Intermountain West Climate Summary

by The Western Water Assessment

Issued September 25, 2007
Vol. 3, Issue 7

September 2007 Climate Summary

Hydrological Conditions — Drought is expected to persist over southern Utah, but drought conditions may improve over Wyoming and northern Utah due to the expected development and persistence of La Niña.

Temperature — Temperatures were 0 – 4°F above average around most of the region in August, consistent with the seasonal climate forecasts for this period issued earlier in the year.

Precipitation — Precipitation was below average in August in part of northern Utah and Wyoming and above average in other areas in each state. The largest areas of above average precipitation were in Wyoming, where there have been drought conditions since 1999.

ENSO — La Niña is developing, and there is a 65% chance that sea surface temperatures in the central Pacific will be below the La Niña threshold through the January-March 2008 season.

Climate Forecasts — Expected La Niña impacts during October-December 2007 season are above average precipitation in the Pacific Northwest (including western Wyoming) and below average precipitation in the Southwest, including parts of Colorado. There is an increased chance of above average temperatures over all of the Intermountain West.

The next summary, released in mid-November, will review the 2007 water year.

In This Issue

Recent Conditions

Forecasts

Upcoming Conferences

Wyoming Water Association Annual Meeting and Education Seminar:
October 31 – November 2, 2007, in Cheyenne, Wyoming. For more information about the conference, contact Executive Secretary John Shields at 307-631-0898 or wwa@wyoming.com.

Utah Water Users Association Annual Water Summit Conference:
December 4, 2007 at the Davis Convention Center in Layton, Utah. For more information, email Carly Burton at utahwatersuers@aol.com.

WWA is advertising a Post-doctoral Research Associate position.
Go to http://cires.colorado.edu/jobs/ for more information.

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

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The Intermountain West Climate Summary is published monthly by Western Water Assessment (WWA), a joint project of the University of Colorado Cooperative Institute for Research in Environmental Sciences (CIRES) and the National Oceanic and Atmospheric Administration (NOAA) Earth System Research Laboratory, researching water, climate and societal interactions.

Drought, Wildfire, and Climate Connections: Research in Forests of the Western U.S.

By Jessica Lowrey, Western Water Assessment

Introduction

The occurrence and severity of wildfires is influenced by climate and forest species composition. While these relationships have been well-studied in lower elevation ponderosa pine forests, research on higher elevation subalpine forests is more limited (Figure 1a). This article highlights the research of Tania Schoennagel, a researcher at the University of Colorado, who has studied the relationship between climate patterns and fire occurrence in high-elevation subalpine forests of the Rocky Mountains (see pink box). First, there is a description of the difference between low-elevation ponderosa pine forests and higher-elevation subalpine forests regarding wildfire frequency and severity and the influence of climate. Next, there is a discussion of the effects of past fire suppression in the different types of forests. Finally, the article summarizes two recent articles by Schoennagel that analyzed the relationship between global climate patterns and wildfire occurrence in subalpine forests of the Rocky Mountains.

Tania Schoennagel is a Research Fellow in the Geography Department at the University of Colorado. She got her Ph.D. in Ecology from the University of Wisconsin-Madison in 2002. Her research addresses the causes and consequences of western forest disturbances, primarily wildfire. As a landscape ecologist, she conducts research at multiple spatial and temporal scales to examine: (1) disturbance dynamics and successional patterns, (2) effects of past climate variability and future climate change, and (3) ecological implications of forest management policy and changing land use. She employs field studies, dendrochronology, GIS analyses and spatial modeling. Her research generally focuses on fundamental ecological questions with applications to forest management, land-use policy and climate change.

Wildfire Frequency and Severity in Subalpine and Ponderosa Pine Forests

Wildfire frequency and severity is influenced by climate and stand density, and is different in two types of forests at different elevations in the Rocky Mountains. High-elevation subalpine forests typically experience infrequent high-severity wildfires, while low-elevation ponderosa pine forests historically experienced more frequent low-severity fires. Fire frequency in these forest types is different by orders of magnitude. In high-elevation subalpine forests, the historical reoccurrence interval for fire is on the order of centuries whereas it is on the order of decades in most low-elevation ponderosa pine forests (Schoennagel, et al., 2004). The reason for this difference is related to climate and forest fuel abundance. Rocky Mountain ponderosa pine forests occur at lower elevations (5500 – 8500 feet in the Colorado Front Range), where the summers are warm and dry (Figure 1b). Ignitions of the dry vegetation can occur fairly easily and often. In comparison, higher elevation subalpine forests (9000-11000 feet in the Colorado Front Range) have cooler summers and more moist vegetation. Fires in subalpine forests occur less frequently at this elevation because it takes a sustained dry period for the vegetation to ignite. Drought frequency is a significant limiting factor affecting fire frequency in the subalpine zone, but not in the ponderosa pine zone (Schoennagel, et al., 2004). Subalpine forests have naturally cooler and moister conditions, and precipitation deficits that dry out the vegetation occur infrequently. In contrast, in the ponderosa pine zone, fuels are often sufficiently dry for ignitions throughout late summer and hence fires occur more frequently.

Figure 1a. Subalpine fire in Grand Teton National Park (Photo by Tania Schoenagel, Schoennagel, et al., 2005).

Climate is interrelated with stand density, and together they influence fire severity in these two types of forests. Stand

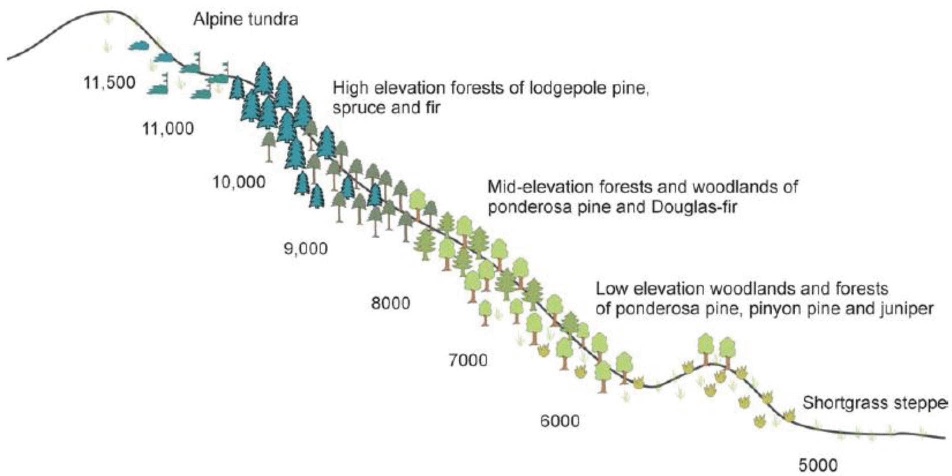


Figure 1b. Colorado forests' species composition change rapidly with changes in elevation, (Graphic created by Laurie Huckaby, Romme, et al., 2006).

density refers to how close the trees grow to one another. Because the high-elevation subalpine zone tends to be moister than the low-elevation ponderosa pine zone, trees can grow closer together (more dense). Higher tree densities in subalpine forests contribute to high fire severity because the trees become ladders for the fire to climb into the canopy and travel as a high-severity crown fire, killing many of the overstory trees. On the other hand, in dry, low-elevation ponderosa pine forests, frequent fires kill mostly the smaller trees and keep the landscape more open (less dense). Here, fires are typically low-severity; they spread along the forest floor consuming much of the ground vegetation (grasses and herbaceous plants), but leaving many of the overstory trees.

Forest Management Practices in Subalpine and Ponderosa Pine Forests

There are differences in the effects of past fire suppression and current restoration practices in the two forest types. The pattern of more frequent frequent low-severity fires low-elevation in ponderosa pine forests may have changed in some of these forests due to fire suppression in the last century[1]. The purpose of fire suppression is to extinguish all forest fires, even those caused naturally by lightening. Fire suppression during the 20th century has led to more dense forest stands that are now at greater risk for high-severity fires by preventing the natural cycle of low-severity fires in ponderosa pine forests that kill small vegetation and keep forests less dense. Supporting evidence shows that there has been an increase in tree densities and a subsequent increase in high-severity fires in some ponderosa pine forests due to fire suppression since the early to mid-1900s (Schoennagel et al. 2004). A fuels reduction program including selective logging and/or prescribed burning has been intended to restore the open forest landscape and decrease the amount of ladder fuels, which help low-severity fires spread to the canopy and become high-severity fires.

However, research is showing that high-elevation subalpine forests have not experienced the same amount of or effects from fire suppression (Schoennagel et al. 2004). Because of the differences in climate, stand density, and historical fire frequency and severity, a fuels reduction program will not restore subalpine forest to natural conditions like it will for most ponderosa pine forests. Specifically, subalpine forests are denser due to a cooler, moister climate and the characteristics of the trees that grow there, and this leads to high-severity wildfires. Furthermore, high-severity fires are hard to suppress, especially in remote high-elevation forests. Therefore, fire suppression has had little effect on fire frequency or stand density in subalpine forests, so a fuels reduction program is not necessary to restore a natural habitat (Schoennagel, et al., 2004). The fundamental differences in forest type and the effectiveness of various forest management approaches, including fuels reduction, may require different protection methods for subalpine versus ponderosa pine forests with multiple uses.

Drought, Climate Patterns, and Fire Occurrence in Subalpine Forests

Schoennagel's recent research finds that the atmospheric mechanisms affecting patterns of drought-induced fires can be hemispheric in scale. Schoennagel looked at the connections

[1]While most ponderosa pine forests experience frequent low-severity wildfires, not all ponderosa forests fit this model. Many higher-elevation or higher-latitude ponderosa pine forests may have historically experienced less-frequent high-severity or mixed-severity fires (Sherriff and Veblen 2006; Kaufmann et al. 2006). Some moister ponderosa pine forests may be characteristically dense and have not experienced an increase in fire severity due to fire suppression.

between fire and broad-scale climate patterns, including El Niño Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and Atlantic Multi-decadal oscillation (AMO) in the Rocky Mountains. She found correlations between fire occurrence and climate patterns at both short and long time scales (Schoennagel, et al., 2005 and Schoennagel, et al., 2007).

Three primary broad-scale climatic patterns, the ENSO, PDO, and AMO, describe variation in sea surface temperatures in the Pacific and Atlantic Oceans, which influence the climate of the western U.S.. ENSO reflects deviations from average sea surface temperatures (SSTs) in the equatorial Pacific Ocean, oscillating between warmer than average SSTs (El Niño) and cooler than average SSTs (La Niña) at 2-6 yr cycles. The PDO index represents variability in average SSTs in the North Pacific Ocean, varying between cool and warm phases at 20-30-yr cycles. The AMO index reflects average annual SSTs in the North Atlantic Ocean, which cycle between warm and cool phases at 50-80 yr frequencies (discussion adopted from Schoennagel, et al., 2007).

Schoennagel's studies analyzed how often fires occurred during particular phases of each climate pattern compared to the expected fire frequency. Schoennagel and her colleagues compared the portion of total years in the study period occurring in each climate phase to the portion of fire years occurring during each phase. She used a chi-squared statistical test to determine if the two proportions were significantly different. If the difference was statistically significant ($P \leq 0.05$), then there was a correlation between fire occurrence and that particular climate phase (Schoennagel, et al., 2005 and Schoennagel, et al., 2007).

