Intermountain West Climate Summary

by The Western Water Assessment

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January 2008 Climate Summary

Hydrological Conditions — Severe drought status persists in western Utah and western Wyoming, and eastern Colorado has been elevated into the abnormally dry category by the U. S. Drought Monitor.

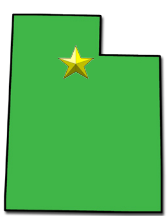
Temperature — Temperatures across most of the region were 0-4°F below average in December, but some areas in each state were 6-10°F below average.

Precipitation — Precipitation across most of the region was near or above average in December, with most of Utah and Colorado getting above 200% of average.

ENSO — A moderate La Niña event is underway in the Pacific Ocean. It is likely to persist through April 2008 and may gradually diminish in Spring 2008.

Climate Forecasts — La Niña impacts during February – April 2008 are above average precipitation in the Pacific Northwest (including Wyoming) and below average precipitation in the Southwest, including southern Colorado and southern Utah. There is an increased chance of above average temperatures across much of the Intermountain West.

Utah Releases Climate Change Report



In Utah, the Governor's Blue Ribbon Advisory Council on Climate Change released their final report in October. The board was made up of government, industry, environment and community representatives, who were tasked with identifying proactive measures that Utah might take to mitigate the impacts of greenhouse gases. They evaluated the science of climate change and how it pertains to temperature trends, snowmelt runoff, drought, and severe weather in Utah. They made recommendations on options for greenhouse gas reductions grouped in five sectors: Agriculture and Forestry, Cross-Cutting, Energy Supply, Residential/Commercial/Industrial, and Transportation and Land Use. The report is available at: http://www.deq.utah.gov/BRAC_Climate/.

Upcoming Workshops *See http://wwa.colorado.edu*

- WWA is organizing a workshop on climate change modeling for water resources managers on February 1st in Denver.
- WWA, NOAA's Colorado Basin River Forecast Center, and NRCS are co-sponsoring a workshop on Forecast Verification on February 19th in Denver. Please see the Feature article on page 2 for more information.

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Recent Conditions

Forecasts

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

Contact Us - To receive an email when a new Summary is available, please email us at: **wwasummary@wwa.colorado.edu.**

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Forecast Verification: Past, Present, and Future

By Julie Malmberg, Western Water Assessment

The goal of this article is to provide forecast users with a framework for assessing the quality of any kind of forecast. Also to this end, WWA is co-sponsoring a workshop on Forecast Verification with NOAA's Colorado Basin River Forecast Center and NRCS on February 19th in Denver. The workshop will provide forecast users with the tools to evaluate the overall quality of the forecast. The workshop will emphasize water supply forecasts in the Western United States but the concepts will be applicable to climate forecasts as well. Please contact Christina Alvord for more information: christina.alvord@noaa.gov.

Forecasts are issued by meteorologists, climatologists, and hydrologists to predict future weather, climate, and streamflows for a wide variety of purposes including saving lives, reducing damage to property and crops and even so people can decide what to wear in the morning. Forecast verification is how the quality, skill, and value of a forecast is assessed. The process of forecast verification compares the forecast against a corresponding observation of what actually occurred or an estimate of what occurred. This article discusses some of the many different forecast verification methods, the concept of forecast value to users, and offers some suggestions for forecast users when considering any forecast.

Overview of Forecasts

The three types of forecasts discussed here are weather, climate, and streamflow forecasts. *Weather forecasts* predict the weather that will occur during a short time frame from six hours to two weeks into the future. *Climate forecasts*, also called climate outlooks, predict the average weather conditions for a season or period from several months to years in advance. Climate forecasts will do not predict the weather for a certain day, but predict the average weather over several days or months. Examples of climate forecasts from NOAA are on pages 13–14. *Streamflow forecasts* predict water supply conditions, including streamflow at a point or volume for a period, based upon variables like precipitation and snowmelt. Streamflow forecasts can be daily or seasonal time scales. An example of a streamflow forecast map is on page 17.

History of Forecast Verification

In order to create better forecasts, forecasters monitor the forecasts for accuracy and compare different forecasting techniques to see which is better and why (IVMW, 2007). Weather forecasting based upon interpreting weather maps began in the 1850s in the United States, but serious efforts in forecast verification began in the 1880s. In 1884, Sergeant John Finley of the U.S. Army Signal Corps began forecasting tornado occurrences for 18 regions east of the Rocky Mountains. His forecasts were made twice a day and would be either "Tornado" or "No Tornado". This is an example of a dichotomous forecast, where there are only two possible choices. He reported a 95.6-98.6% accuracy for the first three months. However, other scientists pointed out that, ironically, he could have had 98.2% accuracy if he forecasted "No Tornado" for all the regions and all the time periods. A 10-year debate started after Finley's publication, referred to as "The Finley Affair." This debate made forecasters realize the need for valid verification methods in order to improve forecasts, and led to the development of verification methods and practices (Murphy, 1996).

Types of Verification

In order for a forecast to be verified, it must be compared with some "truth." Observational data such as rain gauges, thermometers, stream gauges, satellite data, radar data, eyewitnesses, etc. are used as "truth." In many cases, however, it can be difficult to know the exact "truth" due to instrument error, sampling error, or observation errors. Accurate observations and observation systems, then, are critical to forecast verification.

Forecasters and forecast users have many different ways to verify forecasts and assess quality. Two of the traditional ways are looking at the *accuracy* and the *skill* of the forecast. *Accuracy* is the degree to which the forecast corresponds to what actually happened (i.e. "truth" data) and depends on both the forecast itself and the accuracy of the measurement or observation. As mentioned above, observation data can be a limitation in all verification measures, not just accuracy. In addition, the

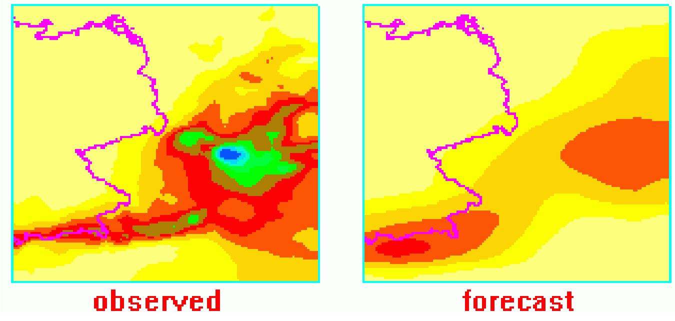


Figure 1a. Observed data versus forecast data (IVMW 2007).

		Observation		
		Yes	No	Total
Forecast	Yes	hits	false alarms	forecast yes
	No	misses	correct negatives	forecast no
	Total	observed yes	observed no	Total

Figure 1b. A contingency table shows what types of errors are being made. A perfect forecasting system would only produce hits and correct negatives.

person verifying the forecast uses expert judgment to decide what makes a forecast accurate. For example, a forecast for a high temperature of 75°F might be considered inaccurate either when the observed high temperature was 76°F or when the high temperature was 85°F.

The second common forecast verification measure is *skill*. Skill is the accuracy of a forecast over a reference forecast. The reference forecast might be random chance, persistence forecasts, climatology, or even another forecast. A random chance forecast would be like flipping a coin to decide whether or not to forecast precipitation. Persistence forecast is forecasting the same conditions that are happening at the time of the forecast. For example, if it is currently snowing, a persistence forecast is for snow to continue. A forecast of climatology is forecasting the average conditions for the forecast period. A "skillful" forecast must show improvement over a reference forecast.

Other measures of forecast quality besides accuracy and skill include bias, resolution, and sharpness. *Bias* measures if forecasts on average are too high or too low relative to the truth. *Resolution* measures the ability of a series of forecasts to discriminate between distinct types of events, even if the forecast itself is wrong. *Sharpness* indicates if the forecasts can predict extreme values. Sharpness is important because forecasters can sometimes achieve high skill scores by predicting average conditions but in some cases the occurrence of extreme events may be more important to users. In general, focusing on just one measure of forecast quality may be misleading. For example, in the case of Findley's forecasts, their apparent high accuracy obscured the fact their skill was less than a constant forecast of no tornado.

Methods of Forecast Verification

Forecast verification methods are chosen depending on the type of verification (accuracy or skill) and the type of forecast (dichotomous, continuous, probabilistic, etc.). Examples of verification methods range from simply "eyeballing" the forecast compared to observations, to statistically and numerically advanced methods.

Eyeballing a forecast is as simple as it sounds and can be use for a variety of forecasts. A forecaster simply looks at the forecast and the observations side by side to see how well they match up (Figure 1a). "Eyeballing" verification is very subjective and can lead to different outcomes depending on the judgment of the individual forecasters looking at the data.

A contingency table is typically used to verify dichotomous forecasts, like the tornado example above, over a period of time. The table shows the "yes" and "no" forecasts and observations (Figure 1b). To find the accuracy of the forecasts, one must sum "hits" and "correct negatives" and divide by the "Total". This will give a number between 0 and 1; the closer to 1, the more accurate the forecast. This type of score can be very misleading in rare events when forecasting "No" will lead to a high "correct negatives" category such as the occurrence of tornados as in the Findley Affair. Numbers in the contingency table can be combined in many other ways than just accuracy. For example, the False Alarm Ratio is the number of events that were forecasted to occur but did not.

One can numerically verify or calculate the error between the forecast and the observed values with the help of graphical representations. Graphical displays, such as scatter or box-and-whisker plots, are used to verify forecasts of continuous variables such as maximum temperature over a period of days. Scatter plots show the observed amount plotted against the forecast amount. An accurate forecast in this case would lie along the diagonal of the scatter plot. Box-and-whisker plots can show the distribution of the observed values relative to the forecasted values, which can provide a measure of the resolution of the forecast. In a well-resolved forecast, the box plot of the forecast would appear to have the same spread as the observed values.

Skill scores can be calculated for almost all types of forecasts, but they are most often used for categorical and probabilistic forecasts, like the seasonal climate outlooks issued by NOAA's Climate Prediction Center (CPC) (see pages 13 and 14). All skill scores measure the fraction of correct forecasts to total forecasts after correcting for the number of correct forecasts a reference forecast – generally persistence, climatology or random chance – would obtain. Three types of skill scores are the Heidke skill score, the Brier skill score, and the Ranked Probability skill score. A score between negative infinity to 1 is calculated, with 1 being a perfect score. If forecasts are consistently better than the reference forecast, the score will be closer to 1, a score of 0 indicates no improvement over the reference forecast, and a negative score indicates the forecast performs worse than the reference forecast. Note that perversely a high negative score may actually provide considerable value if the forecast can be 'inverted'. For this reason, substantial negative skill scores are rarely seen. When comparing skill scores for different forecasts, it is important to use the same method for all forecasts. For example, if you want to compare the CPC seasonal forecast to Klaus Wolter's experimental seasonal guidance, make sure you are looking at either the Heidke or Brier skill score for both.

Forecast Value and Forecast Users

Another important attribute of forecasts is *value*. A forecast might be highly accurate, skillful, unbiased, sharp and well resolved and still not be very useful. A valuable forecast best helps a decision maker. For example, a forecast of clear skies over a desert is probably not very helpful. On the other hand, if a forecast helps a decision maker to gain some benefit, the forecast is considered valuable. Accurately forecasting a drought will help water managers to better prepare for low water supply. Forecasting the April 1st snowpack as early as possible would help improve the annual water management operations. In essence, useful forecasts need a wide variety of attributes including accuracy, skill and value.

NOAA is creating ways to educate decision makers and create better consumers of forecasts. Making forecast verification measures available and explaining the techniques to users will increase the value of forecasts. For example, the Forecast Evaluation Tool and the new verification tools on the NOAA National Weather Service Western Water Supply Application Suite both make verification tools readily available to users (see box). Users will be able to decide which forecasts they want to use for what purpose, and will know the weaknesses, strengths, or biases of particular forecasts. For example, a certain forecast might tend to predict wetter conditions in the spring.

Verifying a forecast should ultimately lead to improvement in the forecasting techniques and an increase in value to the users. Overall, forecasters are starting to understand that they need to think about who is using their forecasts and the value of the forecast to the users, not just the skill score or the accuracy of a forecast. While accuracy is very important, it is not the only element of a good forecast. Whether a forecast is for weather, climate, or streamflows, a user should know what information the forecast provides, how the forecast is verified, and limitations of the forecasts and verification methods. If users are educated about forecasts and forecast verification, they will ultimately be better consumers of those forecasts.

