping 3-month periods from November 2005 to September 2006 (released November 17, 2005). Forecasts are courtesy of the International Research Institute (IRI) for Climate Prediction.

## 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 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 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 the 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.

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.

**On the Web**

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

# Western Regional Climate Center

By Keah Schuenemann, Graduate Student, Western Water Assessment

The Western Regional Climate Center (WRCC), established in 1986, is just one of six regional climate centers across the United States managed by the National Oceanic and Atmospheric Administration. The climate centers are all funded through NOAA's Cooperative Institute for Atmospheric Sciences and Terrestrial Applications and are directed by the National Climatic Data Center. The WRCC is located in Reno, Nevada and is within the Desert Research Institute, a campus of Nevada's University system. The WRCC is responsible for coordinating all applied climate activities and drought monitoring in the 13 western most states. They conduct research on climate issues specifically important to the West such as the impacts of climate variability, extremes weather events, and El Nino Southern Oscillation. They are also responsible for the quality control of their historic climate databases. The databases include climate readings from hundreds of stations on hourly precipitation, 15-minute precipitation, twice daily upper air soundings, lightning data, and other such information. The WRCC provides climate data from their databases to the public and private sector upon request.

**Figure 14b.** WRCC Staff in Dec. 2005

There are various products and data available on the WRCC webpage. In addition, the webpage has links to other organizations with climate data, which makes it a convenient starting point for any search for past or present climate information from the West. The types of historical climate information includes historical summaries of individual stations or states, anomalies for water year periods, average winds, evaporation, amount of sky cover, coastal water temperatures, humidity, precipitation, climate extremes, major storm events, and narratives on the climate of each state. Current meteorological data from ground observations, radar, and satellite imagery are all linked on one page. The site also provides long-term climate outlooks and short-term weather forecasts from the National Weather Service. In addition to climate and weather data, links to reports from organizations that have policy or planning roles in the region such as the Western Governors Association and the Western Drought Coordination Council are available.

The WRCC currently has several ongoing research projects. The Southern Nevada Community Environmental Monitoring Project (CEMP) monitors the air for manmade radioactivity from the Nevada Test Site. The Wind Energy Assessment for Nevada is an ongoing study to find the optimal places to put wind towers for renewable energy. The El Nino and La Nina project focuses on how ENSO affects the western climate. The Yucca Mountain Climate Data Project collects meteorological data from nine sights in the Yucca Mountain area. Finally, the Washoe Evapotranspiration Project (WET) has weather stations around Reno, Nevada to collect evapotranspiration data in order to estimate crop and lawn watering needs. All of these products are available at http://www.wrcc.dri.edu/.

This article was adapted from information in the WRCC brochure, http://www.wrcc.dri.edu/ABOUTUS.html, and the WRCC website.

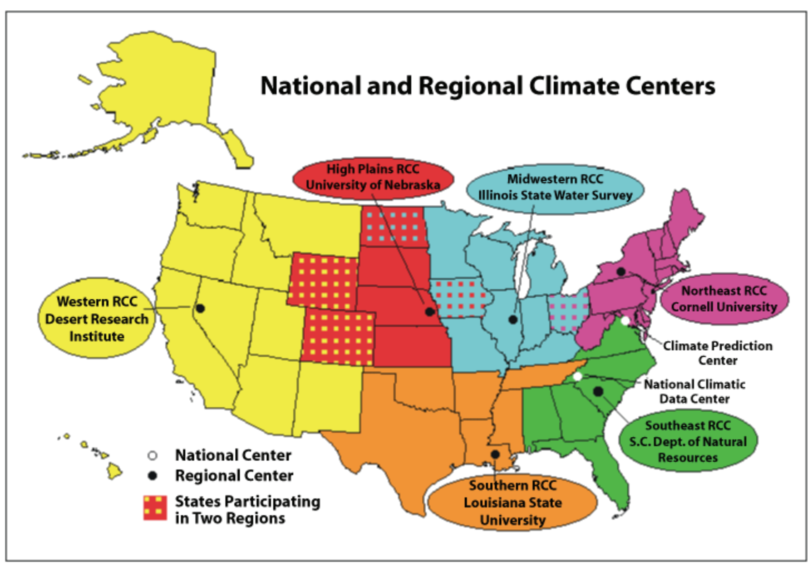



**Figure 14b.** Map showing locations and geographic areas covered by each of NOAA's Regional Climate Centers.

## On the Web

- High Plains Regional Climate Center: http://www.hprcc.unl.edu/,
- NOAA's Regional Climate Center page: http://www.ncdc.noaa.gov/oa/climate/regionalclimatecenters.html