The first study analyzed how different phases of ENSO and PDO affect drought-induced fire occurrence in subalpine forests across the Rocky Mountains from 1700-1975 (Schoennagel, et al., 2005). The three study sites were: Jasper National Park (representing the northern Rockies), Yellowstone National Park (representing the central Rockies), and Rocky Mountain National Park (representing the southern Rockies). Not surprisingly, she found that fires tended to occur during periods of extreme drought. Drought in turn, was affected by ENSO and PDO phases. She found that during years when the PDO and ENSO were either both in their positive (warmer than average) or negative (cooler than average) phases, there was a higher incidence of fire occurrence. However, these climate patterns affected the regions differently (Figures 1c,d):

- Years of both –PDO and –ENSO phases experienced more fires in southern Rockies (P=0.006, significant).
- Years of both +PDO and +ENSO phases experienced more fires in northern and central Rockies (P=0.556, not significant).
- PDO affects fires in the northern Rockies more than ENSO.
- ENSO affects fires in the southern Rockies more than PDO.
- The correlations between ENSO and PDO are not as strong in the central Rockies as in the northern and southern Rockies.

(Note that the results are only for the areas contained in the National Parks, not the entire Rocky Mountain region.)

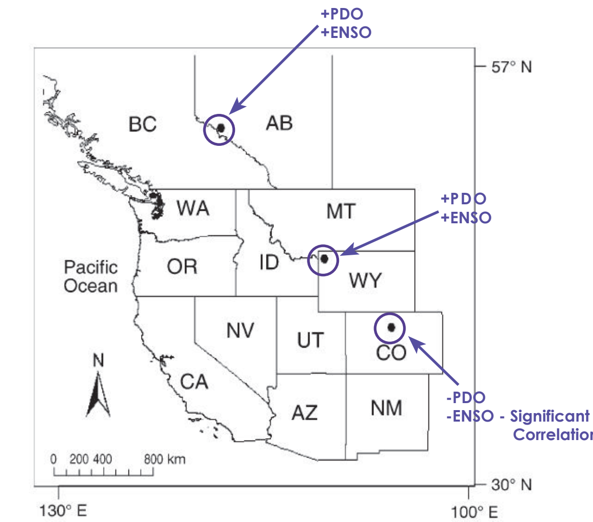


Figure 1c. Location of the three study sites used to examine patterns of climate-fire interactions with phases of the ENSO and PDO from Schoennagel, et al.,2005 (black circles). From north to south: Jasper National Park, Alberta, Canada; Yellowstone National Park, Wyoming; Rocky Mountain National Park, Colorado (Schoennagel, et al., 2005, Figure 1).

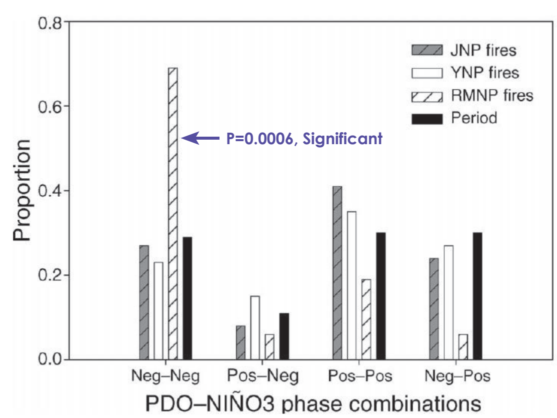


Figure 1d. The proportion of the total number of fires at each study area relative to the total proportion of years during the 1700-1975 study period (black bars) in each PDO-ENSO phase combination. Chi-square tests show that the fires occurred more often than expected in RMNP during negative PDO-La Niña conditions (P=0.006, significant). The frequency of fires in YNP and JNP did not different significantly from expectations, although fires occurred most often during the positive PDO- El Niño conditions (Schoennagel, et. al., 2005, Figure 5).

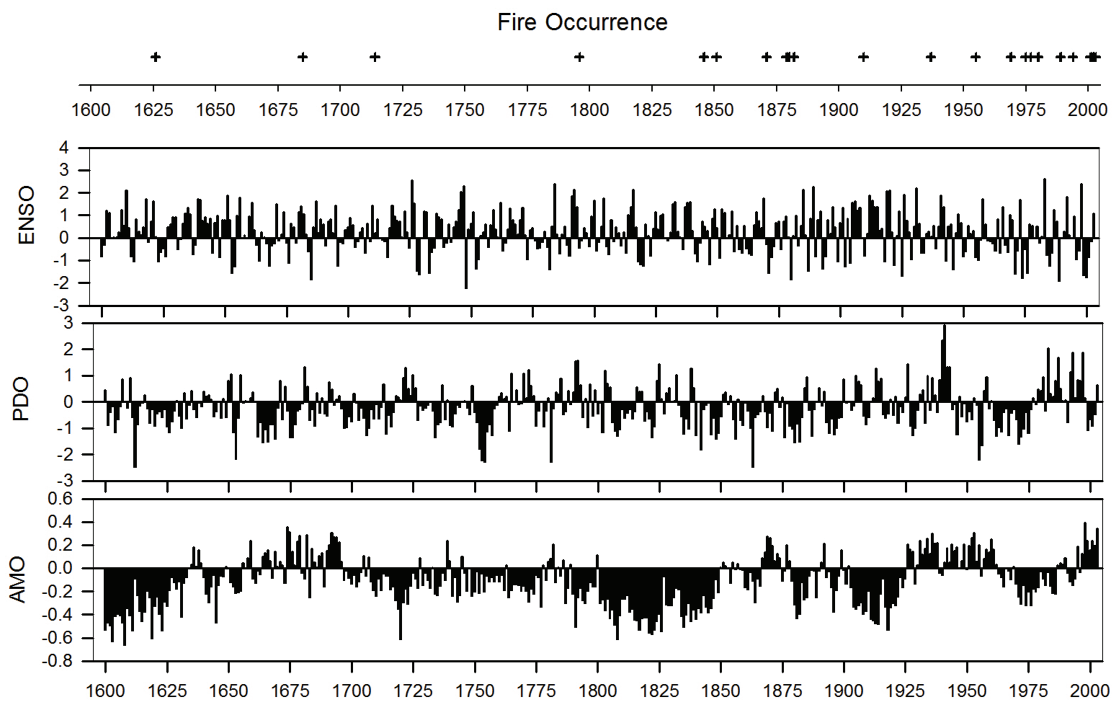


Figure 1e Time series of ENSO, PDO, AMO, and fire occurrences from 1600-2003 in the study area in western Colorado (Schoennagel, et al., 2007, Figure 2).

The second study covered a smaller study area (western Colorado), but it included analysis of the AMO in addition to ENSO and PDO during the period of 1600-2003 (Schoennagel, et al., 2007). Because the AMO is a multi-decadal climate oscillation, it changes signs (phases) at low-frequency (long) time scales of about 50 years, and may have a significant long-term influence on drought and fire regimes in the West. The positive AMO is associated with drought across much of the western US, and prevailed during the 1930s Dust bowl and the 1950s drought (Sutton and Hodson, 2005) (Figure 1e). Schoennagel found that in western Colorado, fires in the subalpine zone occurred most often during years when the +AMO, –ENSO and –PDO phases combined (P=0.041, significant) (Figure 1f). Also, fires generally were synchronous with the +AMO phase over very long time-scales (many decades). Based on this research and that by Kitzberger et al. (2007), the western U.S. could be entering a period of high fire activity due to the recent shift to a warm AMO phase in 1998 that may persist for decades.

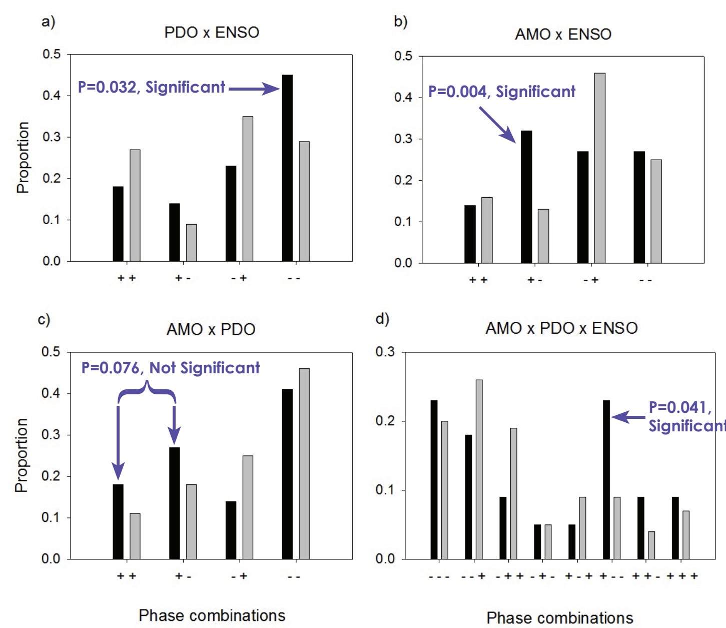


Figure 1f. Relative frequencies of fire and climate occurrences in each of the (a-c) two-way and (d) three-way combined phases of the AMO, PDO, and ENSO during the 1600-2003 study period. Phase combinations refer to different combinations of warm and cool phases on the AMO, PDO, and ENSO in a given year. Black bars represent observed fire occurrence; gray bars represent expected fire occurrence. Significant departure from the expected occurrence was evaluated by chi-square tests, and some results are shown here (Schoennagel, et. al., 2007, Figure 5).

Summary

The research highlighted here shows how high-elevation subalpine forests differ from low-elevation ponderosa pine forest in terms of wildfire frequency and severity, due to fundamental differences in climate and forest fuels. In addition, large-scale climate patterns like ENSO, PDO, and AMO influence the occurrence of drought and severe wildfires in the Rocky Mountains. There is a significant correlation between years experiencing a positive (warm) AMO, a negative (cool) PDO, and a negative (cool) ENSO and wildfire occurrence in the southern Rocky Mountains, especially in Colorado. Other research corroborates these results. For example, recent work on fires and climate by Westerling et al. (2006) also showed that in the last 15 years there was a 5-fold increase in area burned across the western U.S. due to earlier snowmelt, higher temperatures and longer fire season, and these patterns where most pronounced in the northern Rockies and in high-elevation forests. Other related sources are in the references section. Understanding wildfire-climate relationships could be useful in predicting expected wildfire activity in different regions and potential impacts on water resources (see green box).

Wildfire and Water Resources

Romme and colleagues synthesized research on the ways wildfires can affect water resources by impacting streamflows or water quality (2006). Fires can increase streamflows by decreasing the amount of forest canopy that intercepts precipitation and by decreasing the number of live trees that take up water from the soil. However, unless the annual rainfall is above 18-20 inches and at least 15-20% of the forest canopy is dead, no effect on runoff is expected because reduction in interception and transpiration are usually negated by increase in soil evaporation. The exception is when high-severity fire burns so hot that it causes the soil to become hydrophobic and not allow much infiltration. In that case, runoff will increase. A related study has found that by killing ground vegetation, wildfires increase erosion and have a much greater effect on water quality than streamflows. (Romme, et al., 2006)

References

Kitzberger. T., P.M. Brown, E.K. Heyerdahl, T.W. Swetnam, and T.T. Veblen: 2007. "Contingent Pacific-Atlantic Ocean influence on multi-century wildfire synchrony over western North America," *Proceedings of the National Academy of Sciences of the USA*, **104**, 543-548, http://www.pnas.org.

Kaufmann, M.R., T.T. Veblen and W.H. Romme: 2006. "Historical fire regimes in ponderosa pine forests of the Colorado Front Range, and recommendations for ecological restoration and fuels management." *Front Range Fuels Treatment Partnership Roundtable, Findings of the Ecology Workgroup*, http://www.frftp.org/roundtable/pipo.pdf.