References

Murphy, A.H. 1996. The Finley Affair: A Signal Even in the History of Forecast Verification. *Weather and Forecasting*. 11(1): 3-20.

Third International Verification Methods Workshop (IVMW). 2007. Reading, UK. Available online: http://www.bom.gov.au/bmrc.wefor/staff/eee/verif/verif_web_page.html.

Forecast Verification Websites

Two online tools help make forecast verification techniques accessible and understandable to users: the Forecast Evaluation Tool (FET) for NOAA/CPC seasonal climate outlooks and the NOAA National Weather Service (NWS) Western Water Supply Application Suite for their water supply forecasts.

Forecast Evaluation Tool

FET is an online application to look at the successes of CPC seasonal climate forecasts by climate division, season, and lead time of the forecast. Holly Hartmann, a scientist working for CLIMAS, a NOAA RISA program at the University of Arizona, found that forecast users were hesitant to make decisions based upon forecasts without knowing the track record of forecasts. She then initiated FET. In order to use FET, register for free at http://fet.hwr.arizona.edu/ForecastEvaluationTool/. A tutorial is available at the web page. For more information about FET, see the January 2006 Intermountain West Climate Summary.

NWS Western Water Supply Application Suite

The NOAA/NWS Western Water Supply Application Suite launched in January 2008. This brand new tool allows users to select a state, river, and station and then visualize data and also calculate error statistics and skill statistics. The web page is available at: http://www.nwrfc.noaa.gov/westernwater/. To access the verification section, when you get to the web page, first select "Change Application" and then select the "Verification" tab. At this point, the regional data can be entered. More information is also available by selecting the "About Western Water Supply" tab and then the "Verification" tab.

Temperature 12/1/07 - 12/31/07

Monthly average temperature for December 2007 in the Intermountain West region ranged from 10-40°F (Figure 2a). The warmest areas (above 25°F) were across most of **Utah** and eastern and southwestern **Colorado**. Temperatures across most of the region were 0-4°F below average, but some areas in each state were 6-10°F below average (Figure 2b).

Two high temperature records were set in **Colorado** on December 4th. Colorado Springs reached a high of 71°F, which broke the previous record of 69°F set in 1999. A high temperature of 72°F was recorded at the Denver International Airport, breaking the previous high of 69°F set in 1980. However, even with this high temperature, Denver still had a monthly average temperature of 26.7°F for December, which was 3.6°F below average. Several low temperature records over 40 years old were broken in December. A new low temperature of -21°F recorded at the Laramie Airport in **Wyoming** on December 15th broke the previous low of -15°F set in 1965. A low temperature of -33°F in Alamosa, **Colorado**, was reported by the NWS Pubelo on December 29th, breaking the previous record of -28°F set in 1966. The monthly average temperature in Lander, **Wyoming** for December was 15.7°F was 5.6°F below average, according to the NWS Riverton.

Temperatures in December 2006 were higher than temperatures in December 2007 throughout most of the IMW region (Figure 2c). Some areas in all three states had temperatures 0-4°F below average in December 2006, but most of the region was 0-4°F above average in December 2006, including some areas of northern Wyoming that were 4-8°F above average. In contrast, temperatures in December 2007 were all near or below average.

Notes

Figures 2a-c are experimental products from the High Plains Regional Climate Center. These data are considered experimental because they utilize the most recent data available, which have been subject to minimal quality control. These maps are derived by taking measurements at individual meteorological stations and interpolating (estimating) values between known points to produce continuous categories. Interpolation procedures can cause incorrect values in data-sparse regions. For maps with individual station data, please see web sites listed below. *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.

On the Web

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

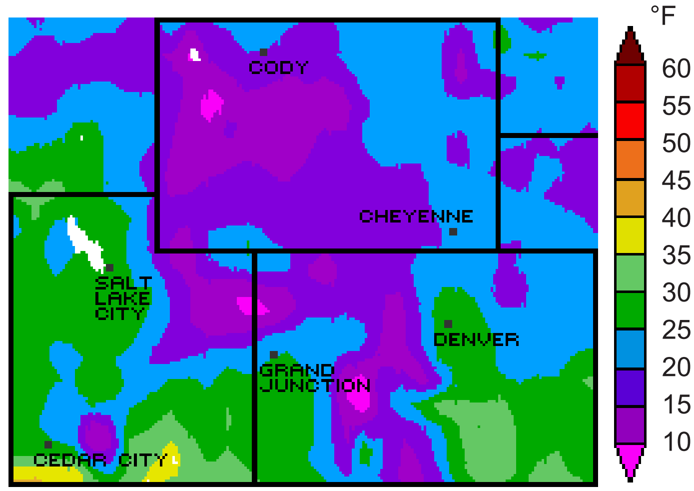


Figure 2a. Average temperature for the month of December 2007 in °F.

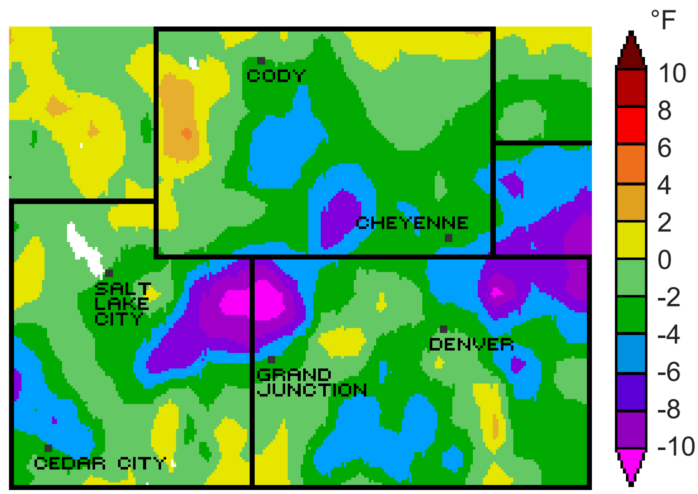


Figure 2b. Departure from average temperature for the month of December 2007 in °F.

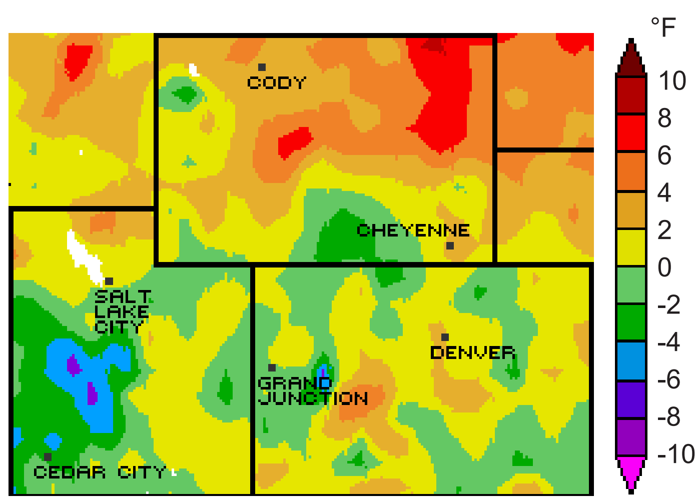


Figure 2c. Departure from average temperature in °F for last year, December 2006.

Precipitation 12/1/07 - 12/31/07

Total precipitation for December 2007 in the Intermountain West region ranged from 0.25 to 3+ inches (Figure 3a). Western **Colorado** and central **Utah** received the highest totals (3+ inches). Southeast **Colorado**, northeast **Wyoming**, and north-central **Wyoming** received the lowest amount (0.25 – 0.50 inch). December 2007 was the wettest on record for western **Colorado**, according to the NWS Grand Junction. Total precipitation at the Grand Junction Airport was 2.05 inches for the month of December, which broke the previous record of 1.89 inches set in 1951.

While there were some areas of below average precipitation in December, most of the region had near or above average precipitation (Figure 3b). Western **Colorado** and most of **Utah** reported above average precipitation (200% +). Areas in northern **Wyoming** reported the lowest percent of average (<40 – 80%). Salt Lake City received 3.35 inches of precipitation for December, which is 272% of normal, according to the NWS Salt Lake.

Precipitation since the start of the water year is near average or above average for most of the region (Figure 3c). Below average areas include southeast **Colorado** and northeast **Wyoming** (<50 – 70%). The wettest areas were in western **Colorado**, eastern **Utah**, and southeast **Wyoming** (110-150%+).

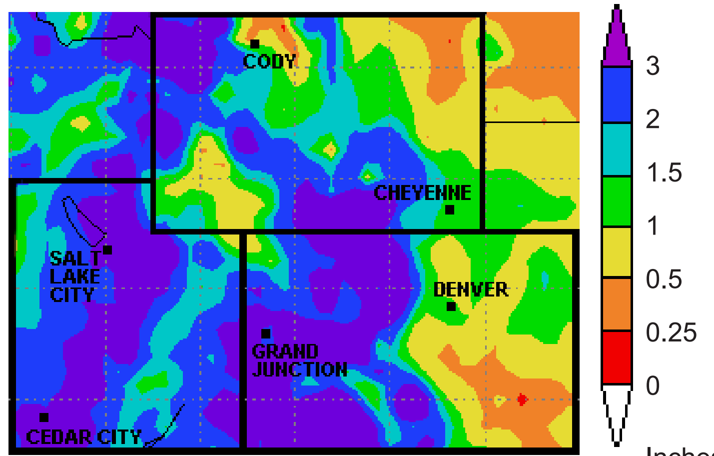


Figure 3a. Total precipitation in inches for the month of December 2007.

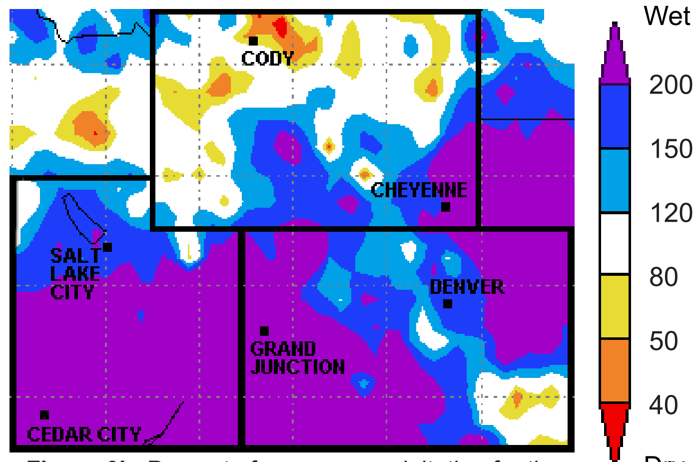


Figure 3b. Percent of average precipitation for the month of December 2007.

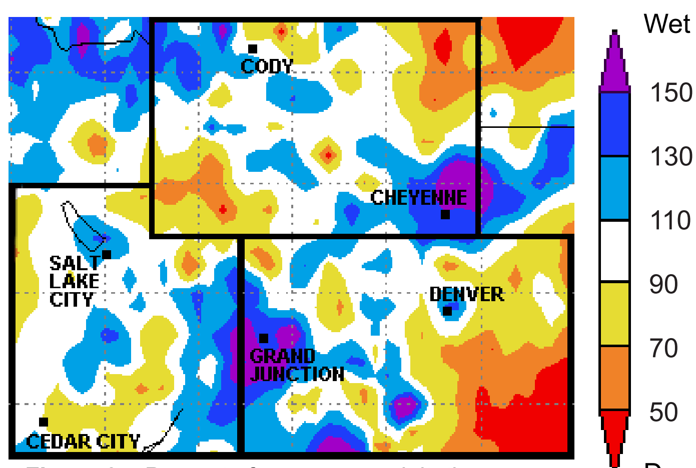


Figure 3c. Percent of average precipitation accumulation since the start of the water year 2008 (Oct. 1, 2007 – Dec. 31, 2007).

Notes

The data in Figs. 3 a-c come from the High Plains Regional Climate Center. These data are considered experimental because they utilize the most recent data available, which have been subject to minimal quality control. These maps are derived by taking measurements at individual meteorological stations and interpolating (estimating) values between known points to produce continuous categories. Interpolation procedures can cause incorrect values in data- sparse regions. For maps with individual station data, please see web sites listed below. The water year runs from October 1 to September 30 of the following year. The 2007 water year began October 1, 2006 (Figure 3c). The water year better reflects the natural cycle of accumulation of snow in the winter and run-off and use of water in the spring and summer. It is a better period of analysis for presenting climate and hydrologic conditions. 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. Percent of average precipitation is calculated by taking the ratio of current to average precipitation and multiplying by 100.

On the Web

- For the most recent versions of these and maps of other climate variables including individual station data, visit: http://www.hprcc.unl.edu/products/current.html.
- For precipitation maps like these and those in the previous summaries, which are updated daily visit: http://www.cdc.noaa.gov/Drought/.
- For National Climatic Data Center monthly and weekly precipitation and drought reports for Colorado, Utah, Wyoming, and the whole U. S., visit: http://lwf.ncdc.noaa.gov/oa/climate/research/monitoring.html.
- For a list of weather stations in Colorado, Utah, and Wyoming, visit: http://www.wrcc.dri.edu/index.html.

U.S. Drought Monitor conditions as of 1/15/08

The U.S. Drought Monitor (Figure 4) shows the highest drought intensity in western **Utah** and western **Wyoming**. Lower drought intensity extends through the rest of **Utah**, central **Wyoming**, and eastern **Colorado**, but the rest of **Wyoming** and most of **Colorado** are not classified in drought status at this time. Above average precipitation in **Utah** and parts of **Colorado** in December helped decrease the drought status in southern **Utah** and south-central **Colorado** since November (see inset). Due to continued below average precipitation in eastern **Colorado**, the southeast corner of the state is now categorized as abnormally dry drought status (D0).

The NIDIS Drought Portal was released on November 1, 2007: http://www.drought.gov. The Drought Portal is a clearinghouse for drought information for the U.S., featuring climate and hydrological data and forecasts, drought impacts, planning resources, and educational tools. See the Focus Page (18) for more information.

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 summary'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 several agencies.

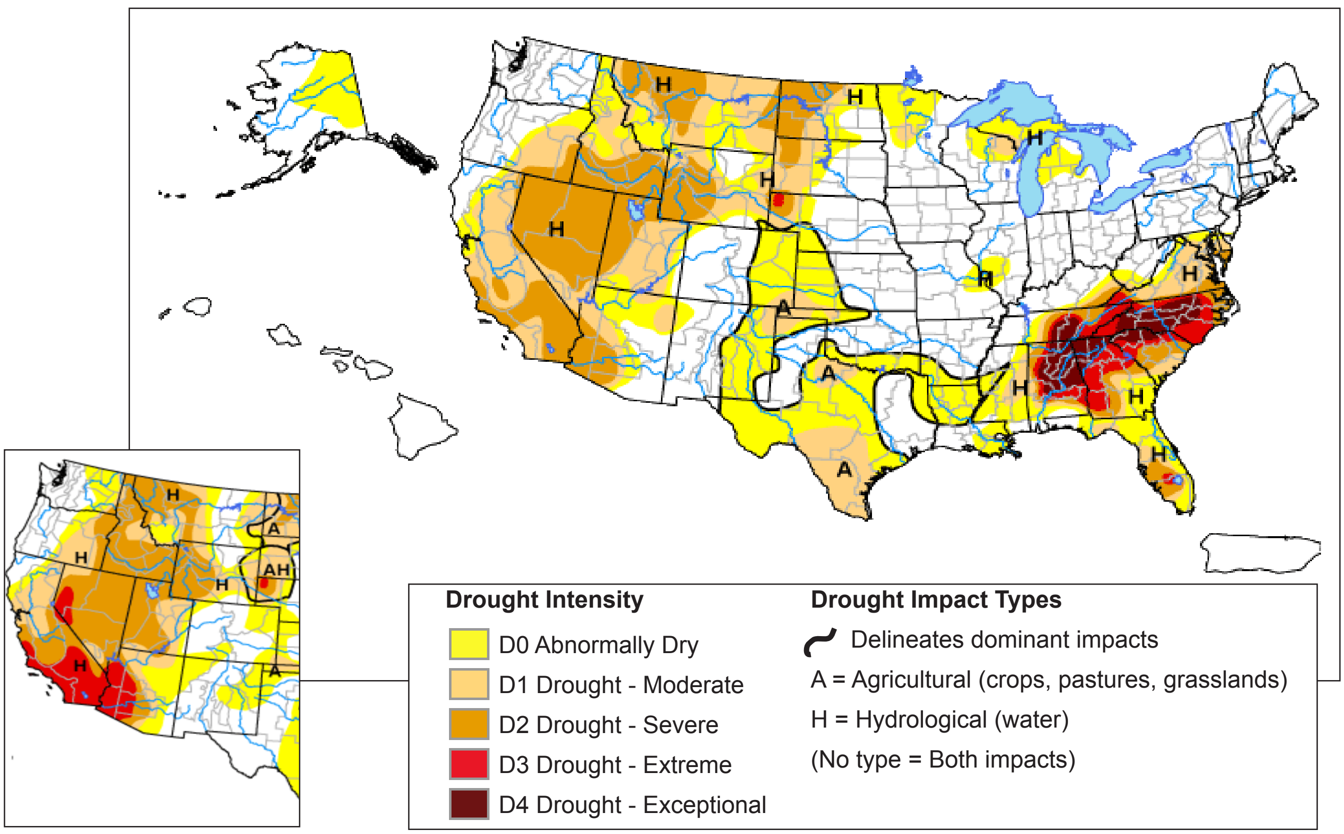


Figure 4. Drought Monitor from January 15, 2007 (full size) and the last summary, November 13, 2007 (inset, lower left) for comparison.

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.
- Drought Impact Reporter (National Drought Mitigation Center): http://droughtreporter.unl.edu/.
- NIDIS Drought Portal: http://www.drought.gov.

Intermountain West Snowpack data through 12/31/07

January 1 snowpack conditions are below average for most of the Intermountain West Region, with the exception of several southern basins in **Colorado** and **Utah** (Figure 5). In water year 2008, there was above average snowfall in October in **Colorado** and northern **Utah**, but this melted out during a warm November. Then, early December brought several large storms to the southern mountains in both **Utah** and **Colorado**, which are the only areas in the region with above average snowpack now. In **Colorado**, the southern basins of the San Juan, Rio Grande, and Arkansas Rivers have sub-basins with above 150% of average SWE. **Utah's** highest SWE is in the Sevier River basin at 115% of average. In contrast to these basins, northern **Colorado**, northern **Utah** and most of **Wyoming** are below average. **Wyoming's** North Platte River basin is above average, but the rest of the state ranges from 58- 102% of average SWE.

This pattern of above average snowfall in the south and below average snowfall in the north is opposite of typical La Niña years. The teleconnection between La Niña and below average snowfall in southern **Utah** is especially strong, but this year is proving to be different from past La Niñas. For more information about the current status of La Niña, see page 16.

Notes

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

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. Basins with no SNOTEL sites or incomplete data are designated in white on the map. To see the locations of individual SNOTEL sites, see each state's water availability page.

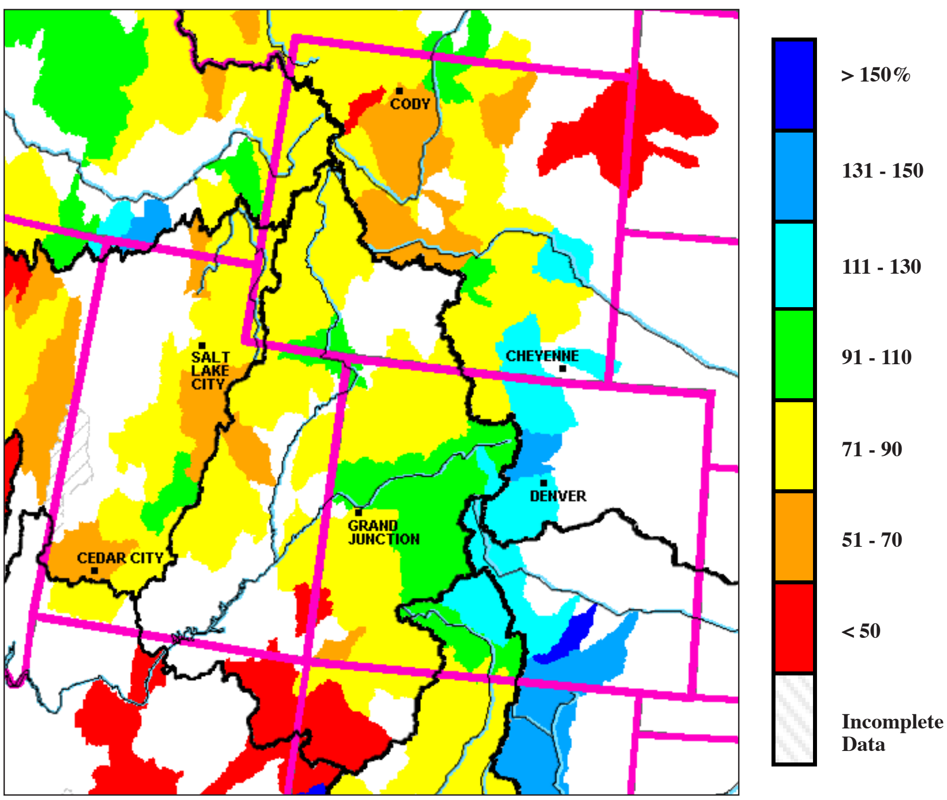


Figure 5. Snow water equivalent (SWE) as a percent of average for available monitoring sites in the Intermountain West as of January 1, 2008 (NRCS).

On the Web

- For graphs like this and snowpack graphs of other parts of the western U.S., visit: http://www.wcc.nrcs.usda.gov/snowcourse/snow_map.html.
- For snow course and SNOTEL data updated daily, please visit one of the following sites: River basin data of SWE and precipitation: http://www.wrcc.dri.edu/snotelanom/snotelbasin.
- Individual station data of SWE and precipitation for SNOTEL and snow course sites: http://www.wcc.nrcs.usda.gov/snowcourse/snow_rpt.html or http://www.wcc.nrcs.usda.gov/snotel/ .
- Graphic representations of SWE and precipitation at individual SNOTEL sites: http://www.wcc.nrcs.usda.gov/snow/snotel-data.html.

Regional Standardized Precipitation Index data through 12/31/07

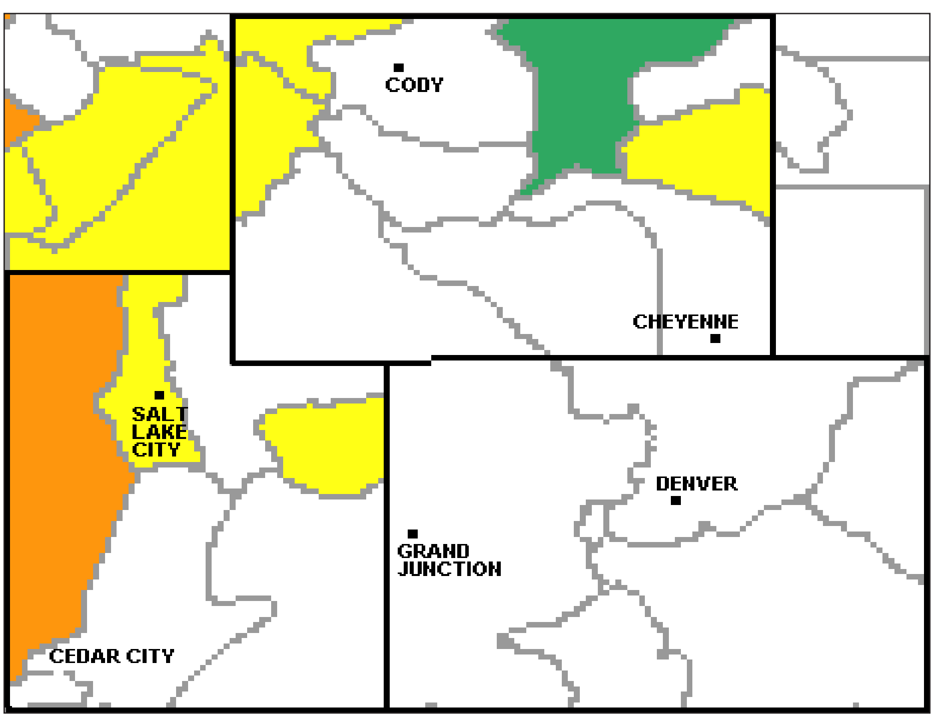
The Standardized Precipitation Index is used to monitor moisture supply conditions. This index identifies emerging droughts months sooner than the Palmer Index and it can be computed on several time scales. 3- and 6-month SPIs are useful in short-term agricultural applications. Longer-term SPIs (12 months and longer) are useful in hydrological applications. This month, we describe the 12-month SPI map.