Romme, W. H., J. Clement, J. Hicke, D. Kulakowski, L. H. MacDonald, T. Schoennagel, and T. T. Veblen: 2006. "Recent forest insect outbreaks and fire risk in Colorado forests: a brief synthesis of relevant research," Colorado Forest Restoration Institute, Fort Collins, CO, http://www.cfri.colostate.edu/docs/cfri_insect.pdf

Schoennagel, T., T.T. Veblen, D. Kulakowski, A. Holz: 2007. "Multidecadal climate variability and climate interactions affect subalpine fire occurrence, western Colorado (USA)." *Ecology*, In press.

Schoennagel, T., T.T. Veblen, W.H. Romme. 2004. "The interaction of fire, fuels and climate across Rocky Mountain forests," *BioScience*, **54**(7), 661-676.

Schoennagel, T., T.T. Veblen, W.H. Romme, J.S. Sibold, E.R. Cook: 2005. "ENSO and PDO variability affect drought-induced fire occurrence in Rocky Mountain subalpine forests," *Ecological Applications*, **15**, 2000-2014.

Sherriff, R.L. and T.T. Veblen: 2006. "Ecological effects of changes in fire regimes in Pinus ponderosa ecosystems in the Colorado Front Range," *J. Vegetation Science*, **17**(6), 705-i(-704)

Sibold, J.S. and T.T. Veblen: 2006. "Relationships of subalpine forest fires in the Colorado Front Range with interannual and multidecadal scale climatic variation," *J. Biogeography*, **33**, 833-842.

Sutton, R., and D. Hodson: 2005. "Atlantic Ocean Forcing of North American and European Summer Climate," *Science*, **309**, 115-118.

Westerling, A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swet nam: 2006. "Warming and earlier spring increases western U.S. forest wildfire activity," *Science*, **313**, 940-943.

On the Web

- Tania Schoennagel's Website: http://spot.colorado.edu/~schoenna/.
- Colorado Forest Restoration Institute: http://www.cfri.colostate.edu/.

Temperature 8/1/07 - 8/31/07

Monthly average temperature for August 2007 in the Intermountain West region ranged from 55-85°F (Figure 2a). The warmest areas (above 75°F) were across most of **Utah** and eastern **Colorado**. Temperatures across most of the region were 0-4°F above average, but some areas in each state were 4-6°F above average (Figure 2b). The NWS Salt Lake City and the NWS Denver-Boulder reported that **Utah** and **Colorado** both had the second warmest Augusts on record.

According to the NWS Denver-Boulder, a record high of 99°F was set on August 13th in Denver, breaking the previous record of 96°F set in 1970 and tied in 1996, and a high of 97°F on August 21st tied the previous record high set in 1960. The NWS Cheyenne reported that Cheyenne set a record high of 95°F on August 13th, breaking the previous record of 92°F set in 1970. The NWS Salt Lake City reported that on August 13th, a high of 102°F tied the previous record set in 1937. On August 14th, a new high minimum temperature of 76°F broke the previous record of 74°F set in 1992. A minimum temperature is the lowest recorded temperature on any given day, usually this occurs around 2-3 a.m.

Temperatures in August 2006 were lower than temperatures in August 2007 throughout most of the IMW region (Figure 2c). In August 2006, most of the region was 0-2°F below average to 0-2°F above average, whereas it was mostly 0-4°F above average in August 2007.

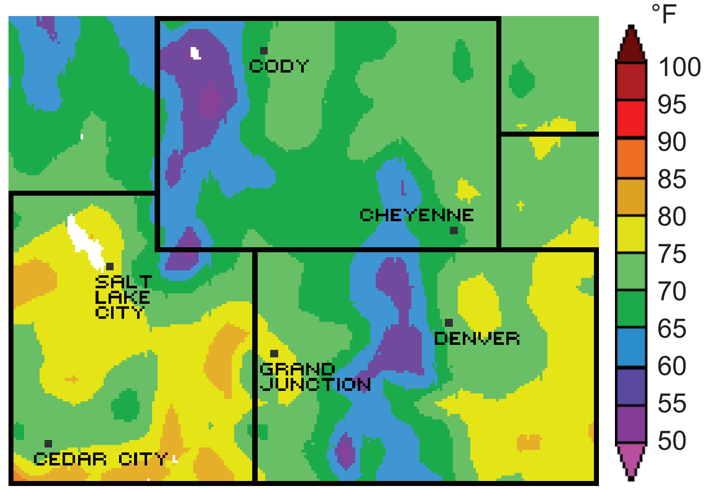


Figure 2a. Average temperature for the month of August 2007 in °F.

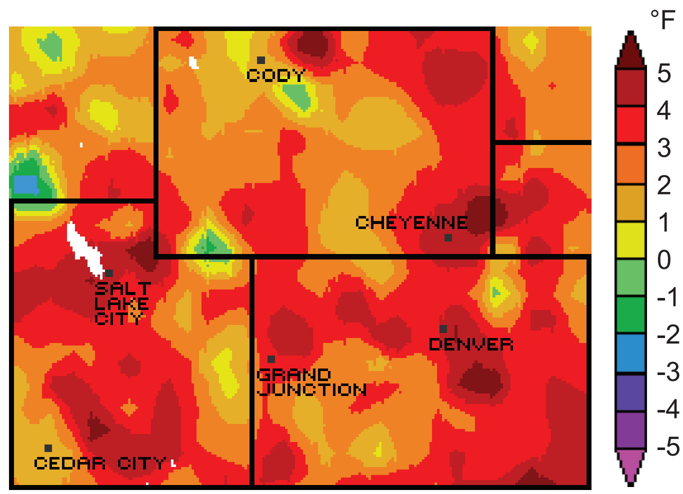


Figure 2b. Departure from average temperature for the month of August 2007 in °F.

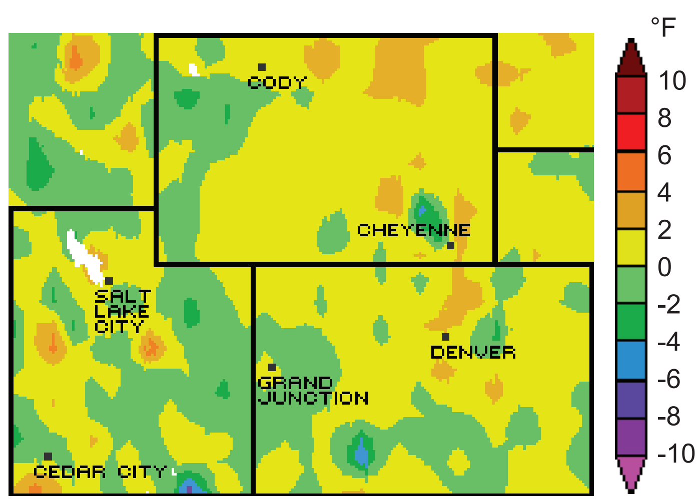


Figure 2c. Departure from average temperature in °F for last year, August 2006.

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.

Precipitation 8/1/07 - 8/31/07

Total precipitation for August 2007 in the Intermountain West region ranged from 0 - 4 inches (Figure 3a). Eastern **Colorado** received the highest totals (2-4 inches). Central **Wyoming** and central **Utah** received the least amount of precipitation (0 - 1 inch). According to NWS Salt Lake City, precipitation at the Salt Lake Airport was 0.10 inch for the month of August, 13% of normal.

Precipitation as a percent of average varied widely for the month of August (Figure 3b). Central and southwestern **Wyoming** and central to southern **Utah** reported above average precipitation (200-400%). Northern **Utah** received the lowest percent of average (5-25%). The NWS Salt Lake City reported that August 2007 was the fifth driest August on record for the city.

Precipitation since the start of the water year is near average to above average for most of north-central **Wyoming**, eastern **Utah**, and most of **Colorado** (Figure 3c). Eastern and central **Utah** and central **Colorado** had the highest precipitation as a percent of average (130-200%). The lowest precipitation was in north central **Wyoming** (25-50%).

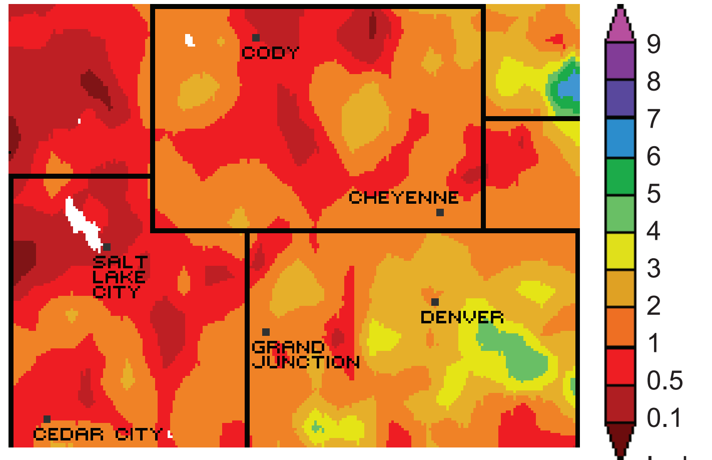


Figure 3a. Total precipitation in inches for the month of August 2007.

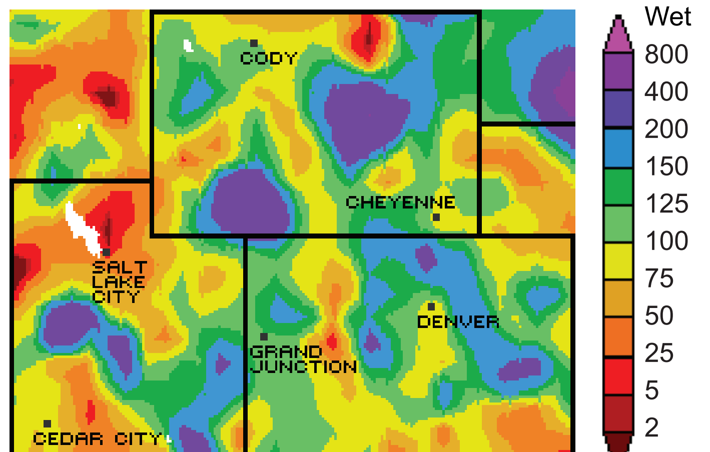


Figure 3b. Percent of average precipitation for the month of August 2007.

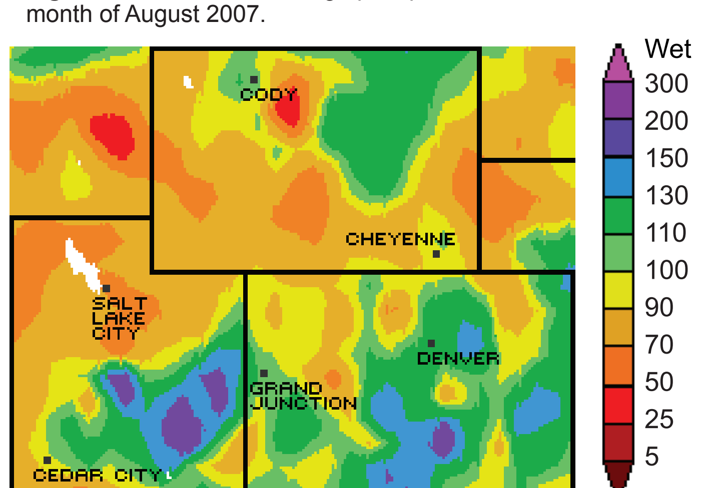


Figure 3c. Percent of average precipitation accumulation since the start of the water year 2007 (Oct. 1, 2006 – Sept. 10, 2007).