At the end of December 2007, several of the climate divisions changed in climate classification as compared to the end of October 2007 (the last IMW Climate Summary). Above average precipitation in **Utah** and central **Wyoming** in December helped move some divisions to wetter categories. The South Central and Northern Mountains divisions in central **Utah** and the Green and Bear Drainage and Wind River divisions in southwest **Wyoming** changed from the moderately dry category to the near normal category. The Powder, Little Missouri, and Tongue division moved from the moderately wet to the very wet category. Near average conditions in southeast **Wyoming** caused the Lower Platte region to change from moderately wet to near normal. There were no changes in climate divisions in **Colorado**.

Notes

The SPI is an index based on the probability of recording a given amount of precipitation, and the probabilities are standardized so that an index of zero indicates the median precipitation amount (half of the historical precipitation amounts are below the median, and half are above the median). The index is negative for drought, and positive for wet conditions. As the dry or wet conditions become more severe, the index becomes more negative or positive. The SPI is computed by the NOAA National Climatic Data Center (NCDC) for several time scales, ranging from one month to 24 months, to capture the various scales of both short-term and long-term drought. The Colorado Climate Center describes the SPI as valuable in monitoring both wet and dry periods, and it can be applied to other types of data (e.g. streamflow, reservoir levels, etc.). 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% would be expected to be drier. An index value of -2 means severe drought with only 2.5% of years expected to be drier.

A 12-month SPI is used for the Intermountain West region (Figure 6) and compares precipitation patterns for 12 consecutive months with the same 12 consecutive months during all the previous years of available data. The SPI at these time scales reflect long-term precipitation patterns. The graphic in Figure 6 comes from the Western Regional Climate Center, which uses data from the NCDC and the NOAA Climate Prediction Center.



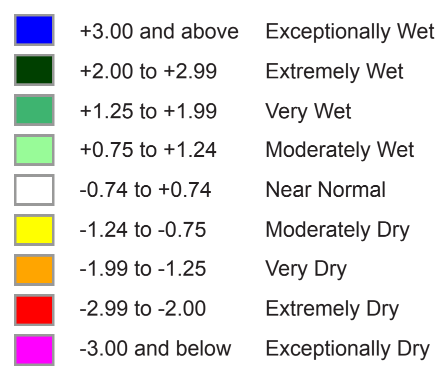


Figure 6. 12-month Intermountain West regional Standardized Precipitation Index (data from 1/1/07 - 12/31/07).

On the Web

- For information on past precipitation trends, visit: http://www.hprcc.unl.edu/products/current.html.
- For SPI products directly form the NCDC, visit: http://lwf.ncdc.noaa.gov/oa/climate/research/prelim/drought/spi.html. These maps use the same data as Figure 5, but the categories are defined slightly differently.

Colorado Water Availability

Snowpack is the primary determinant of water supply estimates from December-April 1. Snowpack is lowest in the Yampa, White, and North Platte basin in the north at 93% of average. Snowpack is highest in the southern portion of the state, ranging from 120%->160% in the Rio Grande, San Juan, San Miguel, Animas, and San Rafael basins. Snowpack is 296% of average in the Rio Grande Basin and snowpack increased from near record lows to near record highs in December, according to the NRCS (Figure 7a). La Niña conditions are present in the Equatorial Pacific, however La Niña's impacts to winter precipitation in Colorado are not consistent.

Reservoir storage is near average, ranging from a low of 83% of average in the South Platte basin to a high of 110% of average in the San Juan, Dolores, Animas, and Miguel basins, according to the NRCS. The USBR expects unregulated inflow to Blue Mesa during December-February to be 99% of average. Initial spring 2008 runoff forecasts released by the NWS River Forecast Centers project near or below average runoff (85–90%) for the North and South Platte Basin and above average runoff (100–130%) for all other basins. For spring and summer streamflow forecasts, see page 17.

January 1 SWSI values are near or above average, ranging from a low of -0.1 in the Yampa, White, and North Platte basin to a high of 2.8 in the Rio Grande basin (Figure 7b). With the majority of the snow accumulation season still ahead, water supply conditions may change throughout the winter months.

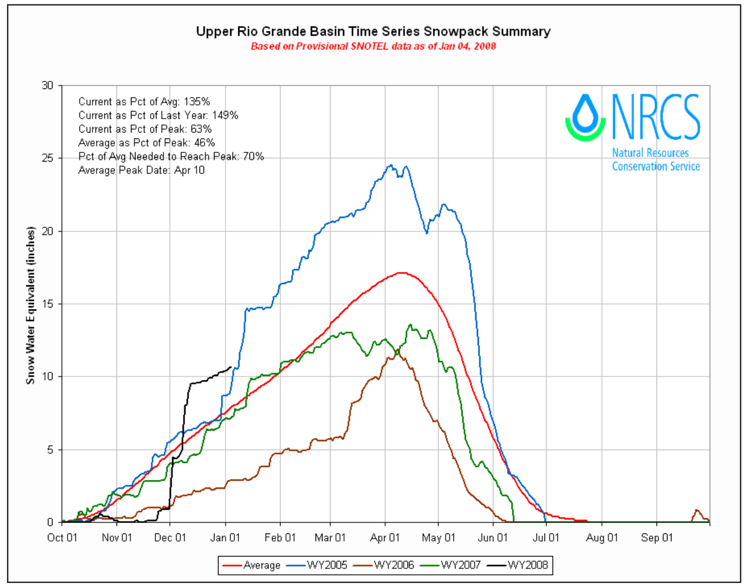


Figure 7a. Accumulated SWE for WY2008 (black line) increased nearly 8 inches during December in the Rio Grande Basin (NRCS).

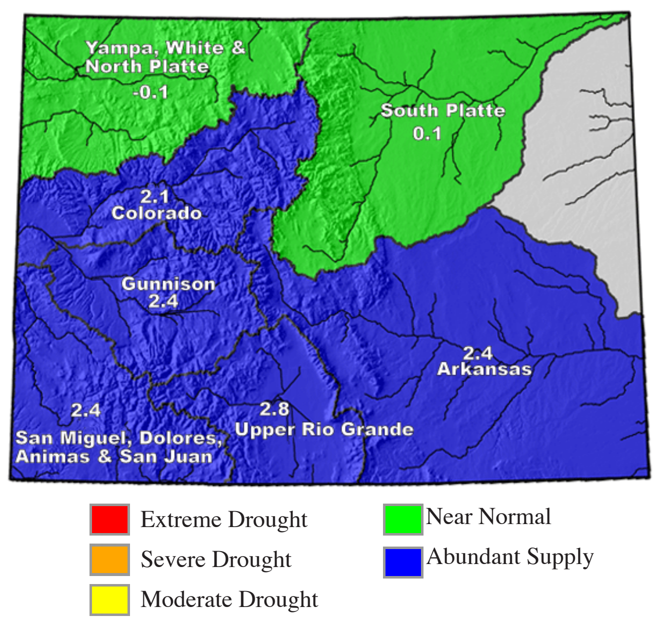


Figure 7b. Colorado Surface Water Supply Index as of January 1, 2008 (Colorado NRCS).

Notes

Figure 7a shows accumulated SWE amounts (inches) based on provision SNOTEL data as of January 4, 2008 for WY2005 (blue line), WY2006 (brown line), WY2007 (green line), WY2008 (black line) plotted against the historical average (red line). The Surface Water Supply Index (SWSI- Figure 7b) developed by the Colorado Office of the State Engineer and the NRCS is used as an indicator of mountain-based water supply conditions in the major river basins of the state. The Colorado SWSI is based on snowpack, reservoir stor¬age, and precipitation for the winter period (November-April). This differs from summer calculations that use streamflows as well. SWSI values in Figure 7b were computed for each of the seven major basins in Colorado on the first of each month, and reflect conditions through the end of the previous month.

On the Web

- Now available from the NRCS are new SWE as a percent of normal state maps available at: http://www.wcc.nrcs.usda.gov/gis/snow.html.
- For monthly reports on water supply conditions & forecasts for major CO river basins, visit: http://www.co.nrcs.usda.gov/snow/snow/snow_all.html and click on "Basin Outlook Reports."
- Information on regional weather forecasts and information, visit NWS Denver/Boulder Weather Forecast Office at http://ww.crh.noaa.gov/bou/.
- The Colorado Water Availability Task Force is scheduled to meet January 18, 2008. Information, including agenda & minutes of upcoming & previous meetings are available at: http://www.cwcb.state.co.us/Conservation/Drought/taskForceAgendaMinPres.htm.
- NRCS SWE line graphs by basin like in Figure 7a available at: http://www.co.nrcs.usda.gov/snow/snow/watershed/current/daily/maps_graphs/swe_time.html.

Wyoming Water Availability

Snowpack is the primary determinant of water supply estimates from December-April 1. Statewide snowpack is lowest is the Little Wind River basin in the southwest at 65% of average and highest in the Little Snake River basin in the south at 107% of average (Figure 8a). According to Wyoming State Climatologist, Steve Gray, snowpack has increased in all basins 5-15 percentage points in the last few weeks. Snowpack in the Lower North Platte River basin in southeastern Wyoming has near-average January 1 snow accumulation (90% of average) for the first time in several years. La Nina conditions are currently present in the Equatorial Pacific and are associated with increased precipitation in the northwest US into northern Wyoming. Snowpack in the northern portion of the state is near or above average and is consistent with conditions in previous La Nina years.

Reservoir storage is below average, ranging from a low of 46% of average in the North Platte basin to a high of 96% of average in the Green River basin, according to the NRCS. Reservoir storage in Boysen, Flaming Gorge, Buffalo Bill, Seminoe, and Fontenelle reservoirs are 104%, 81%, 65%, 62%, and 61% of average, respectively. According to initial streamflow projections from the CBRFC, statewide spring and summer streamflows are expected to be below average ranging from 91% of average in the Upper Yellowstone basin to a low of 59% of average in the Belle Fouche basin. Projected April-July inflow into Fontenelle and Flaming Gorge reservoirs are 81% and 74% of average, respectively.

Notes

Figure 8a, (NRCS), shows the SWE as a percent of average for each of the major river basins in Wyoming. According to the WY NRCS, "The Surface Water Supply Index" (SWSI – Figure 8b) is computed using only surface water supplies for each drainage basin. The computation includes reservoir storage, if applicable, plus the runoff forecast. The index is purposely created to resemble the Palmer Drought Index, with normal conditions centered near zero. Adequate and excessive supply has a positive number and deficit water supply has a negative value. The SWE does not use soil moisture and precipitation forecast, but the runoff forecast may include these values."

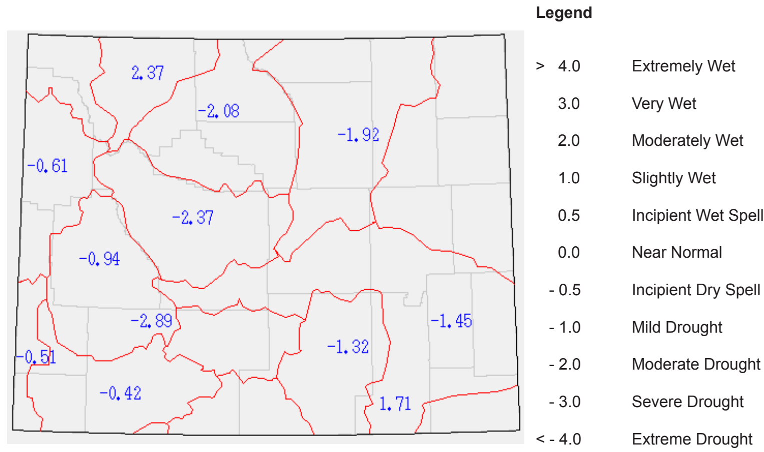


Figure 8b. Wyoming Surface Water Supply Index as of January 1, 2008 (Wyoming NRCS).

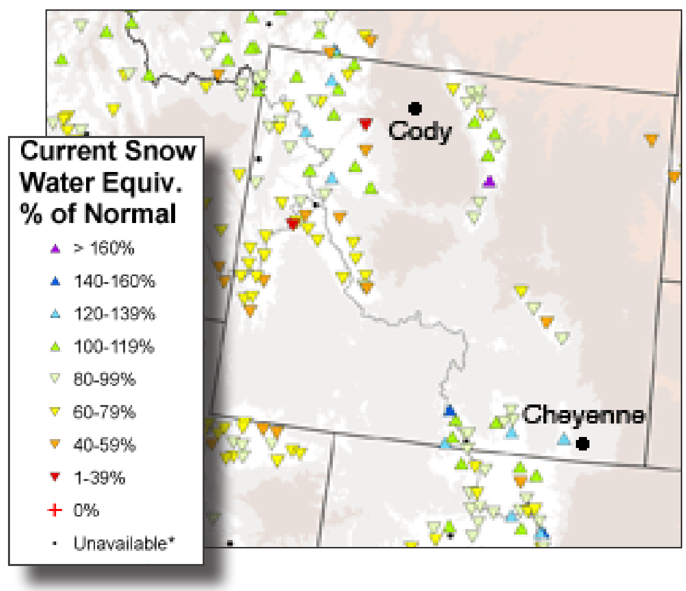


Figure 8a. Current snow water equivalent (SWE) as a percent of normal for SNOTEL sites in Wyoming as of January 2, 2008, (NRCS).

On the Web

- For current maps of SWE as a percent of normal (Figure 8a), visit: http://www.wcc.nrcs.usda.gov/gis/snow.html.
- For current SNOTEL data and plots of specific sites, visit: http://www.wcc.nrcs.usda.gov/snotel/.
- The Wyoming SWSI (Figure 8b), along with more data about current water supply conditions for the state can be found at: http://www.wrds.uwyo.edu/wrds/nrcs/nrcs.html.
- For monthly State Basin Outlook Reports on water supply conditions and forecasts for WY river basins, visit: http://www.wcc.nrcs.usda.gov/cgibin/bor.pl.
- Wyoming Water Resource Data system's drought page is located at: http://www.wrds.uwyo.edu/wrds/wsc/dtf/drought.html.
- Article in the Billings Gazette, "Wyoming snowpack improves," January 8, 2008, available at URL: http://www.billingsgazette.net/articles/2008/01/08/news/wyoming/30-snowpack.txt?CFID=596826&CFTOKEN=e58b7c55620d77b6-64A5EF71-FF33-87D1-F703C0C52BD2145F.

Utah Water Availability

Snowpack is the primary determinant of water supply estimates from December-April 1. Statewide snowpack ranges from a low of 40-79% of average in the Weber, Ogden, and Uintah basins in the north to a high of 120->160% of average in the Virgin and Beaver River basins in the south (Figure 9a). Historically, below average snowfall in southern basins and near or above average snowfall in northern basins is associated with La Niña conditions. While La Niña conditions persist in the equatorial Pacific, the snowfall patterns in Utah are uncharacteristic of past La Niña years, according to the NRCS.

Reservoir storage statewide is 15 percentage points below storage this time last year due to below average snowfall and streamflows during WY2007. Reservoir storage is lowest in the Bear River basin at 20% of average and highest in the Provo and Duchesne basin at 78% of average. Initial April-July streamflow forecasts released by the NWS project a low of 51% of average on Bear River to a high of 122% of average on the San Juan River. April-July inflow projections into Lake Powell are 101% of average. For additional information on spring and summer streamflow forecasts, see page 17.

SWSI values are near or below average statewide, ranging from a low of -3.49 in the Bear River basin to a high of 2.17 in the Virgin River basin (Figure 9b). Although the majority of the snow accumulation season still lies ahead, above average snowpack is needed to improve drought conditions statewide. For information about Utah's drought status and expected persistence, see page 7 for the U.S. Drought Monitor and page 15 for the U.S. Drought Outlook.

Notes

Figure 9a shows the SWE as a percent of normal (average) for SNOTEL sites in Utah, courtesy NRCS. According to the UT NRCS, "The Surface Water Supply Index (SWSI - Figure 9b) is a predictive indicator of total surface water availability within a watershed for the spring and summer water use seasons. The index is calculated by combining pre-runoff reservoir storage (carryover) with forecasts of spring and summer streamflow, which are based on current Snowpack and other hydrologic variables. SWSI values are scaled from +4.1 (abundant supply) to -4.1 (extremely dry) with a value of zero (0) indicating median water supply as compared to historical analysis. SWSI's are calculated in this fashion to be consistent with other hydroclimatic indicators such as the Palmer Drought Index and the [Standardized] Precipitation Index." See page 9 for the SPI.

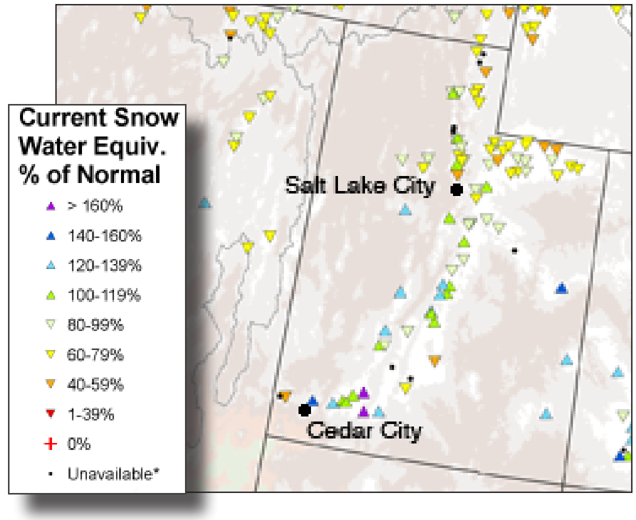


Figure 9a. Current snow water equivalent (SWE) as a percent of normal for SNOTEL sites in Utah as of January 2, 2008 (NRCS).

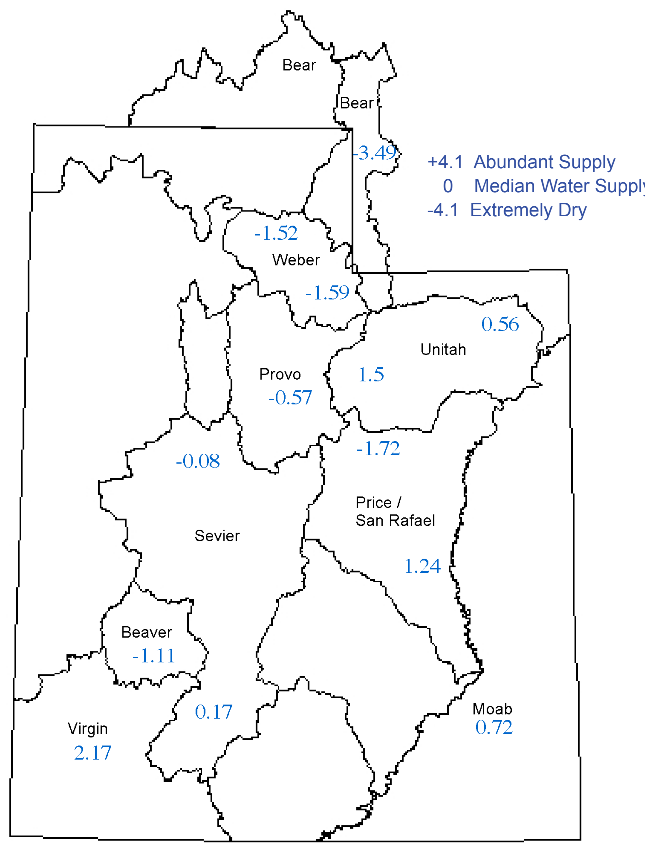


Figure 9b. Utah Surface Water Supply Index as of January 1, 2008 (Utah NRCS).

On the Web

- For current maps of SWE as a percent of normal as shown in Figure 9a, go to http://wcc.nrcs.usda.gov/gis/.
- The Utah SWSI, along with more data about current water supply status for the state, can be found at: http://www.ut.nrcs.usda.gov/snow/watersupply/.
- The Palmer Drought Index is found on NOAA's drought page: www.drought.noaa.gov.
- The Utah January Water Supply Outlook is available by state and basin at: http://www.ut.nrcs.usda.gov/snow/watersupply/wsor.html.

Temperature Outlook February – June 2008

Moderate La Niña conditions are expected to have a greater impact on temperature in February than previous months. The temperature outlook is largely based on trends and composites of climate impacts of La Niña from previous events of similar magnitude.

The forecasts for February 2008 and subsequent seasons indicate an enhanced probability of above average over most of the U.S. including most of the Intermountain West (Figures 10a-c). For the northern tier of the U.S., including northern **Wyoming**, the forecast calls for equal chances (EC) of above-, near, and below average temperatures. In the southwestern U.S. including parts of southwestern **Colorado** and southeastern **Utah**, the odds of the upcoming seasons being in the warmest tercile (see notes below) rises to 50%, which indicates a greatly reduced chance (17% instead of 33%) of temperatures being in the coldest tercile.

An updated temperature forecast for February 2008 will be released on January 31st on the CPC web page. Because of the shorter lead-time, the "zero-lead" forecast (i.e. on the last day of the previous month) often has increased skill over the half-month lead forecasts. The next issue date for the seasonal Outlooks is February 21st.

Notes

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

The CPC outlooks are 3-category forecasts based on climate models in which the skill largely comes from the status of ENSO and recent trends. The categories are defined based on the 1971-2000 climate record; each 1- or 3-month period is divided into 3 categories (terciles), indicating the probabilities that the temperature in the period will fall into the upper third of the years (upper tercile, the middle third of the years (middle tercile, or around average), or the lowest third of the years (lower tercile). The forecast indicates the likelihood of the temperature being in the *above-average* (A, orange shading) or *below-average* (B) tercile--with a corresponding decrease in the opposite category. The near-average category is preserved at 33.3% likelihood, unless the anomaly forecast probability is very high. Equal Chances (EC) indicates areas for which the models do not have sufficient skill to predict the temperature with any confidence, representing equal chances or a 33.3% probability for each tercile. For a detailed description, see notes on the precipitation outlook page.

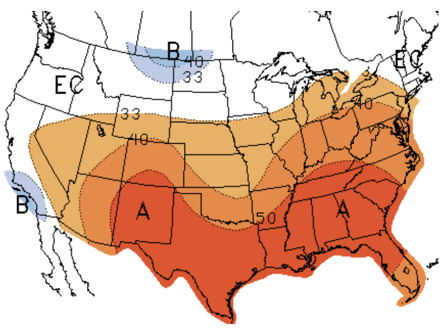


Figure 10a. Long-lead national temperature forecast for February 2008 (released January 17, 2008).

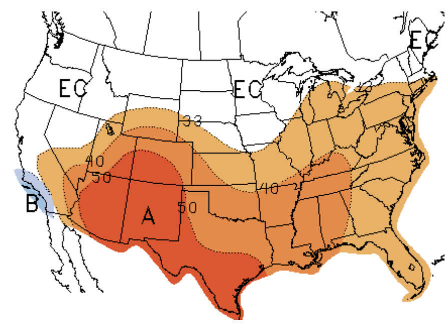


Figure 10b. Long-lead national temperature forecast for Feb. – Apr. 2008 (released January 17, 2008).

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

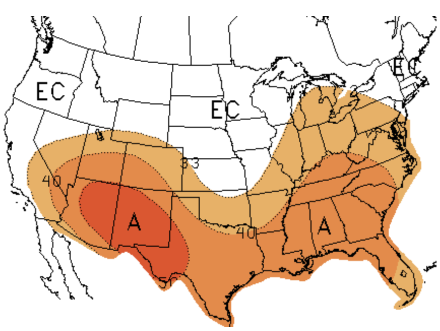


Figure 10c. Long-lead national temperature forecast for Mar. – May 2008 (released January 17, 2008).