Notes

Figures 3a-c are experimental products from the High Plains Regional Climate Center. These data are considered experimental because they utilize the newest 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 9/20/07

The U.S. Drought Monitor (Figure 4) shows little change in **Wyoming**, an increase in drought severity throughout **Utah**, and a small area of southern **Colorado** is no longer classified in drought conditions since the mid-July Drought Monitor (see inset). Most of these changes occurred between mid-July and mid-August, however, so the August 21 Drought Monitor (not shown) looks essentially the same as September 20 (Figure 4).

Authors of the Drought Monitor assert that precipitation is normally at a minimum during September across most of the West, dry weather is usually not a concern, except possibly for wildfires. However, after a below average wet season (November-March) and above average temperatures in March causing an early melt off of the snowpack, drought severity is increasing in parts of the West. Since mid-July, most of **Utah** has had above average temperatures, severe drought, and wildfires, with all of the counties reporting some percentage of loss on crops and/or range land. Water levels in reservoirs and streams were low to nonexistent with conditions worsening. These impacts resulted in severe drought (D2) being expanded across most of the state. In western **Wyoming**, in early September, the Bureau of Reclamation reported that major reservoir storage and streamflows are very low, especially in the western part of the state. Accordingly, extreme drought status (D3) was expanded this week in western Wyoming.

According to the Drought Impact Reporter, twenty-four out of twenty-eight counties in Utah were declared by the U.S. Department of Agriculture to be natural disaster areas resulting from drought, wildfires, and flash floods. In **Colorado**, a homeowner near Aspen has nailed strips of plywood over his windows and doors in an attempt to make his home less hospitable to black bears. The drought has reduced the bears' food supply of berries and acorns and has led them to seek out new food sources, such as people's garbage cans or kitchens. This year there have already been 877 accounts of bear-human conflicts in Colorado, whereas there were 502 incidents for all of 2006.

Upcoming Conference: The U.S. Drought Monitor Forum will be held in Portland, OR, October 10-11, 2007. Authors and users of the U.S. Drought Monitor will convene to discuss user needs and modifications to the tool. Registration is free, but attendance is limited. For information and registration: http://snr.unl.edu/ndmcsurvey/usdmforum.html.

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.

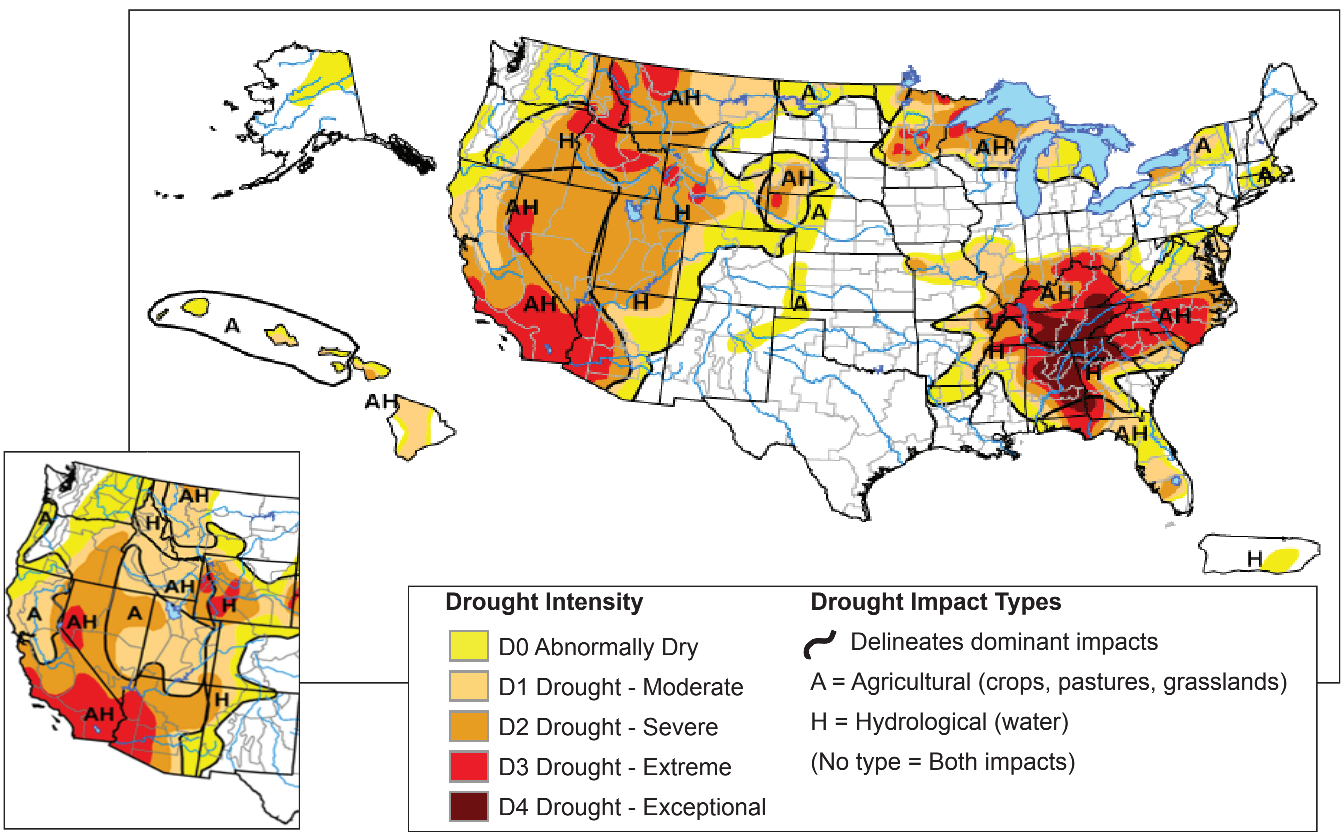


Figure 4. Drought Monitor from September 20, 2007 (full size) and the last summary, July 17, 2007 (inset, lower left) for comparison.

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/.

Regional Standardized Precipitation Index data through 8/31/07

The Standardized Precipitation Index is used to monitor moisture supply conditions. The distinguishing traits of this index are that it identifies emerging droughts months sooner than the Palmer Index, and that it is computed on various 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 features the 12-month SPI map, which has conditions through the end of August.

Since the July IMW Climate Summary, which had conditions as of the end of June, several of the climate divisions changed categories (Figure 5). Due to below average precipitation in the last two months in southwestern **Colorado**, the Arkansas River division moved from a very wet category to a moderately wet category. Three climate divisions in **Wyoming** moved into wetter categories due to above average precipitation. The Green and Bear division and the Upper Platte division changed from moderately dry to near normal, the Wind River division changed from very dry to moderately dry. There were no changes in the climate categories in **Utah** since the end of June 2007: western Utah is in dry categories and eastern Utah is in near-normal or wet categories.

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 5) 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 5 comes from the Western Regional Climate Center, which uses data from the NCDC and the NOAA Climate Prediction Center.

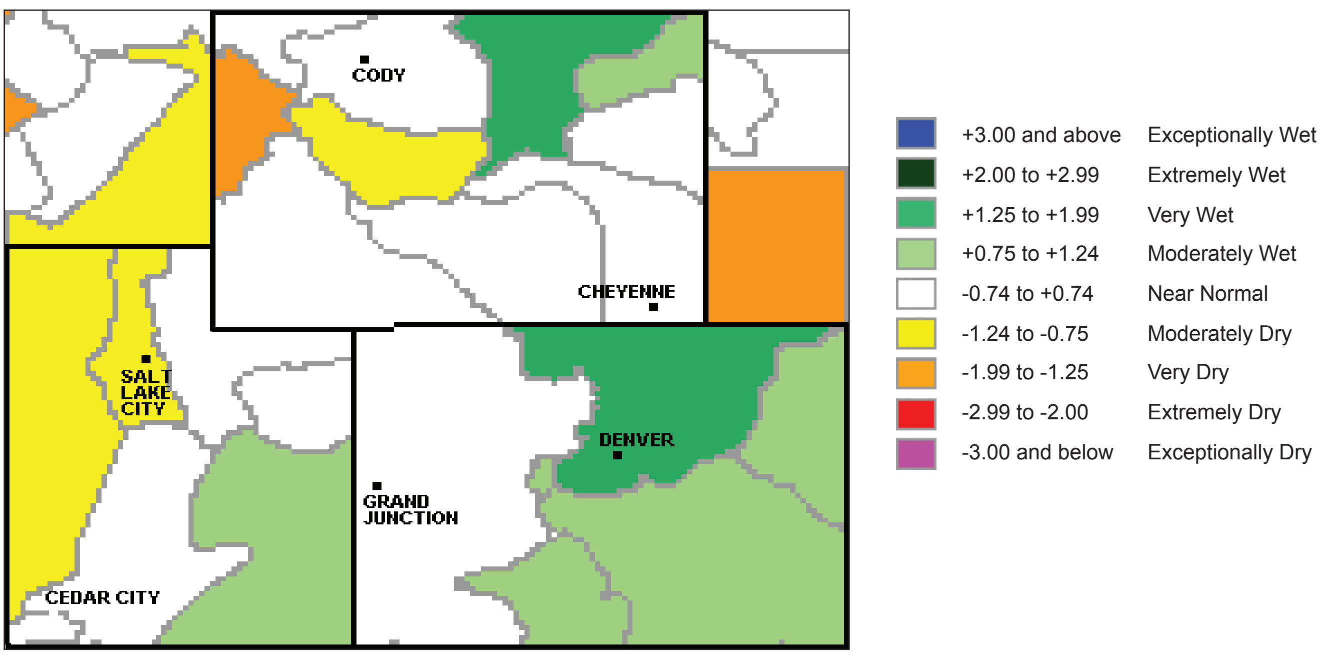


Figure 5. 12-month Intermountain West regional Standardized Precipitation Index (data from 9/1/06 - 8/31/07).

On the Web

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

In Colorado, the 2007 water year has been characterized by average to above average reservoir levels, above average snowpack and streamflows along the Front Range, and below average snowpack and streamflows across the west slope. As we move into the 2008 water year, precipitation, streamflow, and reservoir storage influence water supplies.

According to the NOAA Climate Predication Center, western and northeastern Colorado needs up to 3 inches of precipitation to bring the Palmer Drought Index value to near average (-0.5). Across eastern Colorado, PDI values are already in the near average category (-1.9 - 1.9) as of September 4 (Figure 6a).

Statewide streamflow volumes during the 2007 runoff season (April-July) varied, with gauges along the South Platte, Arkansas River, Rio Grande, San Miguel, Dolores, Animas, and San Juan River basin reporting volumes at near or above average categories, (25-75% of average). Below average streamflow volumes in April-July (< 10-24% of average) existed in the Yampa, White, and Gunnison basins. At the first of September, streamflows across most of Colorado are in the average (25-75% of average) and above average (76 - >90% of average) categories with the exception of streamflows in the Yampa, White, and Gunnison basins, currently flowing in the below average (< 10-24% of average) categories (Figure 6b).

According to a press release by the Colorado River Water Conservation District on August 8, despite the lack of a call on the river by the Shoshone Power Plant, a target flow agreement of 1200 cfs though Glenwood Canyon was made between reservoir operators and Upper Colorado River water users to protect endangered fish and sustain the rafting industry through Labor Day weekend.

In September, complete meltout has occurred, streamflows have returned to baseflows, and reservoirs have exceeded peak storage. On September 1, Dillon, Turquoise, Lake Granby, Blue Mesa reservoir storage was near or above average (99-122% of average). Blue Mesa is at 110% of average, and unregulated inflow for August was 75,000 acre feet and 116% of average. Blue Mesa is scheduled for maintenance in October, so a reduction in releases from Crystal is expected at the end of September. From now until the 2008 snowmelt season, reservoirs will be depleted until next spring runoff replenishes reservoir levels.