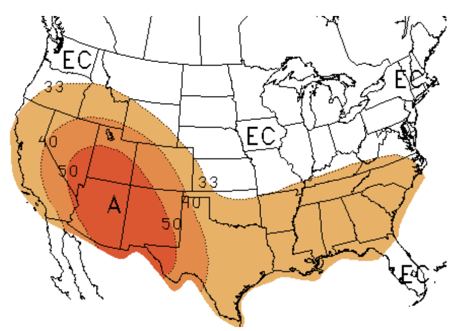


Figure 10d. Long-lead national temperature forecast for Apr. – Jun. 2008 (released January 17, 2008).

On the Web

- For more information and the most recent forecast images, visit: http://www.cpc.ncep.noaa.gov/products/predictions/90day/. 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 February – June 2008

The precipitation outlooks issued by NOAA/CPC are derived almost entirely from composites of moderate La Niñas, i.e., the observed records of past events, with probabilities adjusted to reflect the expected moderate La Niña conditions. While there are significant temperature trends in the Intermountain West region, precipitation trends are not significant.

Based on these La Niña composites, the NOAA/CPC precipitation forecast for February (Fig. 11a) calls for below average conditions across the southern U.S. including southern **Utah** and **Colorado** and above average conditions in the Pacific Northwest including most of **Wyoming**. La Niña conditions are expected to have a greater impact on precipitation in February than previous months.

Similarly, the outlook for February-April 2008, shows **Wyoming** to have a slightly increased chance of above average conditions (Figure 11b), while southern **Colorado** and **Utah** remain in the region with a slightly increased risk for below average conditions through the March-May season (Figure 11b-c). Between these areas of opposite signals, for other areas of the Intermountain West, the outlooks indicate "EC" or "equal chances" of above-average, near-normal or below-average precipitation (Figures 11a-c). In the April-June season, the interior West is forecasted to have an increased risk of below average conditions centered over **Utah** (Fig 11d)

An updated precipitation forecast for February 2008 will be released on January 31st on the CPC web page. Because of the shorter lead-time, the "zero-lead" forecast (i.e. on the last day of the previous month) often has increased skill over the half-month lead forecasts. The next issue date for the seasonal Outlooks is February 21st.

Notes

The seasonal precipitation outlooks predict the likelihood (chance) of precipitation occurring in the above-average, near-average, and below-average categories. The numbers on the maps do not refer to actual precipitation values, but to the probability in percent that precipitation will be in one of these three categories.

The CPC outlooks are 3-category forecasts based on climate models in which the skill largely comes from the status of ENSO and recent trends. The categories are defined based on the 1971-2000 climate record; each 1- or 3-month period is divided into 3 categories (terciles), indicating the probabilities that the precipitation in the period will fall into the upper third of the years (upper tercile, the middle third of the years (middle tercile, or around average), or the lowest third of the years (lower tercile). 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 occurring in the below-average (B, brown shading) or above-average (A, green shading) --with a corresponding decrease in the opposite category, The near-average category is preserved at 33.3% likelihood, unless the anomaly forecast probability is very high.

Thus, areas with dark brown shading indicate a 40.0-50.0% chance of below-average, a 33.3% chance of near-average, and a 16.7-26.6% chance of above-average precipitation. Light brown shading displays a 33.3-39.9% chance of below-average, a 33.3% chance of near-average, and a 26.7-33.3% chance of above-average precipitation and so on. Green shading indicate areas with a greater chance of above average precipitation. Equal Chances (EC) indicates areas for which the models cannot predict the precipitation with any confidence, representing equal chances or a 33.3% probability for each tercile, indicating areas where the reliability (i.e., 'skill') of the forecast is poor. "N" indicates an increased chance of near-average conditions, but is not forecasted very often.

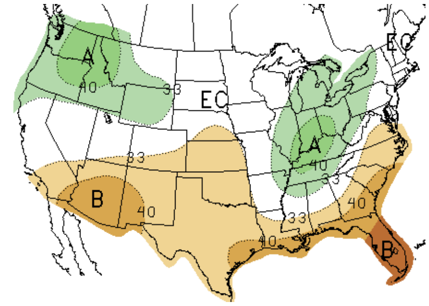


Figure 11a. Long-lead national precipitation forecast for February 2008 (released January 17, 2008).

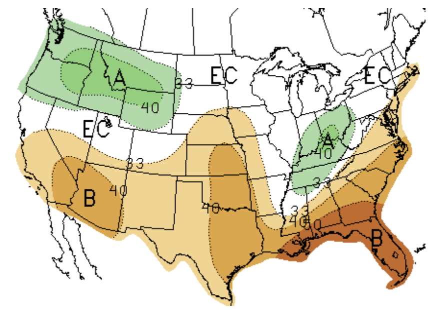


Figure 11b. Long-lead national precipitation forecast for Feb. – Apr. 2008 (released January 17, 2008).

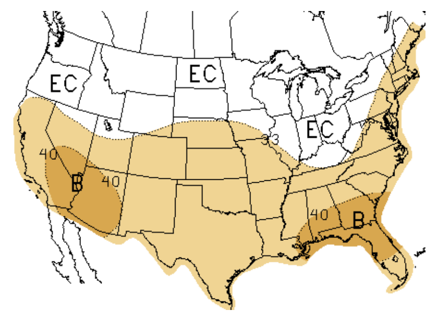


Figure 11c. Long-lead national precipitation forecast for Mar. – May 2008 (released January 17, 2008).

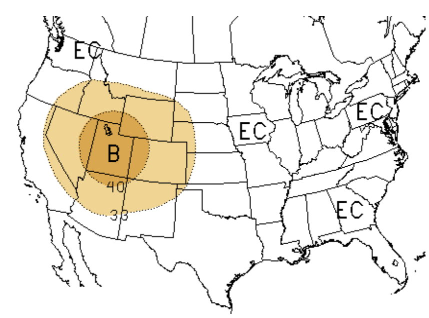


Figure 11d. Long-lead national precipitation forecast for Apr. – Jun. 2008 (released January 17, 2008).

EC = Equal Chances

A = Above
- 40.0–49.9%
- 33.3–39.9%

B = Below
- 50.0–59.9%
- 40.0–49.9%
- 33.3–39.9%

On the Web

- For more information and the most recent CPC forecast images, visit: http://www.cpc.ncep.noaa.gov/products/predictions/90day/. 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 precipitation 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 PSD experimental guidance product, including a discussion and executive summary, will be updated by January 19th, and is available on the web at: http://www.cdc.noaa.gov/people/klaus.wolter/SWcasts/index.html

Seasonal Drought Outlook through April 2008

With the forecasted persistence of La Niña conditions into 2008, the current Drought Outlook (DO) is based on precipitation anomalies that typically occur during La Niña episodes. To develop the DO each month, CPC experts start with the designations from the U.S. Drought Monitor (USDM, see p 7), and considers the latest short and medium range weather forecasts, climate outlooks from the Climate Prediction Center (see pages 13 and 14), climatological considerations, and initial drought conditions. This product projects changes in status of the USDM, which currently designates most of the western U.S. as in various categories of drought.

The DO released January 21st depicts general, large-scale trends through the end of April 2008 (3.5 months, Figure 12). Consistent with La Niña signal for above average precipitation in the Pacific Northwest and northern tier, the DO projects significant decrease in drought status across the drought areas in the interior Northwest and Great Basin, including western Wyoming and much of Utah. A Pacific storm in early January substantially boosted snow pack in California and other parts of the West, but below-average precipitation is expected during February – April for the Southwest, so the odds favor no change or limited decrease in drought status at best for this region.

The next DO will be issued in two weeks, on January 31st.

Notes

The Seasonal Drought Outlook (DO) depicts general, large-scale trends from that date through the end of the forecast period (3 to 3.5 months, depending on the date of issue). The delineated areas in the (Figure 11) are defined subjectively based on expert assessment of numerous indicators, including outputs of short- and long-term forecasting models. Areas of continuing drought 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.

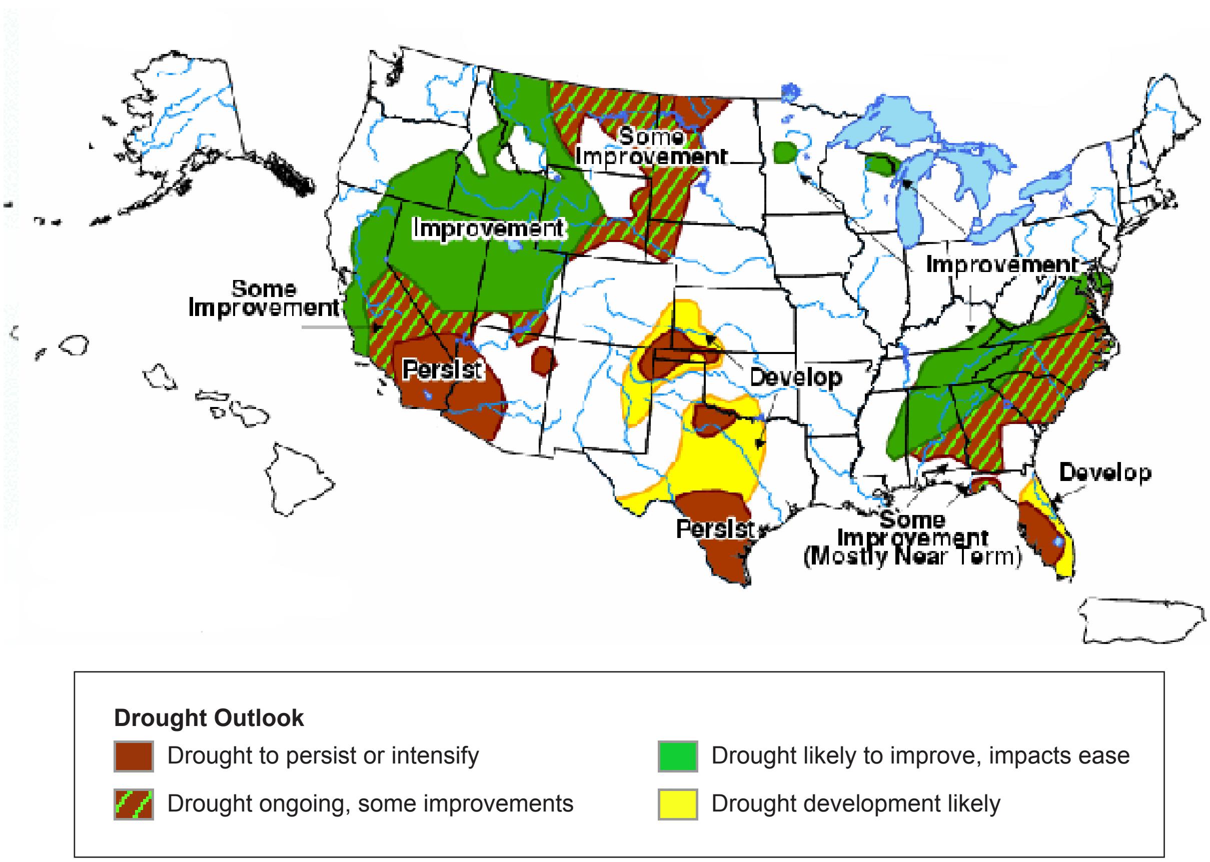


Figure 12. Long-lead national precipitation forecast for April – June 2008 (released January 17, 2008).

On the Web

- For more information, visit: http://www.drought.noaa.gov/.
- Forecasts of drought termination probabilities can be found at: http://www.ncdc.noaa.gov/oa/climate/research/drought/current.html

El Niño Status and Forecast

A moderate La Niña continues in the tropical Pacific, with below-average sea surface temperatures (SSTs) extending from 160ºE to the South American coast. SST indices in the NINO 3.4 region averaged 1.5 ºC below average during December, where a value of 1.0 -1.5 ºC below average indicates the existence of moderate La Niña conditions (Figure 13a). The recent SST forecasts (dynamical and statistical models) for the Niño 3.4 region indicate a continuation of La Niña conditions into Northern Hemisphere spring 2008 (Figure 13b). Over half of the models predict at least moderate La Niña conditions to continue through February-April, followed by weaker La Niña conditions. Current atmospheric and oceanic conditions and recent trends are consistent with a likely continuation of La Niña into the Northern Hemisphere spring 2008. According to the International Research Institute for Climate and Society, a NOAA partner, based on the latest observations and forecasts, there is a 96% probability of maintaining La Niña conditions over the January-March 2008 season, and a 50% probability that it will continue through the May-July season. The probability of an El Niño developing by May-July is less than 10%.

During January-March 2008, the potential impacts La Niña over the continental U.S. include above-average precipitation in the Northern Rockies, the Pacific Northwest, the Ohio and Tennessee Valleys, and parts of the Great Lakes region. Below-average precipitation is expected across the southern tier, particularly in the southeastern states where there is an ongoing severe drought.

The CPC ENSO Diagnostic Discussion will be updated next on February 7th, and the IRI ENSO "Quick Look" on February 21st.

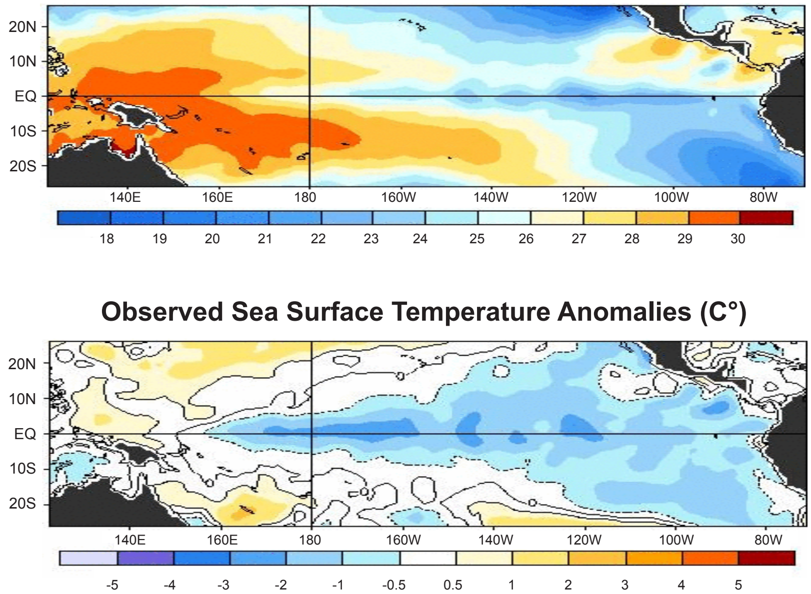


Figure 13a. Observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. The Niño 3.4 region encompasses the area between 120°W-170°W and 5°N-5°S. The graphics represent the 7-day average centered on January 9, 2008.

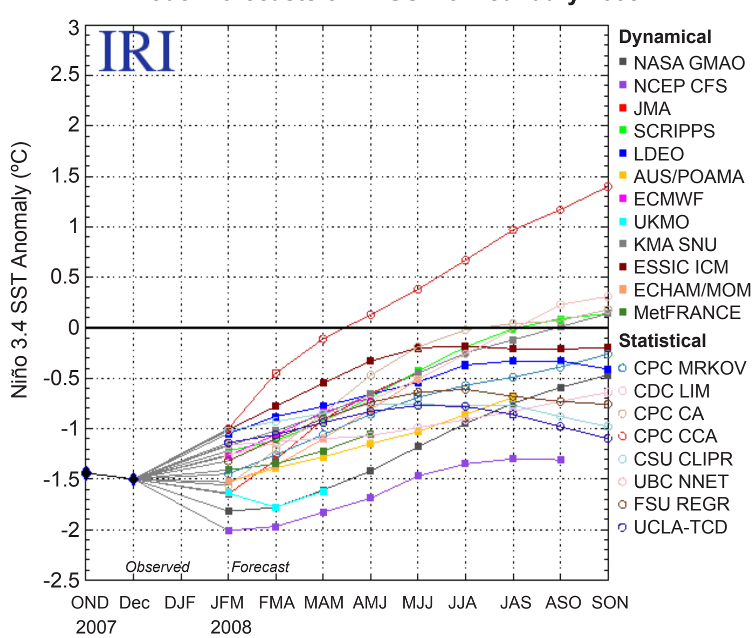


Figure 13b. Forecasts made by dynamical and statistical models for sea surface temperatures (SST) in the Niño 3.4 region for nine overlapping 3-month periods from January through November 2008 (released January 16, 2008). Forecast graphic is from the International Research Institute (IRI) for Climate and Society.

Notes

Two NOAA graphics in Figure 13a show observed SST (upper) and SST anomalies (lower) in the Pacific Ocean, averaged over a recent 5-day period. Data are from satellite observations and the NOAA TAO array of 70 moored buoys spread out over the Pacific Ocean, centered on the equator. The buoys measure temperature, currents, and winds and transmit data in real-time. NOAA uses these observations to predict short-term (a few months to one year) climate variations.

Figure 13b shows forecasts for SST in the Niño 3.4 region for nine overlapping 3-month periods. "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 used as an SST-based index for defining ENSO. Abbreviations represent groups of three months (e.g. SON = Sept-Nov). The expected skills of the models, based on historical performance, vary among the models, and skill generally decreases with lead-time. Forecast skill also varies over the year because of seasonal differences in predictability of the system, e.g., forecasts made between June and December are generally better than those made between February and May. Differences among forecasts 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 Niño conditions, visit: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/.
- For updated graphics of SST and SST anomalies, visit this site and click on "Weekly SST Anomalies": http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml#current.
- For more information about El Niño, including the most recent forecasts, visit: http://portal.iri.columbia.edu/climate/ENSO/.

Spring and Summer Streamflow Forecasts for the 2008 Runoff Season

Due to below average snowpack across most of the Intermountain West Region, streamflow forecasts are mostly for below average conditions, with some southern basins expecting above average (Figure 14). **Colorado** has the highest streamflow forecasts, with most of the state near average. The highest forecast is for the Rio Grande River basin at 130% of average, and the lowest is for the North and South Platte River basins at 85-90% of average. **Utah** has a similar north-south pattern, but there is a much greater difference than Colorado: 51% of average is expected in the Bear River in the north and the 122% of average expected in the San Juan River in the south. **Wyoming** has below average snowpack, with most basins projected to have below average streamflows. The forecasts project average streamflows in the Shoshone and Clarks Fork, Snake, Yellowstone and Madison River basins, but the rest of the state is expected to get between 59% and 89% of average streamflows.

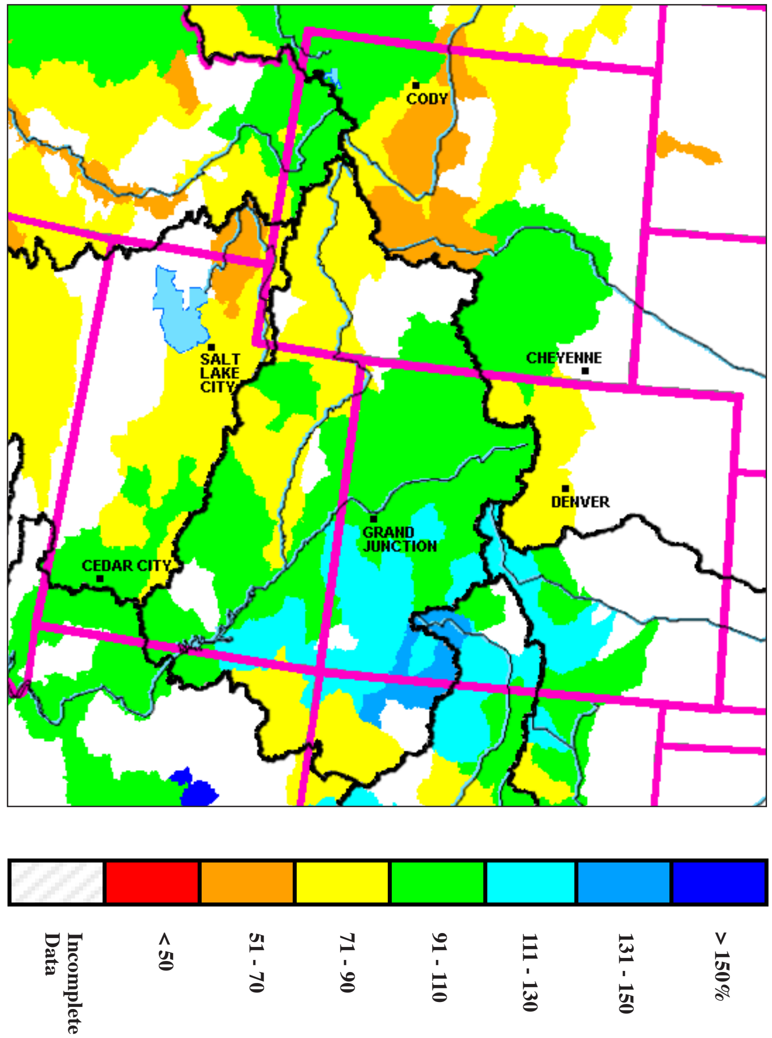


Figure 14. NRCS outlook for natural streamflows for spring and summer in the Intermountain West region as a percent of average streamflows (data through January 1, 2008).

Notes

Forecasts of natural runoff are based principally on measurements of precipitation, snow water equivalent, and antecedent runoff, influenced by precipitation in the fall before winter snowfall (Figure 14). Forecasts become more accurate as more of the data affecting runoff are measured (i.e. accuracy increases from January to May). In addition, these forecasts assume that climatic factors during the remainder of the snow accumulation and melt season will have an average affect on runoff. Early season forecasts are, therefore, subject to a greater change than those made on later dates.

The graphic shown here is from the NRCS, but the forecast is a collaborative effort between the NRCS and the NOAA River Basin Forecast Centers. You can see the official NOAA streamflow forecasts on the individual river basin forecast centers' websites. (See On the Web box below for links to the official NOAA forecasts.)

On the Web

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

The official NOAA streamflow forecasts are available through the following websites of individual River Forecast Centers:

- Colorado Basin (includes Great Basin): http://www.cbrfc.noaa.gov/
- Missouri Basin (includes South Platte and North Plate: http://www.crh.noaa.gov/mbrfc/
- West Gulf (includes Rio Grande): http://www.srh.noaa.gov/wgrfc/
- Arkansas Basin: http://www.srh.noaa.gov/abrfc/
- The NOAA CBRFC has a new interactive website that shows streamflow forecasts as inputs to reservoirs: http://www.cbrfc.noaa.gov/westernwater/

National Integrated Drought Information System Drought Portal

By Christina Alvord, Western Water Assessment

Introduction

A new clearinghouse for drought information is now available. The U.S. Drought Portal, (http://www.drought.gov) released on November 1, 2007, features drought information, resources, and products useful in monitoring emerging and ongoing droughts, assessing impacts, and providing mitigation and preparedness strategies. The Drought Portal is a part of the National Integrated Drought Information System (NIDIS), a cross-agency effort to minimize vulnerability by collaborating drought management, planning, and preparedness on a national, state, and regional scale. It features updated drought information including hydrological, agricultural, and metrological conditions useful to a wide spectrum of user groups.

The Drought Portal was based on the need to assimilate, archive, and quality- control data and drought information, and to address drought questions, information gaps, and user needs in a consolidated location. The Drought Portal is intended as a localized tool to foster communication and partnership between NIDIS personnel, experts, and users to develop early detection and preparedness strategies. A goal of the Drought Portal is to provide a customized approach to drought information by providing a "My Page" feature, allowing users (decision makers, producers, general public, etc) to select and save products, content, data, and/or indices specific to their knowledge level and information needs.

Content selection and organization is based on providing users with tools and resources necessary in early drought detection and is available on the county, regional, and national scale. Three main boxes on the homepage feature the latest U.S. Drought Monitor, the Drought Impact Reporter, and the U.S. Seasonal Outlook, which provides information on current conditions, impacts, and expected persistence (Figure 15a). The Drought Portal features data and information from federal and non-federal sources, as well as an overview of NIDIS, drought education, planning, and research. A searchable database allows users to find specific products or resources, and a scroll of recent national drought news features drought information from a regional perspective.