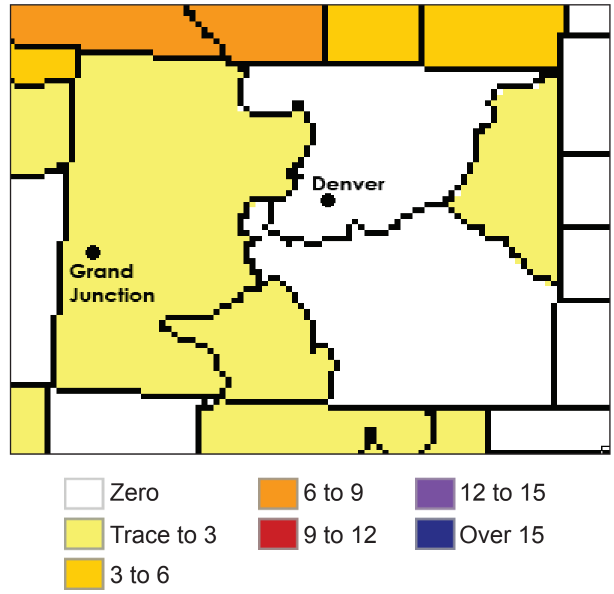


Figure 6a. Additional precipitation (in inches) needed in each climate division in Colorado to bring the Palmer Drought Index to near average values. Data as of September 4, 2007, NOAA Climate Prediction Center product.

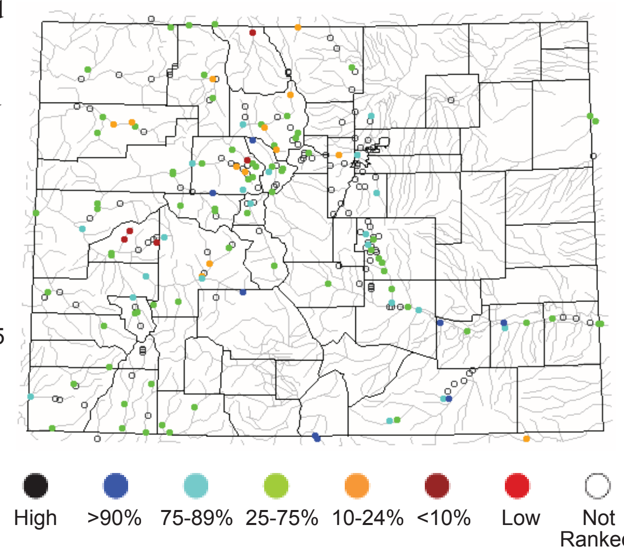


Figure 6b. 7-day average streamflow conditions for points in Colorado as of September 4, 2007, recorded at USGS gauging stations.

Notes

Figure 6a expresses drought conditions in terms of precipitation needed *in addition to average precipitation* to bring the weekly Palmer Drought Index to -0.5 (the near normal category). It is a somewhat artificial calculation, but provides users a conceptualization of the precipitation needed to end precipitation deficits in the next week. This calculation is made weekly for each climate division; if a given division receives above average rainfall in a week, the precipitation deficit is lower and the following week, the precipitation needed to bring the PDI to near normal conditions is likely to be lower. The PDI incorporates precipitation and temperature data as well as the current soil moisture conditions (for more information on the PDI, see the Feature Article in the July IWCS).

Figure 6b shows the average streamflow conditions for the past 7 days compared to the same period in past years. The "near normal" or 25th – 75th percentile class indicates that the stream flows are in the same range as 25 – 75% of past years. Note that this "normal" category represents a wide range of flows. Only stations having at least 30 years of record are used. These data are provisional and may be subject to significant change.

On the Web

- For weekly NOAA CPC maps of additional precipitation needed to bring PDI to normal for the continental US, like Figure 6a visit: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/addpcp.gif.
- "Agreement on the Colorado River maintains flows for endangered fish, rafting industry," Colorado River Water Conservancy District, August 8, 2007, available at: http://www.crwcd.org/page_292.
- For current streamflow information from USGS, Figure 6b, visit: http://water.usgs.gov/waterwatch/.
- The Colorado SWSI, along with more data about current water supply conditions for the state can be found at: http://www.co.nrcs.usda.gov/snow/index.html.
- For monthly reports on water supply conditions & forecasts for major CO river basins, visit: http://www.wcc.nrcs.usda.gov/cgibin/bor.pl
- Water Supply Outlook information for the Upper Colorado River Basin, produced by the Colorado Basin River Forecast Center, is available at: http://www.cbrfc.noaa.gov/wsup/wsup.cgi.

Wyoming Water Availability

The water supply conditions in Wyoming are below average, and even lower than they were at this time last year due to a below average winter snowpack and seasonal streamflows, and above average temperatures. As we move into the 2008 water year, precipitation, streamflow, and reservoir storage influence water supplies.

Precipitation since the start of the water year was between 90-50% of average across most of the state except the northern basins of Powder, Tongue, and Belle Fourche (see page 8 for precipitation graphics). According to the NOAA Climate Prediction Center, an additional 3-9 inches of precipitation is needed in most of the state, and 9-12 inches of precipitation is needed in northwestern Wyoming to bring the Palmer Drought Index to -0.5, representing average conditions (Figure 7a). Wyoming State Climatologist, Steve Gray, noted that precipitation in July and August was 150-200% of average across central and southern Wyoming, and "this provided short-term relief to the area, but was not sufficient enough to significantly recover current water supply deficits."

Statewide streamflow volumes were below average in June-August due to below average winter snowpack, with the exception of the Powder River basin. Streamflows on September 4 were in the near average category (25-75% of average) across eastern and southwestern Wyoming, and were in the below average categories (< 10-24% of average) across western basins including the Upper Yellowstone, Upper Snake, Upper Green, and Wind River basins (Figure 7b).

Reservoir storage at the end of August are below average, with Seminoe, Boysen, and Fontenelle currently at 38%, 71%, and 76% of average, respectively. Dr. Gray indicates that statewide water conditions will increase only if this winter brings above average snowfall and/or wet spring conditions.

The Wyoming Water Association's Education Seminar and Annual Meeting will be held October 31 - November 2 in Cheyenne, Wyoming. For more information about the conference, contact Executive Secretary John Shields at 307-631-0898 or wwa@wyoming.com.

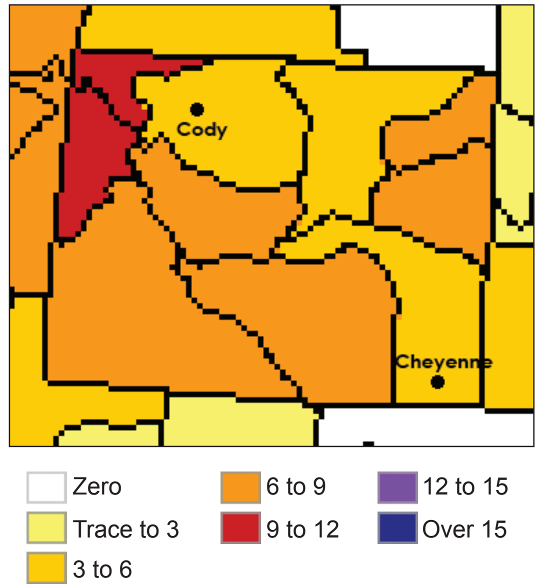


Figure 7a. Additional precipitation (in inches) in each climate division in Wyoming needed to bring the Palmer Drought Index to near average values. Data as of September 4, 2007, NOAA Climate Prediction Center product.

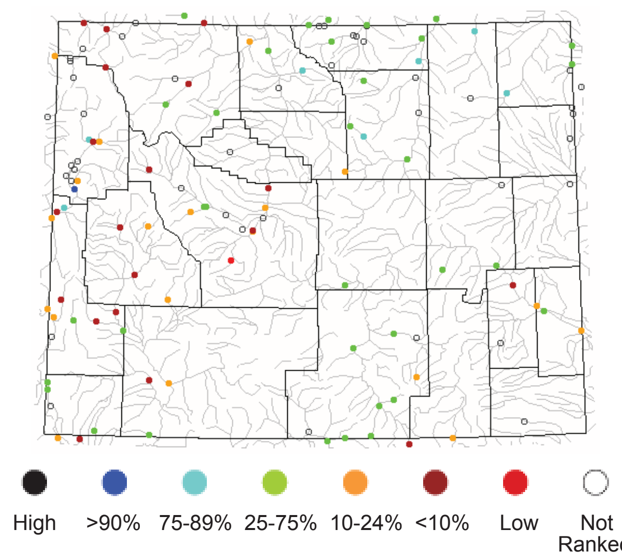


Figure 7b. 7-day average streamflow conditions for points in Wyoming as of September 4, 2007, recorded at USGS gauging stations.

Notes

Figure 7a expresses drought conditions in terms of precipitation needed *in addition to average precipitation* to bring the weekly Palmer Drought Index to -0.5 (the near normal category). It is a somewhat artificial calculation, but provides users a conceptualization of the precipitation needed to end precipitation deficits in the next week. This calculation is made weekly for each climate division; if a given division receives above average rainfall in a week, the precipitation deficit is lower and the following week, the precipitation needed to bring the PDI to near normal conditions is likely to be lower. The PDI incorporates precipitation and temperature data as well as the current soil moisture conditions (for more information on the PDI, see the Feature Article in the July IWCS).

Figure 7b shows the average streamflow conditions for the past 7 days compared to the same period in past years. The "near normal" or 25th – 75th percentile class indicates that the stream flows are in the same range as 25 – 75% of past years. Note that this "normal" category represents a wide range of flows. Only stations having at least 30 years of record are used. These data are provisional and may be subject to significant change.

On the Web

- For weekly NOAA CPC maps of additional precipitation needed to bring PDI to normal for the continental US like Figure 7a, visit: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/addpcp.gif.
- High Plains Regional Climate Center precipitation and temperature maps available at: http://www.hprcc.unl.edu/maps/current/.
- The Wyoming Drought Status map can be found on the Wyoming Water Resource Data system's drought page is located at: http://www.wrds.uwyo.edu/wrds/wsc/dtf/drought.html.
- For current streamflow information from USGS as in Figure 7b, visit: http://water.usgs.gov/waterwatch/.
- The Wyoming SWSI, 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.

Utah Water Availability

The 2007 water year in Utah has been characterized by persistent drought conditions due to below average winter snowpack, above average spring temperatures, and below average streamflows. Precipitation, streamflow, and reservoir storage influence the water supply picture for this time of year.

Precipitation averages for the 2007 water year are below average for all basins, 74-87% of average in most of the state except the Dirty Devil and Escalante basins at 95% and 103%, respectively (see page 8 for precipitation graphics). According to the NOAA Climate Prediction Center, despite above average precipitation in August, all climate divisions except the southeast still need at least 3-6 inches of additional precipitation to bring the Palmer Drought Index value to near average (-0.5) (Figure 8a).

Currently, streamflow volumes across the state are in the average (25-75% of average) and below average (< 10-24% of average) categories (Figure 8b). According to the NRCS, reservoirs did not fill due to average to below average streamflows in April-July across Utah. As a result, statewide reservoir storage was 60% of average at the end of August, ranging from a low of 30% of average for reservoirs in Bear River basin to a high of about 80% of average for Provo river basin. Lake Powell reached a seasonal peak of 51% of average and April-July unregulated inflow into Lake Powell was 51% of average as well.