From the homepage, users click on topic headings or the main boxes for related products and resources categorized by methodologies, sector, topic, and regional resources. Information is categorized in several ways to appeal to multiple user groups,

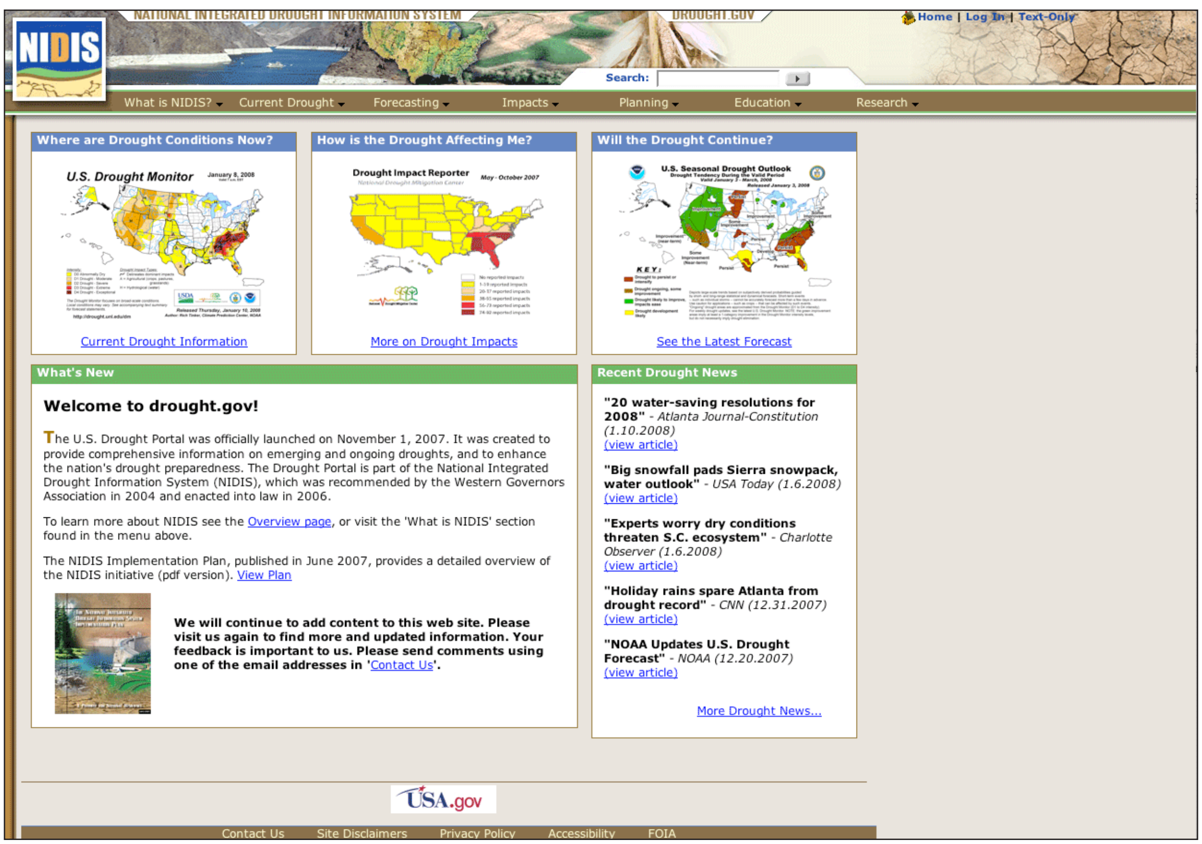


Figure 15a. The NIDIS Drought Portal homepage features drought information organized by topic, an introduction to NIDIS, and articles of regional interest.

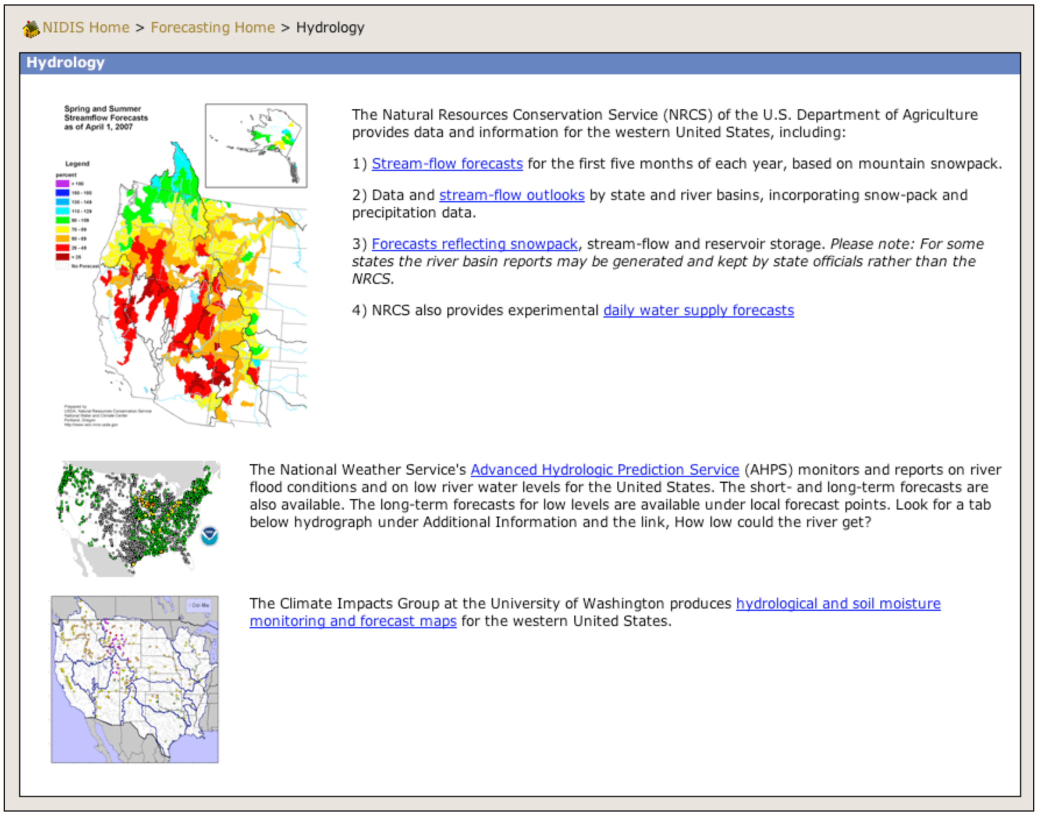


Figure 15b. Snapshot of "hydrology" webpage located under the "Forecasting" tab on the homepage. Each subtopic heading features one or more products and links, allowing users to view and compare data and products from a variety of agencies.

and level of drought knowledge For example, under the "Current Drought" homepage tab, sub topic headings include drought indicators, hydrological monitoring, remote sensing, wildfire, paleoclimatic data, water quality, and local, state, and regional resources. Each topic and the majority of sub topic headings feature one or more national drought products such as the Palmer Drought Severity Index (Current Drought section) or the NRCS streamflow forecasts (Forecasting section) (Figure 15b).

Future Development

In coming months, members of the Drought Portal working group will continue to add content including GIS applications and database development, and expand customization options for individual users. The Drought Portal working group encourages user feedback regarding the utility, content and format. You can submit feedback by clicking on "Contact Us" link located at the top right corner of the homepage for email information.

NIDIS

The development of the Drought Portal fulfills a milestone goal for NIDIS and is a key step in centralizing early warning detection, response, and prevention efforts. NIDIS was created to improve the nation's capacity to manage drought risk, provide tools and information needed to assess potential impacts, and to better respond to and mitigate the effects of drought. NIDIS is comprised of an Executive Council, Program Office, and Implementation Team that oversees five technical working groups: Public Awareness and Education, Engaging Preparedness Communities, Integrated Monitoring and Forecasting, Interdisciplinary Research and Applications, and the Drought Portal. The five technical working groups consist of representatives from a variety of federal, state, and tribal agencies selected to provide diversity in geography, expertise, and/or affiliation. WWA affiliate, Roger Pulwarty, is acting Director of the NIDIS Program Office. For more information about NIDIS, including organization, current research, and future goals, go to the Drought Portal homepage and click under "What is NIDIS?" or download the NIDIS Implementation Plan pdf (see On the Web box).

On the Web

- USDP available at URL: http://www.drought.gov.
- NIDIS Implementation Plan pdf available at URL: http://www.drought.gov/pdf/NIDIS-IPFinal-June07.pdf.

Research Notes

Compiled and written by Koren Nydick, Mountain Studies Institute (www.mountainstudies.org)

The Research Notes is a new page with summaries of recent journal articles relevant to climate and water resources in the west. We will feature this page approximately four times a year in the IMW Climate Summary. If you have any articles that you would like to see in a future Research Notes page, please email us at wwasummary@wwa.colorado.edu.

Raupach, M.R., et al. 2007. Global and regional drivers of accelerating CO_2 emissions. *Proceedings of the National Academy of Sciences* 104: 10288 – 10293. & Canadell, J.G et al. 2007. Contributions to accelerating atmospheric CO_2 growth from economic activity, carbon intensity, and efficiency of natural sinks. Proceedings of that National Academy of Sciences 104: 18866-18870. Growth in atmospheric CO_2 is accelerating and could lead to stronger-than-expected-and sooner-than-expected climate changes. Three reasons are given for this acceleration: 1) increased economic activity, 2) increasing carbon intensity of the global economy, and 3) reduced efficiency of land and water in taking up carbon emissions. Global CO_2 emissions from fossil-fuel burning and industry grew by >3% per year in 2000-2004 compared to 1.1 % per year in the 1990s. In the 1990's the amount of CO_2 emissions produced per unit of economic activity began to decrease (due to increased energy efficiency), but since 2000 this trend has flattened or reversed. Growth rate in CO_2 emissions is strongest in developing countries like China, but developed countries currently still emit the majority of emissions.

Meko, D.M. et al. 2007. Medieval drought in the upper Colorado River basin, *Geophysical Research Letters*, 34, L10705, doi: 10.1029/2007GL029988. New tree-ring records extend the historical reconstruction of Colorado River streamflow at Lee's Ferry back to A.D. 762. The long-term record illustrates patterns of multidecadal variability in stream flow, including large swings from very wet to very dry conditions. A major period of low flow is shown in the mid-1100s that exceeds even the late-1500s North American megadrought. The 1100s Medieval drought includes periods of very low flow embedded in a generally dry 62 year period that lacked any high flows. Several other tree-ring reconstructions from the western United States suggest that this drought occurred over a large region but varied in intensity in different locations.

Seager, R. et al. 2007. Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America. *Science*, 316: 1181-1184. Eighteen of 19 climate models show a drying trend in the 21st century for SW North America. A decrease in precipitation of 0.1 mm/day occurs in many of the projections by mid-century, but some models show that it could happen sooner. For comparison, precipitation during the Dust Bowl and 1950s SW droughts was 0.09 and 0.13 mm/day lower than average, respectively. The projected drying appears to be caused by changes in atmospheric circulation cells rather than shifts in tropical sea surface temperatures, which were responsible for major 20th century droughts. Instead, events such as La Niña will be superimposed upon drier average conditions, possibly causing droughts worse than any since the Medieval period.

McCabe G. J., D. M. Wolock. 2007. Warming may create substantial water supply shortages in the Colorado River basin, *Geophysical Research Letters*, 34, L22708, doi:10.1029/2007GL031764. Potential effects of two levels of warming (+0.86˚C, +2˚C) on streamflow in the Colorado River basin were evaluated with a water balance model. The warming scenarios were applied to 20th century climate data and to the driest century from a tree-ring reconstruction of streamflow for 1490-1998. Warming by +2˚C applied to the 20th century climate or +0.86 or +2˚C applied to the driest century resulted in lower streamflow and water shortages more severe than those inferred from the tree-ring reconstructions. A flow/surplus water-supply model indicated that expanding storage capacity would not alleviate shortages in most cases.

Painter, T. H. et al. 2007. Impact of disturbed desert soils on duration of mountain snow cover, *Geophysical Research Letters*, 34. L12502, doi:10.1029/2007GL030284. Field measurements and snowmelt modeling show that deposition of desert dust reduced the duration of snow cover in a San Juan Mountain (SW Colorado) watershed by 18-35 days. The dust increased energy absorption, resulting in faster melting. Three to 4 dust events per year were observed from 2003-05. Eight events occurred in 2006, which was a year of intense drought in the CO Plateau. More frequent and heavy dust events, less post-event snowfall, and clearer skies resulted in more energy absorption and faster melting in 2006 than 2005. Other measurements suggest that the dust originates SW of the study site in AZ and NM. More intense and frequent droughts in the desert SW may increase dust emissions, which could further reduce snow cover duration.