The Utah Water Users Association Annual Water Summit Conference will be held on December 4, 2007, at Davis Convention Center in Layton, UT. For more information email Carly Burton at utahwaterusers@aol.com.

Notes

Figure 8a expresses drought conditions in terms of precipitation needed *in addition to average precipitation* to bring the weekly Palmer Drought Index to -0.5 (the near normal category). It is a somewhat artificial calculation, but provides users a conceptualization of the precipitation needed to end precipitation deficits in the next week. This calculation is made weekly for each climate division; if a given division receives above average rainfall in a week, the precipitation deficit is lower and the following week, the precipitation needed to bring the PDI to near normal conditions is likely to be lower. The PDI incorporates precipitation and temperature data as well as the current soil moisture conditions (for more information on the PDI, see the Feature Article in the July IWCS).

Figure 8b shows the average streamflow conditions for the past 7 days compared to the same period in past years. The “near normal” or 25th – 75th percentile class indicates that the stream flows are in the same range as 25 – 75% of past years. Note that this “normal” category represents a wide range of flows. Only stations having at least 30 years of record are used. These data are provisional and may be subject to significant change.

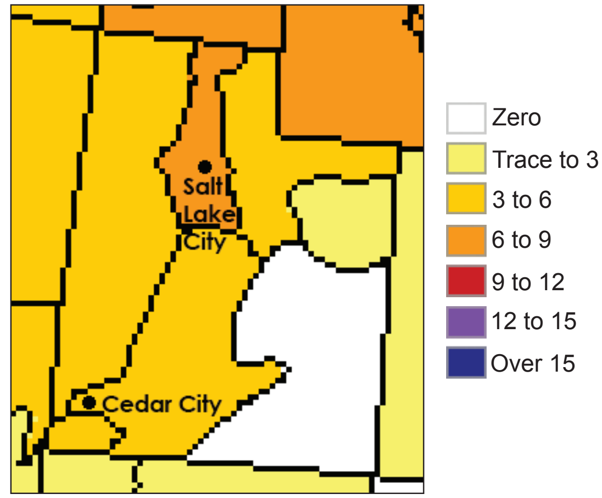
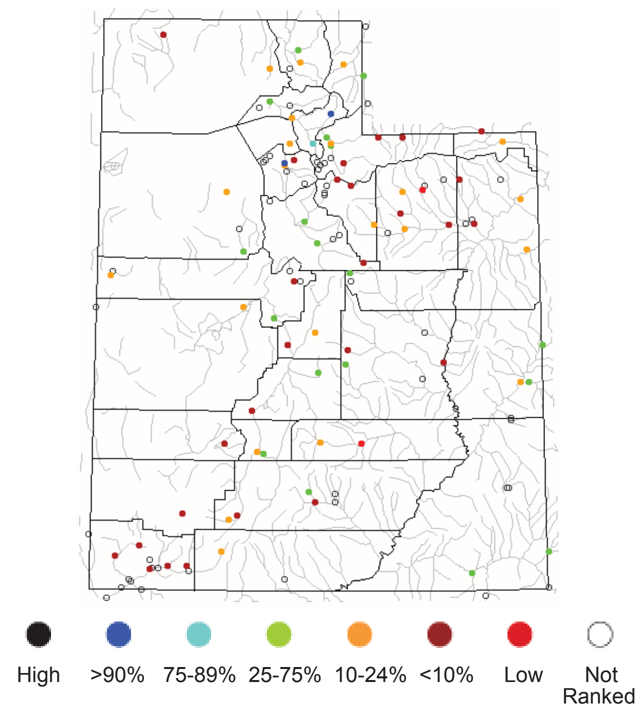


Figure 8a. Additional precipitation (in inches) needed in each climate division in Utah to bring the Palmer Drought Index to near average values. Data as of September 4, 2007, NOAA Climate Prediction Center product.



Figures 8b. 7-day average streamflow conditions for points in Utah as of September 4, 2007, recorded at USGS gauging stations.

On the Web

- For weekly NOAA CPC maps of additional precipitation needed to bring PDI to normal for the continental US like Figure 8a, visit: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/addpcp.gif.
- For monthly reports on water supply conditions & forecasts for major CO river basins, visit: http://www.wcc.nrcs.usda.gov/cgibin/bor.pl.
- For current streamflow information from USGS as in Figure 8b, visit: http://water.usgs.gov/waterwatch/.
- Utah NRCS Soil Moisture plots can be found at: http://www.ut.nrcs.usda.gov/snow/climate/.
- Utah NRCS SNOTEL Basin time-series summary graphics for the state or individual basins are at: http://www.ut.nrcs.usda.gov/snow/data/current/basin_charts.htm.
- For monthly reports on water supply conditions & forecasts for major UT river basins, visit: http://www.wcc.nrcs.usda.gov/cgibin/bor.pl.
- Water Supply Outlook information for the Upper Colorado River Basin, produced by the Colorado Basin River Forecast Center, is available at: http://www.cbrfc.noaa.gov/wsup/wsup.cgi.

Temperature Outlook October 2007 – February 2008

The NOAA Temperature Outlook for October 2007 shows no shift in the odds towards warm or cool for most of the Intermountain West (IMW) region ("EC," Figure 9a). The seasonal outlooks for October-December 2007 (OND) and upcoming seasons calls for an increased chance of above average temperatures over most of the U.S. including all of the IMW region (Figure 9b-d). The chances of above normal temperatures are above 50% for some parts of the Southwest over the upcoming winter, and are elevated due largely to the long-term trends and ongoing drought conditions. The increased chance of above average temperatures continues into the spring of 2008 (not shown, see CPC).

The seasonal outlooks for November 2007-January 2008 into the spring are based on a subjective blend of La Niña composites with the NOAA consolidated forecast tool. Long-term trends in temperature dominates the forecasts through much of the year and especially in winter. The La Niña composites in many areas of the country show below average temperatures – but not in the Intermountain West.

The October temperature forecast will be updated on September 30th 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 have increased skill over the half-month lead forecasts. The 3-month seasonal Outlooks will be updated next on October 18th.

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, or the near-average category is expected to be more likely than the other two. 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.

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

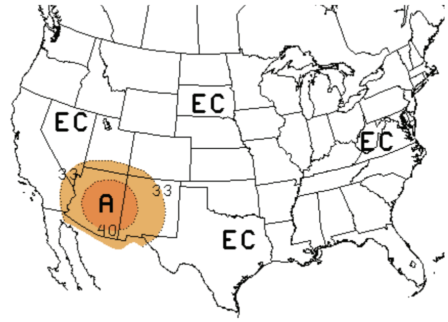


Figure 9a. Long-lead national temperature forecast for October 2007 (released September 20, 2007).

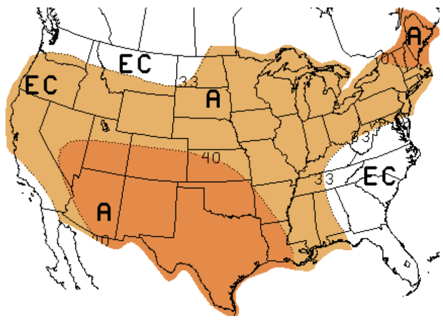


Figure 9b. Long-lead national temperature forecast for Oct. – Dec. 2007 (released September 20, 2007).

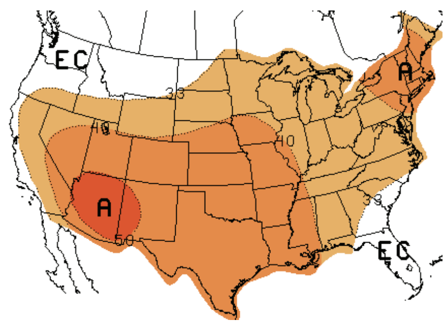


Figure 9c. Long-lead national temperature forecast for Nov. 2007 – Jan. 2008 (released September 20, 2007).

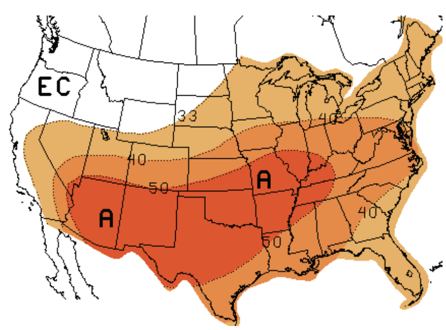


Figure 9d. Long-lead national temperature forecast for Dec. 2007 – Feb. 2008 (released September 20, 2007).

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 October 2007 – February 2008

The NOAA Precipitation Outlook for October 2007 anticipates an increased chance for dry conditions over the southwest, including southern **Utah** and most of **Colorado** (Figure 10a). Whether or not this dry outlook verifies depends on late season eastern Pacific tropical cyclone activity – these storms often bring precipitation to the region but are not forecastable with skill at half a month lead time. The October outlook will be updated on September 30th; the "zero-lead" forecasts (i.e. on the last day of the previous month) often have increased skill over the half-month lead forecasts.

The outlooks for October 2007 – February 2008 seasons are based on a subjective blending of the NOAA Consolidated Forecast Tool with composites of precipitation observed during similar past La Niña events (Figure 10b-d). Consistent with long term trends and typical La Niña impacts on the U.S., in the Oct. – Dec. 2007 season above median precipitation is expected in the Pacific Northwest (including western **Wyoming**) and a greater chance of below median precipitation is expected in the Southwest, including parts of **Colorado** (Figure 10b). This pattern of below average precipitation for the Southwest and parts of **Colorado** extends through the April-June 2008 season (not shown). For other areas of the IMW, the outlooks indicate "EC" or "equal chances" of above-average, near-normal or below-average precipitation for much of the region. The seasonal precipitation outlooks will be updated next on October 18th.

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 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, or the near-average category is expected to be more likely than the other two.

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.

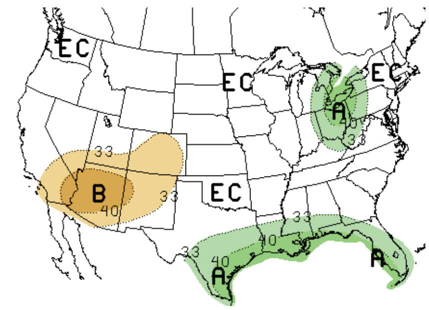


Figure 10a. Long-lead national precipitation forecast for October 2007 (released September 20, 2007).

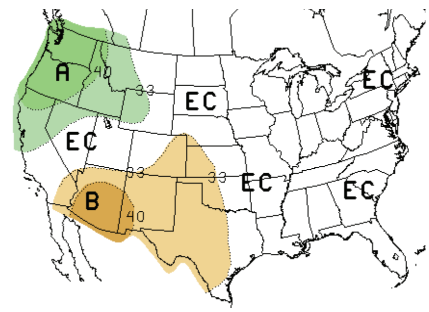


Figure 10b. Long-lead national precipitation forecast for Oct. – Dec. 2007 (released September 20, 2007).

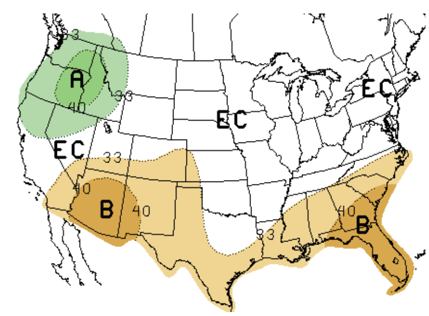


Figure 10c. Long-lead national precipitation forecast for Nov. 2007 – Jan. 2008 (released September 20, 2007).

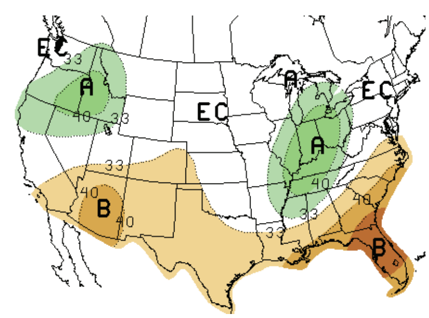


Figure 10d. Long-lead national precipitation forecast for Dec. 2007 – Feb. 2008 (released September 20, 2007).

EC = Equal Chances	A = Above	B = Below
	40.0–49.9%	50.0–59.9%
	33.3–39.9%	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 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 cont.

The experimental forecast guidance for the fall season (October-December) projects below average precipitation for Arizona and eastern Colorado, both regions where these forecasts have shown skill in the recent past (Figure 10e). This outlook is consistent with La Niña conditions, which are projected to continue into the late winter season (January-March 2008); La Nina winters also correlate with dry conditions in Arizona, eastern Colorado, and New Mexico. Near average precipitation is forecasted for the next six months in Utah and western Colorado. If this cold ENSO event does not last as long as projected, the winter could have more precipitation than this forecast.

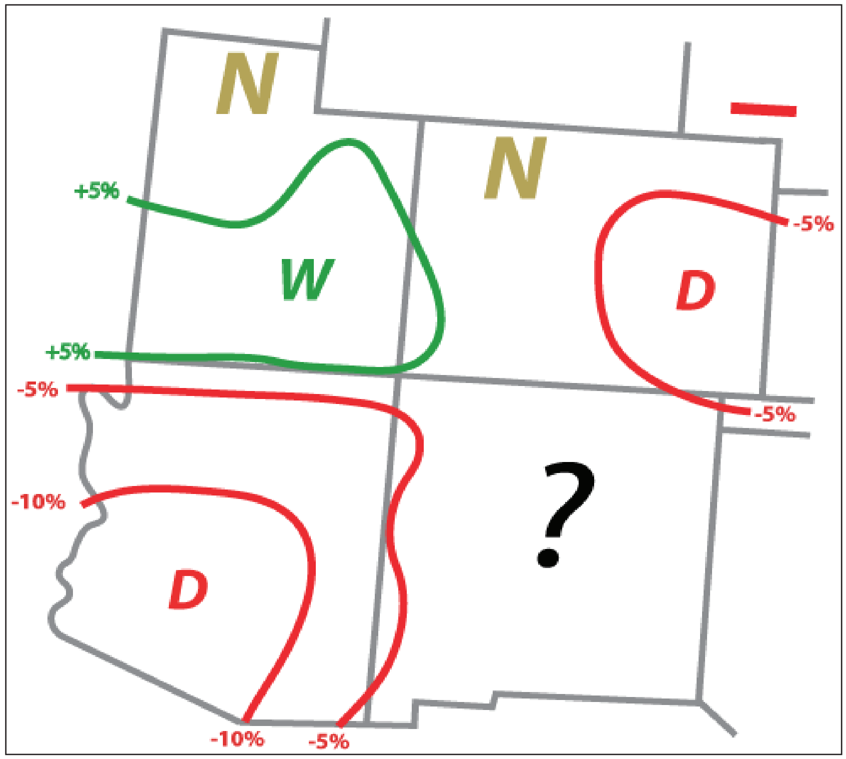


Figure 10e. Experimental Precipitation Forecast Guidance. Forecasted shifts in tercile probabilities for Oct. - Dec. 2007 (released September 12, 2007).

Notes

The experimental guidance for seasonal future precipitation in Figure 10e shows most recent forecast of shifts in tercile probabilities for October – December 2007. In order to be shown on this map, a forecast tilt in the odds has to reach at least 3% either towards wet (above-average), dry (below-average), or near-normal (average). Shifts towards the wettest (driest) tercile are indicated in green (red), and are contoured in 5% increments, while near-normal tilts of at least 3% are indicated by the letter "N". Shifts over 10% considered significant. Positive (negative) shifts between three and five percent are indicated by a green (red) plus (minus) sign, while minor shifts of one or two percent are left blank in this display.

On the Web

- The WWA 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 December 2007

With the development and expected persistence of La Niña conditions through the end of 2008, the current NOAA Drought Outlook (DO) is based more than recent DO's on precipitation anomalies that typically occur during La Niña events. The DO depicts general, large-scale trends through the end of December 2007 (3.5 months, Figure 11). This product projects changes in status of the U.S. Drought Monitor (USDM, see p. 9), which currently designates most of the western U.S. as in drought. To develop the DO each month, CPC experts start with the designations from the USDM, and consider the latest official forecasts through early October, the official October and October-December outlooks from the Climate Prediction Center, and climatological considerations.

Near term forecasts favor above-average precipitation across western **Wyoming**, thus, drought conditions are expected to improve there and in much of the Pacific Northwest. Modest improvement is forecast in a swath from central California eastward through northern **Utah**, northwestern **Colorado**, **Wyoming**, and the dry areas in the northern High Plains. Drought conditions are expected to persist in much of the Southwest, including southern **Utah**, because of the dry forecasts for the fall and at least early winter.

The next DO will be issued in two weeks, on October 4th. CPC is increasing the frequency of issuance of this product, which – until now – had been issued once a month on the 3rd Thursday with a valid period of about 3.5 months after issuance. As of this month, CPC will also issue the DO on the 1st Thursday of the month with a valid time covering the rest of the month plus the next two months (i.e. just under 3 months after issuance). This is designed to provide an improved and more consistent level of service.

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.

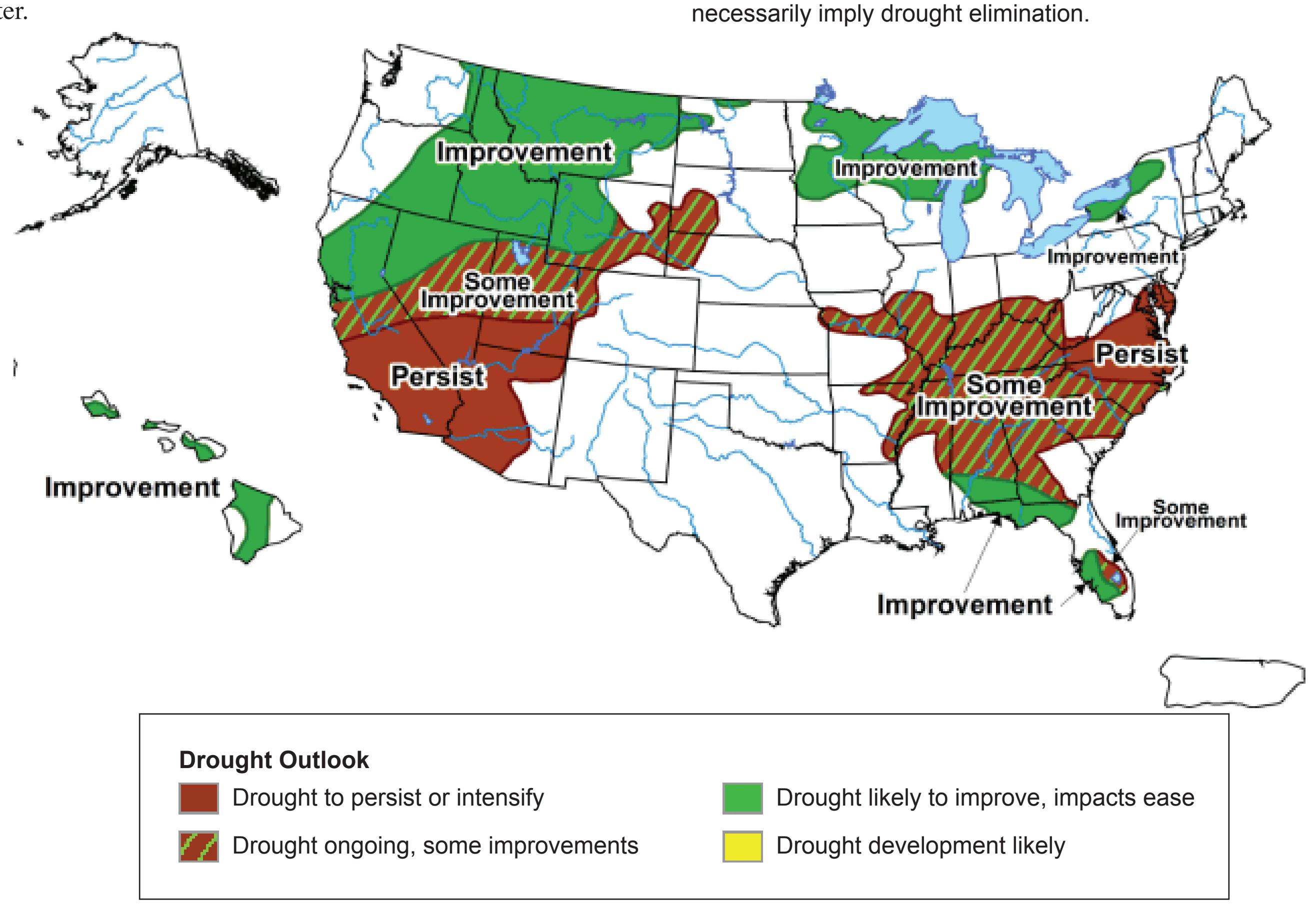


Figure 11. Seasonal Drought Outlook through December 2007 (released September 20, 2007).

On the Web

- For more information, visit: http://www.drought.noaa.gov/.
- Drought termination probabilities: http://www.ncdc.noaa.gov/oa/climate/research/drought/current.html

El Niño Status and Forecast

A La Niña is developing, according to a press release by the NOAA Climate Prediction Center (CPC) on September 6th (Figure 12a). The NOAA threshold for declaring an ENSO anomaly is when the 3-month mean SSTs for the Niño 3.4 region in the equatorial Pacific (see Notes) are more than ±0.5º C (0.9º F) different from the long-term average, 0.5º C below average for La Niña. As of September 20th, it is expected that this threshold will be reached for the July – September 2007 season. "While we can't officially call it a La Niña yet, we expect that this pattern will continue to develop during the next three months, meeting the NOAA definition for a La Niña event later this year," said Dr. Mike Halpert, CPC's acting deputy director, in the press release. La Niña refers to the occasional cooling of sea surface temperatures (SSTs) in the central and east-central equatorial Pacific that typically occur every three to five years.

Seasonal SSTs in the central Pacific are expected to be below the La Niña threshold through the January-March (JFM) 2008 season. The IRI, which collaborates with NOAA on these forecasts estimates the probability of a La Niña in the January-March 2008 period is 65% and the probability of El Niño conditions developing is near zero (Figure 12b).

La Niña conditions are anticipated to have some influence on the global and U.S. climate through the early part of 2008. Typically, the U.S. Southwest is drier than average during La Niña winters and the Pacific Northwest is wetter than average. The CPC ENSO Diagnostic Discussion and the IRI ENSO "Quick Look" will be updated next on October 11th and 19th, respectively.

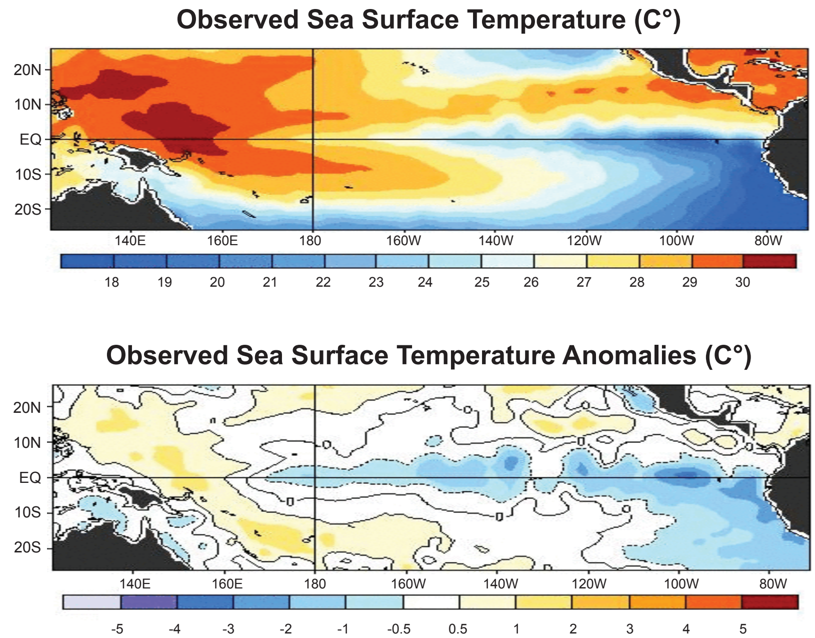


Figure 12a. Observed SST (upper) and the observed SST anomalies (lower) in the Pacific Ocean. The Niño 3.4 region encompasses the area between 120°W-170°W and 5°N-5°S. The graphics represent the 7-day average centered on September 12, 2007.

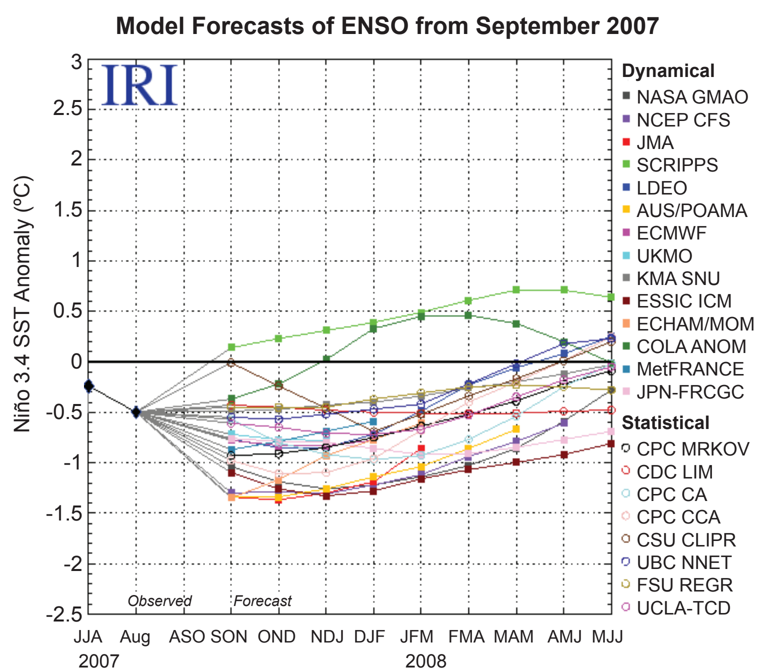


Figure 12b. Forecasts made by dynamical and statistical models for sea surface temperatures (SST) in the Niño 3.4 region for nine overlapping 3-month periods from September 2007 through July 2008 (released September 20, 2007). Forecast graphic is from the International Research Institute (IRI) for Climate and Society.

Notes

Two NOAA graphics in Figure 12a 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/.

The U.S. Hazards Assessment

By Christina Alvord, WWA and Edward O'Lenic, Climate Prediction Center

Introduction

The U.S Hazards Assessment (Assessment) forecasts potential natural hazards related to climate, weather and hydrologic events to assist emergency managers, forecasters and the public in disaster planning and preparedness. Developed in 1997 by Edward O'Lenic of the Climate Prediction Center (CPC), this product was developed as an early warning/monitoring tool after a strong El Niño in the winter of 1997-1998 caused considerable economic losses in the U.S. and elsewhere. Initially developed for extreme precipitation events, this product now includes temperature, wind, flooding, drought, wildfire, and ocean waves. This article describes the product and how it assigns hazard risks and the future development of the U.S. Hazards Assessment.

Hazards Assessment Map & Discussion

The Assessment is a weekly forecast map for the continental U.S. depicting potential weather-related hazards for the next 3-14 days (Figure 13). To develop the assessment, CPC forecasters use current conditions, official NWS medium- (3-7 day), extended- (8-14 day), and long- (1-month and 3-month) forecasts, and more than 15 other climatic and hydrologic products from NWS River Forecast Centers, USGS, the NWS Storm Prediction Center, and the NRCS. The Assessment designates risk areas for seven hazard categories: extreme precipitation, temperature, wind, drought, flood, wildfire, and wave events. A composite map shows different colored areas indicating the location and type of hazard forecasted; individual maps also are issued for each hazard category. A text discussion of current and projected conditions supplements the maps, and describes the hazards in the context of seasonal or long-term climate behavior. The latest maps, discussion, and information on methodology and applications are on the CPC Hazards Assessment website (see On the Web box).

Classification of Natural Hazard Risk

Hazard risk is based on threshold criteria, climatic and hydrologic data and projections, and user input. Threshold criteria are the basic framework of the Assessment. Based on analysis of historical data and trends, a specific value or set of conditions is assigned as the threshold criteria for each natural hazard category (Table 13). Risk is assigned when projected conditions exceed threshold criteria determined for each hazard category. For some hazards, such as wildfire and waves, where historical data are not always available to create thresholds, expert judgment by the forecaster supplements information gaps. The threshold criteria are not absolute in assigning risk; threshold values may be lowered when pre-existing conditions are expected to exacerbate the forecasted event. For example, the threshold value for characterizing precipitation risk is forecasted events in the 95th percentile.

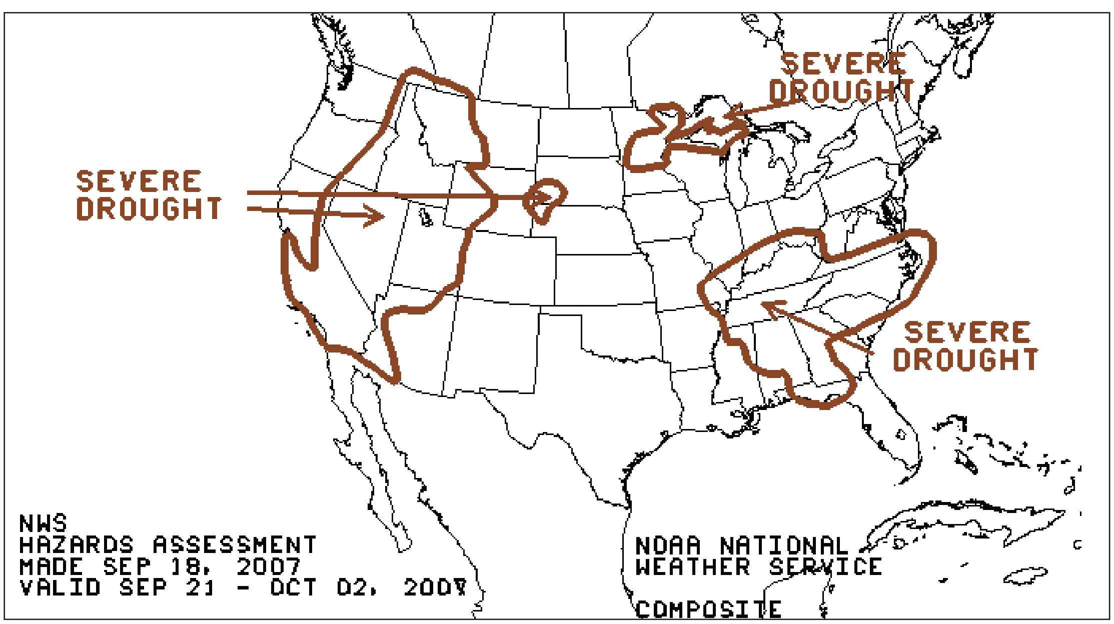


Figure 13: According to the U.S. Hazards Assessment composite map for September 21-October 2, 2007, risk of severe drought across the West, the Southeast and in Minnesota and Michigan is the only hazard assigned at this time.

However, in regions that are already experiencing saturated soils and above average precipitation, hazard forecasters could lower the precipitation threshold value to the 90th percentile or below for the forecasted period.

Climate and hydrologic processes are not uniform across the nation, so hazard forecasters select products that best characterize risk for a given region. For example, the causes of flooding are different in the eastern and western parts of the U.S. In the east, there is a higher risk of flooding year-round after above average precipitation falls in a short amount of time, while in the intermountain west, flooding risk is most pronounced in the spring if above average temperatures result in rapid snowmelt. Therefore, forecasters look at different weather parameters to determine flood risk in different parts of the country. When possible, Hazard forecasters place predicted weather events in the context of ongoing climate events, such as ENSO (El Niño Southern Oscillation), MJO (Madden-Julian Oscillation) and NAO (North Atlantic Oscillation), all of which can impact the frequency and strength of weather events over the continental United States. As a result, hazards are assigned, to some degree, based on expert analysis of conditions by the forecasters.

The risk of specific hazards is not assigned until forecasters gather input from agencies and users. Each Wednesday at 2 p.m. Eastern Time, a hazards forecaster hosts a conference call open to agencies, forecasters, or anyone interested in providing input into the upcoming Assessment. These calls give users and forecasters the opportunity to discuss the Assessment, to exchange ideas, and to respond to mutual concerns, questions, and comments from others in the community. Very often, users' suggestions are incorporated into the product. For example, user group input prompted including wildfire as a permanent risk category. To participate in weekly teleconferences, call 888-590-4933, (participant code: 3994107), Wednesday at 2:00 PM Eastern Time.

Future Development

The CPC is continually improving the Assessment. Edward O'Lenic, developer and director of the Assessment program, says that assigning probabilities of occurrence to each hazard category is an important next step, an they hope to begin adding probabilities to heavy precipitation forecasts . CPC would also like input from anyone who has ideas for enhancing the quality or utility of the product. You can contact the CPC about this product by calling during the weekly conference call or email Edward O'Lenic at Ed.Olenic@noaa.gov.

Natural Hazard Category	Threshold Criteria	Threshold Criteria Lowered When:
Precipitation	Events in the 95th Percentile	• Flooding • Heavy Mountain Snow • Saturated Soils
Temperature	Events that fall in the upper and lower 1/8th of the distribution (upper/lower 12.5%)	• Fire • Warm Season + Low RH (Relative Humidity) • Cold Season + Wind
Wind	34 mph winds for 1 hr 58 mph gusts	• Fire • Heavy Snow • Extreme Cold
Drought	D2 Drought Monitor classification (Severe Drought)	
Flood	USGS Flood Criteria	• Heavy Precipitation
Wildfire	D2 Drought Monitor classification during April-October	• Dry Lightening (thunderstorms which produce no rain at the surface) • High Winds • Extreme Heat + Low RH
Waves	Long Fetch (A large area in which ocean waves are generated by the wind)	• Strong on-shore Flow through Several Tidal Cycles

Table 13: U.S. Hazards Assessment threshold criteria for assigning risk are based on occurrence of extreme events for each hazard category (See the Notes for detailed explanation). Threshold values are lowered when current conditions in column three are present.

On the Web

- Weekly Hazard Assessment map and discussion: http://www.cpc.ncep.noaa.gov/products/predictions/threats/index.html.